


Developing Financial Intermediation Mechanisms for Energy Efficiency Projects in Brazil, China and India

Energy Efficiency Case Studies in Indian industries.

September, 2007

Preface

This report brings out a collection of case studies on energy efficiency projects successfully implemented in Indian industries, prepared by Confederation of Indian Industries (CII), as a part of activities under the *Three Country EE Project*. The objective is to disseminate information on innovative energy efficiency case studies successfully implemented by Indian industries to EE stakeholders. This is expected to motivate other similar plants to replicate innovative measures reflected in the case studies.

The CII holds an annual conference on *National Awards for Excellence in Energy Management* which has served as a forum for showcasing innovative EE projects in India. The case studies were selected mainly from winners of the CII awards in the preceding years. The report contains 50 case studies, of which 25 were funded through parallel USAID support.

The case studies were released by Mr. Shabbir Ali Mohd, Minister for Energy and Coal, Government of Andhra Pradesh during the CII *8th National Award for Excellence in Energy Management* competition on September 13, 2007. The event was well attended by heads of energy intensive industries, mangers from various industries, energy consultants, maintenance engineers, decision makers from financial and R&D institutions and educational institutions.

September 2007 UNEP Risoe Centre, Denmark

Case Study : 1

HEAT RECOVERY FROM THE HOT WATER SYSTEM OF TYRE CURING SECTION

Project Implemented by : Apollo Tyres Ltd, Limda, Baroda
Project Implemented in : 2005

Company Details

Apollo Tyres Limited is one of the leading tyre manufacturing industries in India. The company has operations all over India and having manufacturing units at Baroda, Pune, Perambra, and Kalamassery.

Apollo Tyres Limited was incorporated in the year 1972 and production was started in 1976. Apollo Tyres Limited, Limda unit has a plant capacity of 215 MT/day with a product range of Truck, Passenger, Light Commercial Vehicle, Rear Tract & Animal Driven Vehicle tyres.

Apollo Tyres Limited, Limda unit's main focus is to become the most modern plant in India with continuous expansion and reduction in energy cost.

Background:

At the tyre curing section, hot water was being pumped to process at 200 m^3/hr & 30 kg/cm^2 for process heating through a C/V (control Valve) station. The return water was collected in a HBD tank and it was pumped back to de-aerator through a BRW (Bag Return Water) pump at 8 kg/cm^2.

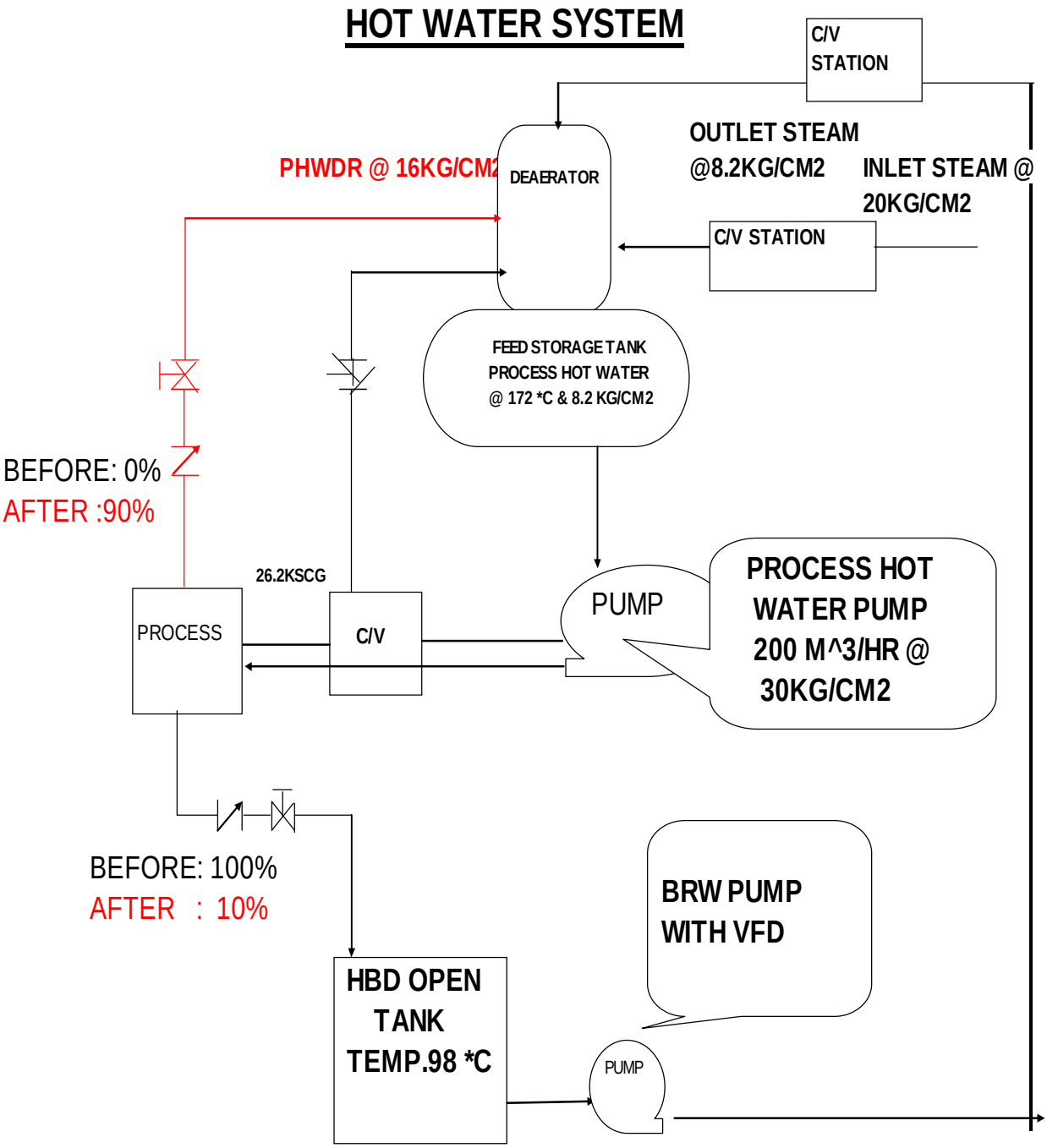
The HBD tank was an open tank at atmospheric pressure. This resulted in loss of heat in the HBD tank as flash team. As a part of the energy conservation initiatives, the plant team came up with a proposal to connect the return hot-water directly to the de-aerator.

Project Details:

Waste heat recovery and utilization is one of the major potential areas of energy conservation. Before the implementation of the project, substantial portion of the heat content present in return hot water was being lost as flash team at the HBD tank.

This heat was recovered, by connecting the process hot water return line to the de-aerator through a control valve at 16 kg/cm^2. This resulted in reduction in steam consumption in the de aerator. The quantity of water to be handled by the BRW pump also reduced. The power consumption of BRW pump also reduced, as it was operated at a lower RPM using variable speed control using a Variable Frequency Drive (VFD). Before modification, process steam consumption was 120 MT/day for tyre curing process and the flash steam losses were 50 MT/day.

A schematic diagram of implemented system is given below.



LEGEND

MODIFIED LINE

PHWR- PROCESS HOT WATER RETURN

PHWDR- PROCESS HOT WATER DIRECT RETURN

BRW- BAG RETURN WATER

Issues faced during implementation

No major issue was faced during the implementation of the project.

Comments from the Plant team

The project was identified by the plant team & implemented by a cross functional team comprising of process team and maintenance team. The process hot water return line to the de aerator was connected during a maintenance shut down. No major issues were faced during implementation. The project resulted in saving of steam as well as pumping Power.

Financing of the Project

The plant invested about Rs 0.9 million for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Implementation of the project "Heat recovery from Hot water system of Tyre Curing Section" resulted in reduced steam consumption in the de- aerator, reduced the fresh water make-up as well as reduction in power consumption of the BRW pump.

Steam consumption for process heating came down to 60 MT/day from the original 120 MT/day. Flash steam losses were almost eliminated. The reduced steam consumption, in turn, resulted in reduction in fuel consumption of the boiler to the extent of 4000 liters/day.

The annual savings achieved is Rs 0.78 million (0.0195 Million USD). The investment made for this project is Rs 0.90 million (0.0225 Million USD). The simple payback period is 14 Months.

Annual savings	– Rs 0.78 million (0.0195 Million USD)
Investment	– Rs 0.90 million (0.0225 Million USD)
Payback	–14 months

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Case Study: 2

INSTALLATION OF HT VFD FOR COOLER ESP FAN REPLACING SPRS CONTROL SYSTEM

Project Implemented by : Ultratech Cement Limited, A.P Cement Works
Project Implemented in : 2005

Company Details

Ultratech Cement Limited, a subsidiary of Grasim industries Limited, a group company of Aditya Birla Group is a leading manufacturer of Cement in India with installed capacity of about 17 million tons per annum.

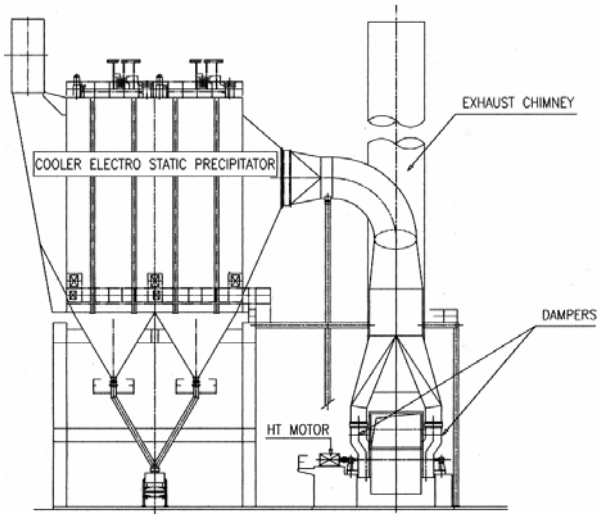
Ultratech Cement Limited is having 5 integrated manufacturing units, and 5 grinding units in all over India. They also own three bulk cement terminals, two in India, and one in Sri Lanka.

Ultratech Cement Limited, A.P Cement Works is operating at a capacity of 2.7 million tons per annum and mostly caters to the south Indian cement market.

Project Details

Fans are major consumers of power in Cement Industry. In this plant, the clinker cooler ESP (Electrostatic Precipitator) fan was operating with Slip Power Recovery system (SPRS) for speed control. While full speed of the fan is 475 rpm (revolutions per minute), the minimum speed of operation of the fan that could be achieved with SPRS control was 335 rpm. Any additional control requirement was done through regulation of damper. The damper inlet pressure was measured as -38 mmWC (Water column) while the pressure after damper was measured as -48 mmWC, thus resulting in a pressure drop of 10 mmWC across the damper. The fan was being driven by a 650 kW HT (High Tension) motor, operating at 6.6 KV.

The power consumption of the clinker cooler ESP fan was 190 KW. After SPRS recovery of 50 kW, the net power consumption of the clinker cooler ESP fan was 140 kW.



Features of HT Variable Frequency Drive

To further reduce the power consumption of the clinker cooler ESP fan, the plant team decided to install a HT variable frequency drive (VFD) to the fan. This would enable the plant team to have greater range of speed control. The energy loss due to control of the fan using damper, could be avoided.

After the commissioning of the HT VFD, the clinker cooler ESP fan operates at 50% speed with 100% damper opening.

The damper losses have been minimized and the regulation of the fan is only by speed control. This resulted in saving of 50 kW power.

Input T/F

Slim Inverter

Output T/F

HT Breaker

Fan HT Motor

Issues faced during implementation

No major issue was faced during the implementation of the project. The project could be implemented on line.

Comments from the Plant team

The project was identified earlier by the plant team during the course of a detailed energy audit. The same was taken up for implementation after a detailed feasibility study by the manufacturer of the variable frequency drive. No major issues were faced during implementation. The project was implemented during annual shut down.

Financing of the Project

The plant invested about Rs 0.35 million (USD 0.00875 Million) for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Implementing this project resulted in annual energy saving of 0.4 million kWh per year. This amounts to a saving of **Rs 0.12 million (USD 0.003 Million)** with an investment of **Rs 0.35 million (USD 0.00875 Million)** and had a simple pay back period of **36 Months.**

Annual savings	**– Rs 0.12 million (USD 0.003 Million)**
Investment	**– Rs 0.35 million (USD 0.00875 Million)**
Payback	**– 36 Months**

Contact Information of the plant

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Case Study : 3

PROVISION OF 2 BAR COMPRESSED AIR LINE IN PLACE OF 5 BAR COMPRESSED AIR LINE FOR PACKING PLANT AERATION

Project Implemented by : Ultratech Cement Limited, A.P. Cement Works
Project Implemented in : 2005

Company Details

Ultratech Cement Limited, a subsidiary of Grasim industries Limited, a group company of Aditya Birla Group is a leading manufacturer of Cement in India with installed capacity of about 17 million tons per annum.

Ultratech Cement Limited is having 5 integrated manufacturing units, and 5 grinding units in all over India. They also own three bulk cement terminals, two in India, and one in Sri Lanka.

Ultratech Cement Limited, A.P Cement Works is operating at 2.7 million tons per annum with a turnover of Rs.5 billions and mostly caters to the south Indian market.

Background:

Compressed Air is referred to as the fourth utility. The compressors are also 'all pervasive' and are present in every industrial sector, be it engineering, automobile, textile, Cement, etc. There is a potential to save about 15-25% energy in compressed air systems.

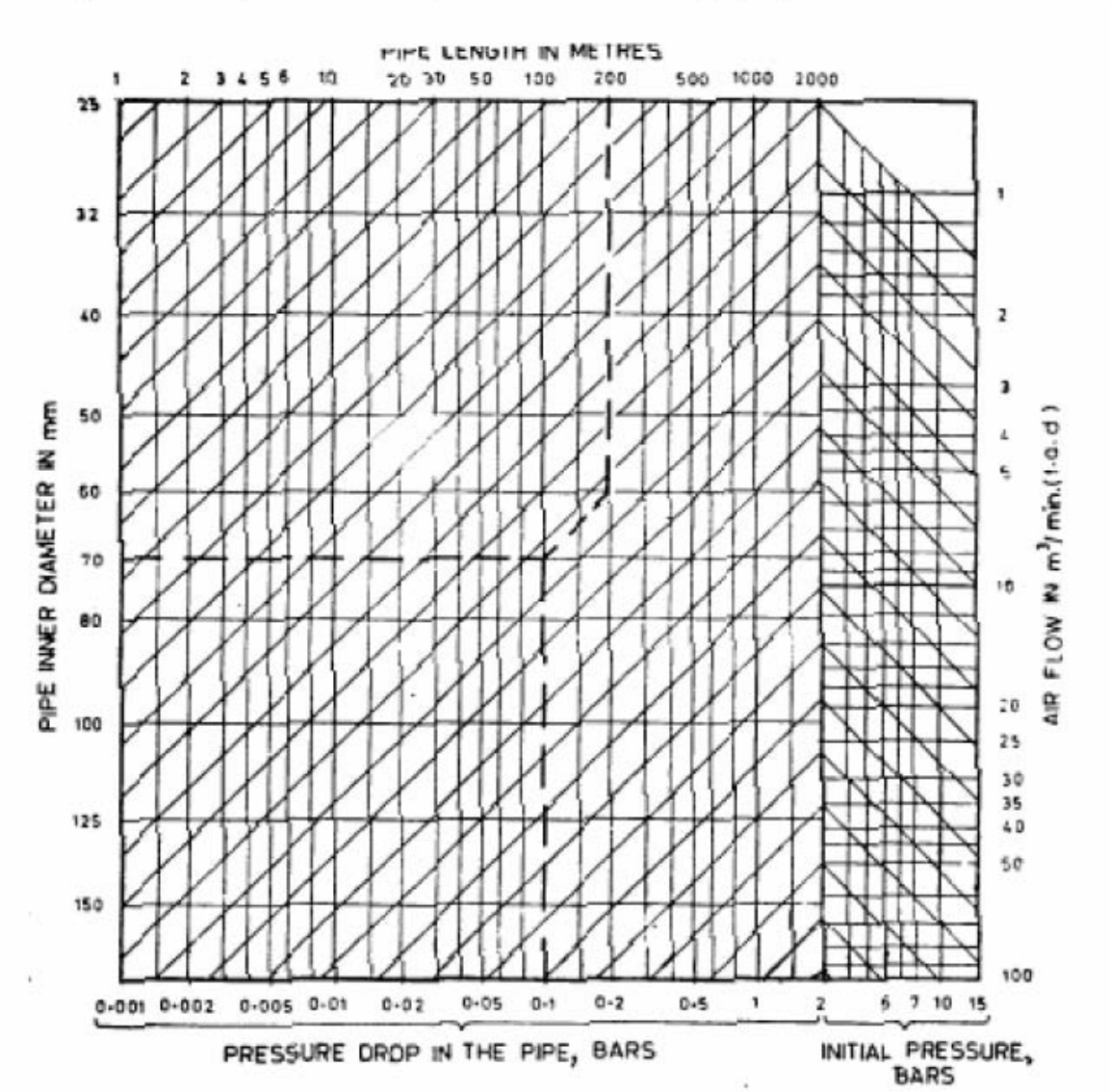
In a compressor, the power consumption is directly proportional to the operating pressure. Power consumption increases with increase in operating pressure and vice versa.

Also if the pressure drop is high in the distribution system, the operating pressure at the generation end has to be increased to match with the requirement. This results in increased power consumption of the compressor.

Velocities between 6 and 10 m/sec are usually maintained in compressed air mains. This velocity is sufficiently low to prevent excessive pressure drops on most systems and also will allow moisture to precipitate.

Pressure drop in a pipeline is dependant on the quantity of airflow, diameter of the pipe line, pipe length and pipe geometry i.e. bends in the pipe lines.

The pressure drop can be readily obtained from the graph given below.



Pressure drop in a pipeline
(Source: Indian Standards IS 6206 –1985)

The pipelines should therefore be designed with minimum number of joints, bends and fittings. It is also better to have the joints welded instead of flexible or screwed joints, as this facilitates minimizing the leakages and pressure drop.

The typical thumb rule regarding maximum pressure drop is that between the compressor plant and the farthest end of compressed air consumption the drop should not be more than 0.3 bar.

The above mentioned guidelines on pipe-line sizing were followed and wherever required the pipelines were modified to meet the requirements.

Project Details

The compressors in the packing plant were operating with an average pressure of 5 kg/cm^2. For aeration application, the maximum pressure required is only 2 kg/cm^2. For the application, volume of compressed air is the only criterion and not higher pressure. Hence, the power consumption of the compressor can be reduced by simply optimizing the generating pressure, to meet the demand.

Features of this project:

The project required only a small change in the setting of compressed air generation pressure from 5 bar to 2 bar. Minor modifications in compressed air piping were carried out.

Issues faced during implementation

No major issue was faced during the implementation of the project.

Comments from the Plant Team

The project was identified by the maintenance team and was taken up as a part of TPM activity (Total Preventive Maintenance).

Financing of the Project

The plant has invested about Rs 0.01 million for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

The project resulted in reducing the power consumption by 0.2 million kWh per year, which was equivalent to Rs 0.59 millions (USD 0.015 Million). The investment required is Rs 0.01 millions (USD 0.00025 Million) and the simple pay-back is less than one month.

Annual savings	– Rs 0.59 millions (USD 0.015 Million)
Investment	– Rs 0.01 millions (USD 0.00025 Million)
Payback Period	– Less than a month

Contact Information of the plant

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Case Study: 4

INTERCONNECTION OF ACW & VAHP SUMPS & DISCHARGE LINES SO AS TO SWITCH OFF ACW SYSTEM DURING FAVOURABLE WINTER CONDITIONS

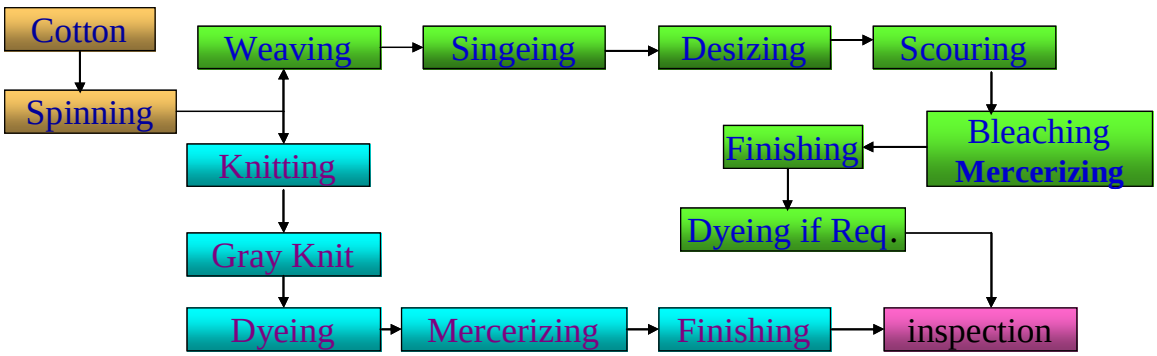
Project Implemented by : Arvind Mills limited, Santej Unit

Project Implemented in : 2005

Company Details

Arvind Mills Limited was established in the year of 1930. Arvind Mills Limited is the world's largest producer of Denim. Arvind Mills Limited also has Asia's largest effluent RO system and the first denim mill in the World to receive Eco-Tex Certification from Germany.

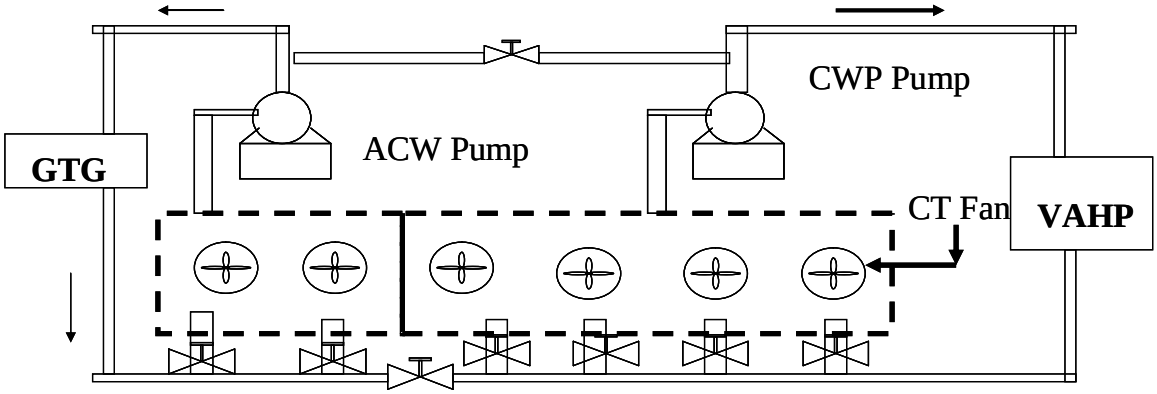
Process Flow sheet



Project Details

The cooling water system has two pumps connected to a common header. Two pumps namely ACW pump and CWP pump supply cooling water to all the end-users. One of the major users of the cooling water was the air compressors. In the winter season, it was observed that the cooling water flow through compressors is more than the required quantity.

The temperature difference (ΔT) across the end users were measured and were found to be between $1^{o}C$ and $2^{o}C$. Typically, all the end users are designed for a ΔT of 8-$9^{o}C$. The low ΔT value across the cooling tower indicated excess flow of cooling water to the users.



Based on all measured and calculated values, plant carried out a trial by stopping one of the pumps (ACW Pump). In winter CWP Pump alone caters to the entire demand & ACW Pump is switched off.

Features:

ACW & VAHP sumps & discharge lines have been interconnected. This has resulted in following benefits

1) In winter CWP system alone caters to the demand & ACW Pump is switched off.
2) Greater flexibility for operation.
3) Savings 241920 kWh of Power per annum.

Issues faced during implementation

No major issues were faced during the implementation of the project. The project could be implemented on line.

Comments by the Plant team

The project was identified during an internal audit exercise and has given excellent benefits.

Financing of the Project

The plant has invested about Rs 0.01million for implementation of the project. The investment was taken up fully with internal funds.

Results of the Project

The annual energy savings potential is Rs 0.77 Million (USD 0.020 Million). The investment required is Rs 0.01 Million (USD 0.00025 Million).

Annual savings	– Rs 0.77 Million (USD 0.020 Million)
Investment	– Rs 0.01 Million (USD 0.00025 Million)
Payback Period	– Less than a month

Contact Information of the plant

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Case Study: 5

REPLACEMENT OF ELECTRICAL HEATING OF BIN WASHING SYSTEM WITH LPG HEATING SYSTEM

Project Implemented by : Bajaj Auto Limited, Waluj
Project Implemented in : 2005

Company Details

Bajaj Auto Limited is one of the major producers of two wheelers and three wheelers in India, having 3 manufacturing units at Akurdi, Waluj and a state of the art plan at Chakan.

Bajaj Auto Limited is also a large exporter of two wheelers and three wheelers. In 2004-05 they sold around 1.875 million vehicles and achieved a turnover of Rs. 714 Billion.

Back ground:

Electric heaters convert nearly 100% of electricity into heat. But electricity is a form of "high quality heat" as it can be used for various applications. Hence the major disadvantage of electric heating is that cost of heating through this mode is comparatively higher compared to other modes of heating. Typically calculation of Rs/ MM Kcal enables comparison of different sources of heating. At Bajaj Auto Ltd, Waluj the power cost was Rs 3.5 per kWh & the cost of electric heating Rs 4200 / MM Kcal. The plant used a 36 kW heater in their bin washing machine of capacity 1000 liters, to heat water to a pre set temperature of 60^0C.

Project Details

This project mainly involved avoiding the electric heating for Bin washing machine and replacing it with natural aspirated LPG Heating System.

Advantages of LPG heaters:

LPG eliminates the environmental risks associated with fuel spillage and provides cleaner, convenient power for a range of heating equipment, with clear advantages over fuel oil and electricity. The portable LPG heater costs roughly the same to run as a conventional electric heater

The major advantage of LPG heaters is that the cost of heating with this mode is lesser compared to electricity. The calorific value of LPG is 13500 kCal/kg and that of electricity is 860 kCal/ kWh. Efficiency of thermal heating is lower, at 80 % where as with electricity the same is around 98 %. The cost of heating with LPG is around Rs.3200/MM kcal where as with electricity it is around Rs 4150/ MM Kcal.

Features:

The comparative cost of heat using electric heating & Thermal source (LPG) is as follows:

Cost of electric heating - Rs.4200/MM kCal @ Rs. 3.50/kWh

Cost of LPG heating - Rs.3200/MM kCal @ Rs. 25/Kg of LPG

This indicates that electrical heating is 1.3 times costlier than LPG heating for the same amount of heat output. The project takes advantage of this comparison and ensures cost savings due to switch over from electrical heating to thermal heating using LPG.

Issues faced during implementation

No major issues were faced during the implementation of the project. The project conceptualization took about 3 months. Implementation of the project and hooking up with the existing system was done during a weekly maintenance shut down.

Comments from the Plant team

The idea of using thermal source of heating instead of electrical energy came from the operation team. LPG was chosen as the source because it is a relatively “Clean” fuel.

Financing of the Project

The plant has invested about Rs 0.175 Million (USD 0.0044 Million) for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

The annual energy savings achieved due to implementation of the project was Rs 0.15 million (USD 0.0038 Million). The investment required is Rs 0.175 Million (USD 0.0044 Million) with a simple payback period of 15 months.

Annual savings	– Rs 0.15 million (USD 0.0038 Million)
Investment	– Rs 0.175 Million (USD 0.0044 Million)
Payback	–15 months

Contact Information of the plant

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Case Study : 6

HEAT RECOVERY FROM DG SET JACKET COOLING WATER

Project Implemented by : Century Rayon, Shabad, Maharastra
Project Implemented in : 2005 (Presented in 2005)

Company Details

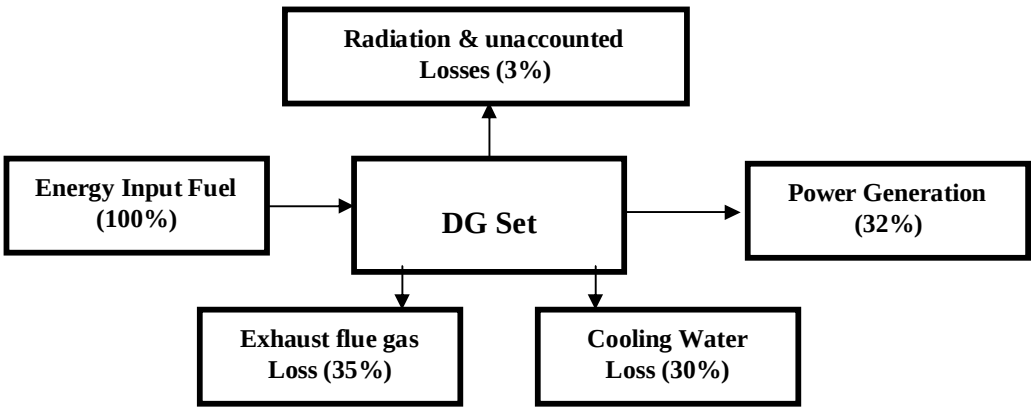
Century Rayon, Shahad (a B K Birla Group of company) an ISO – 9001 certified company – A unit of M/s Century Textile & Industries Ltd., commenced its operation in 1956 with an initial capacity of 5 Tons Viscose Filament Yarn.

Today after successive capacity expansion, Century Rayon is the largest Viscose Filament Yarn (VFY) producer in the country with approx 65 TPD productions of VFY and commanding 26 % of Indian VFY market. The quality of its yarn is well accepted in Indian market and acknowledged in several overseas markets.

The company is continuously striving to achieve excellence to keep it leadership position intact & shining in the world market through product supremacy by means of energy conservation, participative management practices and continuous improvement in all its activities .

Background:

This project mainly involves utilization of heat from D G jacket water
Typically, the energy balance of a DG set of this capacity would have the following heat dissipation:



The HT & LT water circuits in a DG set are cooled across heat exchangers. The heat dissipated across the cooling water is about 30% of input energy. This is a significant fraction of the total energy input to the DG set.

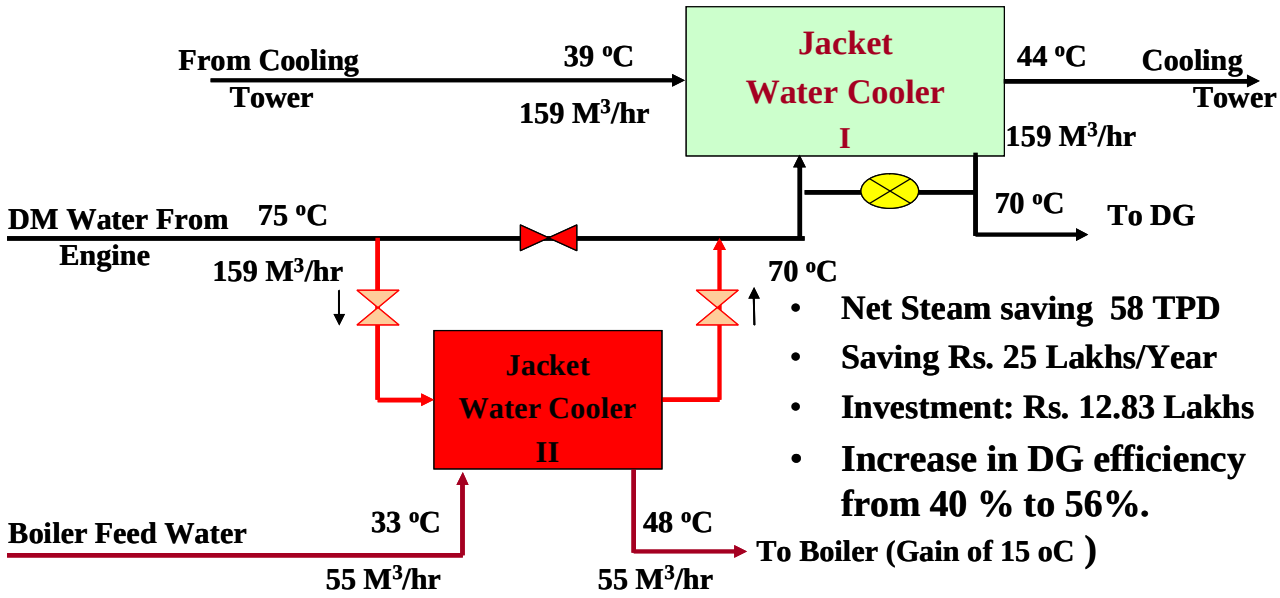
Project details:

DG jacket DM water was cooled from 75°C-70°C. The heat was rejected to the cooling tower with cooling water entering at a temperature of 39°C and leaving at 44°C to the cooling tower.

This heat content which was getting rejected in the cooling tower was used as a heat source to pre heat boiler make up water.

The boiler make-up water was originally entering the system at 330C. With the installation of this system, a significant amount of heat was transferred from DG jacket cooling to preheat boiler make up water and increase the temperature from 33 °C to 48°C.

The schematic is as illustrated below :



- **Net Steam saving 58 TPD**
- **Saving Rs. 25 Lakhs/Year**
- **Investment: Rs. 12.83 Lakhs**
- **Increase in DG efficiency from 40 % to 56%.**

Issues faced during implementation

No major issue was faced during the implementation of the project. The project could be implemented during the annual shut down.

Financing of the Project

The plant invested about Rs 1.28 million for implementation of the project. The investment was taken up fully with internal funds.

Results of the Project

The implementation of the project resulted in steam saving to the tune of 58 TPD and was equivalent to Rs 2.50 million (USD 0.0625 Million). The investment incurred was Rs 1.28 millions (USD 0.032 Million) with a payback period of 6 months.

Annual savings	– Rs 2.50 millions (USD 0.0625 Million)
Investment	– Rs 1.28 millions (USD 0.032 Million)
Payback	– 6 months

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Case Study : 7

COMBINED MODULATION OF ID FAN SUCTION VANE AND SCOOP (VARIABLE SPEED HYDRAULIC COUPLING)

Project Implemented by : Budge Budge Generating Station (BBGS), CESC Limited

Project Implemented in : 2005

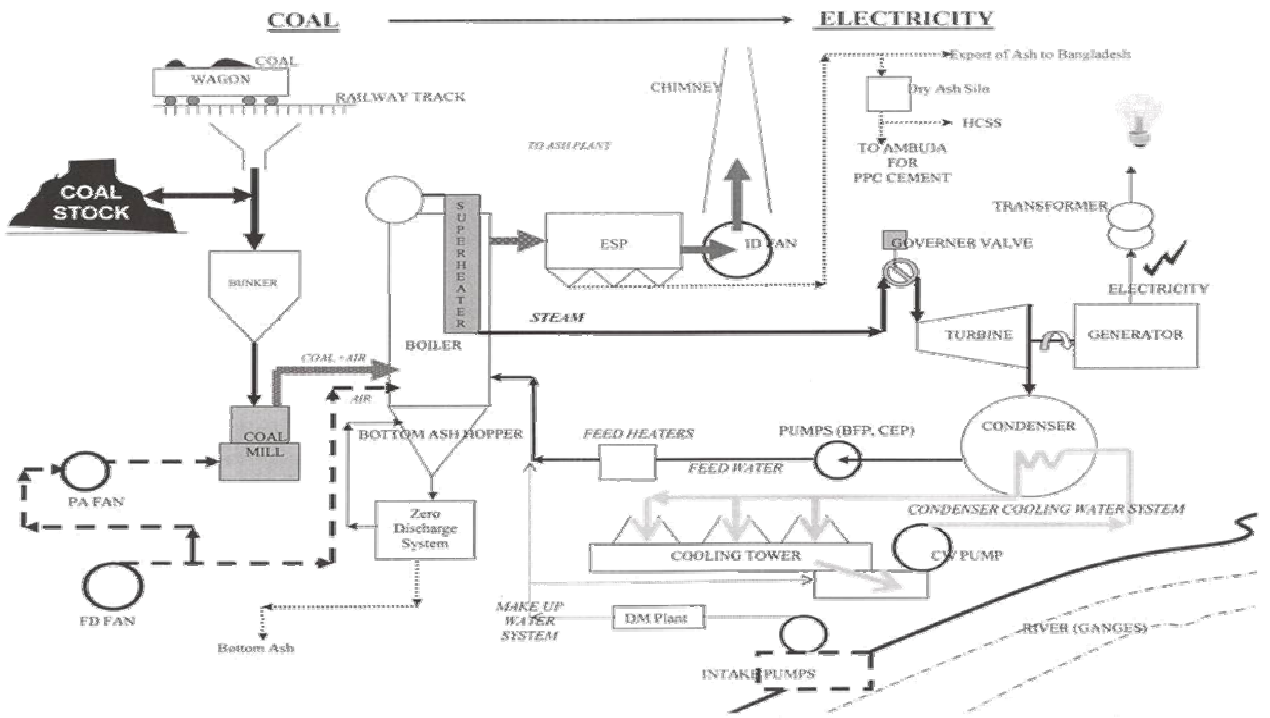
Company Details

CESC Limited, an RPG Enterprise, is in the business of generation and distribution of electricity since 1899. The Total Installed capacity of CESC limited is 975 MW comprising of 4 Generating Stations

Budge Budge Generating Station, one of the most modern generating stations of CESC is having a capacity of 2 x 250 MW and is the largest and the most modern thermal power station in CESC. BBGS has achieved a PLF (Plant Load Factor) of 103.96% in Aug-2005, and 103.67% in Sep-05 highest in the country for two consecutive months

Some of the notable features of BBGS include best efficient Low Nox downshot burner, High Concentration Slurry System, Dry Fly Ash Handling System and a Bottom Ash Re-circulating system.

Process Flow Diagram



Background

Suction vane control

In a Thermal Power Plant, the Boiler Induced Draft (ID) fans are controlled based on the furnace pressure. Typically these fans are provided with Guide Vanes (IGV) at the inlet and these IGVs are regulated to control the fan.

Project Details

At BBGS, ID fan control was being done using a combined modulation method involving both ID Fan suction vane and scoop (variable speed hydraulic coupling).Original configuration of Vane upper and lower limits were fixed at 55 % and 35 % as per OEM recommendation. When vane position reached the higher limit, scoop was increased and vice-versa.

A study conducted in the plant indicated that the ID Fan was consuming high energy due to inefficient operation. The Scoop was tending to open 100 % when vane was only 55 % open.

Based on the internal deliberations, CESC Limited adopted the solution such that Vane upper and lower set points made dynamic and dependant on scoop position.

Upper Dynamic Vane set point= [(scoop feed back x 0.406) + 40]

Lower Dynamic Vane set point= [(scoop feed back x 0.406) + 25]

Features modification of Furnace draft control loop - Fan vane and scoop control

Modification of this fan control system resulted in an Electrical energy saving due to efficient fan operation, 3.4 Million kWh, equivalent to Rs 9.2 Million (USD 0.23 Million) per annum

Issues faced during implementation

No major issues were faced during the implementation except some minor disturbances during the adjustments of scoop control. The project was implemented on line.

Comments from the plant team

The earlier control logic which led to inefficient operation of the fan was as suggested by the OEMs. The plant team analyzed the operation of other units operating with similar control system but no standard for modification of control logic was available. Under these conditions, plant team decided upon their own logic, keeping in mind the stability of process control.

Financing of the Project

This project involved only a modification in the control logic of the ID Fan & did not require any investment.

Results of the Project

Modification of this fan control system logic resulted in an Electrical energy saving due to efficient fan operation to the tune of 3.4 Million kWh, equivalent to Rs 9.2 Million (USD 0.23 Million) per annum.

Annual savings – Rs 9.2 Million (USD 0.23 Million)
Investment – Nil

Contact Information of the plant

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Case Study: 8

COMPUTATIONAL FLUID DYNAMICS CFD ANALYSIS & FLOW SMOOTHENING IN PREHEATER DOWN COMER DUCT FOR PRESSURE DROP REDUCTION

Project Implemented by : Dalmia Cements, Dalmiapuram
Project Implemented in : 2005

Company Details

Dalmia Cement is old of the old cement plants in India having started in 1939, with an installed capacity of 250 Tonnes per day. The plant has continuously upgraded the equipment, systems and technology to such an extent that it is one of the most energy efficient units in the country.

Also, in the year 1991, a Regional Training Centre sponsored by World Bank was established at the unit to cater to all Cement Plants, located in South India. A major capacity expansion project was taken up by the unit enhancing the capacity to 4200 TPD.

Dalmia Cements produces Oil Well Cement, Airstrip Cement, Railway sleeper Cement, and special cements like Coastal Cement,Superoof Cement, Super foundation Cement, Ordinary Portland Cement, Portland Pozzolana Cement.

Background

Fans are major energy consumers in Cement Industry. Fans in the cement industry usually have to handle large gas volumes as well as high pressure, high temperatures and high dust loading. The various applications of Fans include Raw and cement mill de dusting, Pre heater exhaust, Cooler exhaust and forced draft, Pre calciner and turbo separator and Coal grinding plants. One of the major reasons of higher power consumption in fans in the cement industry is the high pressure drop in various ducts.

Computational fluid dynamics (CFD) is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the millions of calculations required to simulate the interaction of fluids and gases with the surfaces used in engineering. CFD analysis could be employed to pinpoint high pressure drop zones in ducts.

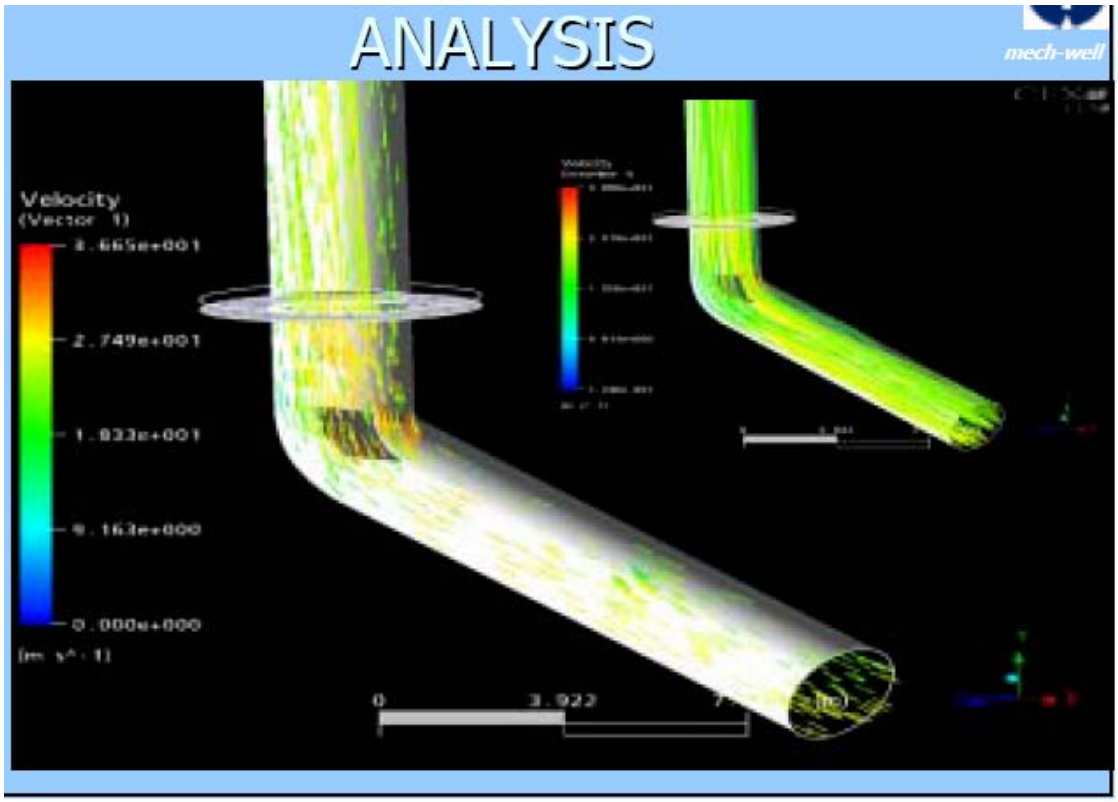
Project Details

The observations made on the Pre-Heater down comer duct are as follows:

High pressure drop of 110 mmWg was noticed over a length of 136 m. The velocity of gases was 19 m/sec.The typical pressure drop for a length of 136 m for this velocity should be in the range of 30 – 40 mmWg only. Therefore an additional pressure drop of 70 mm - 80mm Wg results in excess power consumption of both PH fans.

Additional pressure drop of 70 – 80 mmWg, is equivalent to 10 % of the total pressure raised by the fan. The power consumed by the fan is directly proportional to the pressure raised.

Computational Fluid dynamics (CFD) analysis was carried out to find out the exact reason for this excess pressure drop and also identify the methods for reducing the same.



It was observed that pressure drop was higher near the two bends, one at the top and other at the bottom. It was concluded that these bends cause turbulence due to improper flow & a higher pressure drop.

After the Computational fluid dynamic study flow distribution plates were installed at both bends (2 at the top and one at the bottom) of the duct. This has smoothened the flow resulting in a reduced pressure drop of 80 mmWg instead of the previous 110 mmWg.

Replication potential:

Third Party CFD analysis was carried out for pressure drop minimization, for the first time in the cement in dustry. Subsequently, at least 10 other plants have carried out similar studies and reaped benefits. There is a high Replication potential for CFD study in other plants as well as well as in other sectors where there are high pressure drops in various ducts.

Issues faced during implementation

CFD study and analysis was carried out when the plant was running in full capacity. The installation of flow diverter plates inside the ducts was done when the Plant was shutdown. Installation of the plates was done in a day.

Comments from the Plant team

The plant team was aware of the higher pressure drop in the pre heater down comer duct. The CFD analysis pin pointed the exact spot where modification needed to be carried out. The modification was done by the plant team. No major issues were faced during the project implementation.

Financing of the Project

The plant has invested about **Rs 0.5 Million (USD 0.0125 Million)** for implementation of the project. The investment was made fully with internal funds.

Results of the Project

Implementation of the project resulted in an annual energy saving of 0.6 million kWh. The annual cost saving achieved is **Rs 1.45 Million (USD 0.037 Million)**. The investment made was **Rs 0.50 Million (USD 0.0125 Million)** with a pay back period of **5 months.**

Annual savings	**– Rs 1.45 Million (USD 0.037 Million)**
Investment	**– Rs 0.50 Million (USD 0.0125 Million)**
Payback	**– 5 Months**

Contact Information of the plant

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Case Study: 9

STEAM GENERATION USING PARABOLIC SOLAR CONCENTRATORS

Project Implemented by : Kirloskar Copeland Ltd, Karad - Atit
Project Implemented in : 2006

Company Details

Kirloskar Copeland Ltd is one of the best manufactures of compressors especially Reciprocating Type Hermetically Sealed type Compressors. They will manufacture wide range of design specifications starting from $1/8^{th}$ HP to 40 HP.

The total production capacity is 10 lakhs compressors per annum and turnover for the year 2006 – 06 was Rs. 3400 millions. Kirloskar Copeland Ltd is one of the ISO 14001 certification company.

Kirloskar Copeland Ltd will market there products to national customers like LG ,UCPL, Blue Star, FLC, Godrej, Hitachi, Videocon, Carrier & SSI OEMs etc. and as well as internationally customers like SAMCO, AWAL, UNIONAIR, GREE etc.

Project Details

Against the back ground of dwindling availability of conventional energy sources like coal, oil and gas the plant looked at using Renewable energy for various applications, in tune with the corporate policy. Solar energy can be utilised to generate power through photovoltaic cells and generate heat through flat plate collectors or concentrators.

Solar concentrators:

Solar concentrators are the latest technology to capture the solar radiations as much as possible. As the name implies, concentrators are collects the solar radiation from all the direction and places at one place so that the total energy available will be maximum.

Parabolic Dish type collectors are generally used in solar power plants. A mirror shaped like a parabolic trough is used to concentrate sunlight on an insulated tube or a heat pipe placed at the focal point, containing coolant which transfers heat from the collectors to the boilers in the power station. Solar concentrators have the potential generate temperatures up to 400^0C. These can be used in the normal atmospheric conditions also where the maximum ambient temperatures are around 30^0C.

Ordinary flat plate solar thermal collectors are generally used to generate hot water. Flat plate collectors will generate temperatures only around 60 to 100^0C. The system contains of an insulated box equipped with black metal sheet built in pipes is placed in sun with an over head water tank. Solar energy heats up water in the pipes and it circulates through the tank automatically by convection. It is generally used in hotels and apartment complexes, to generate hot water

Steam generation:

Kirloskar Copeland Ltd uses 16 m2 area solar parabolic concentrator dishes to trap the solar rays. The trapped rays are concentrated on one point to generate the heat. The point will be the range of within a circle of 450 mm diameter (at circular receiver), at 5.5 m distance. A high optical temperature above 500-700^{o}C is generated.

Water flowing in the tubes is converted into steam at receiver. Parabolic Panels are designed in such a manner that the focal point of concentration remains fixed. To trap the solar radiations through out the day, these parabolic concentrators have to rotate in the direction of sun. Photovoltaic cells are in operation for providing power supply to these trackers to rotate.

Steam applications:

Since the steam generated in this process contains huge latent heat, steam is used as heating media for stator washing. The remaining steam is used for rotor bluing. The total heat content available is equivalent to 1, 50,000 kcal/ day. This steam replaces electrical heating to the tune of 175 kWh/ day.

Operating parameters:

- No. of concentrators = 4
- Heat generation capacity = 1,50,000 Kcal/day
- Average solar radiation = 750 W/m^2
- Efficiency of concentrators = 65%
- Area of each concentrators = 16m^2
- Average operating hours = 8 hrs per day
- Equivalent electrical energy = 45 KWh/ concentrator
- Total Equivalent electrical energy = 175 kWh / day

Financing of the Project

The plant was installed at a total cost of Rs.0.564 Million with 35% subsidy from Ministry of Non-conventional Energy Sources (MNES), Govt of India.

Issues faced during implementation

No major issues were faced during the implementation of the project. The maintenance requirements of the system are also few.

Comments from the plant team

The installation of steam generation system was taken up as a part of the initiative to increase utilization of renewable energy in place of using thermal sources like FO and LPG.

Results of the Project

This is the first industrial application in India and this project was appreciated & recognized by Maharashtra Energy Development Agency (MEDA). Installation of the parabolic concentrators has resulted in reduction of power consumption of 175 kWh per day.

The annual savings achieved is **Rs 0.15 Million (USD 0.00375 Million)**. The total investment made is Rs 0.564 Million (USD 0.014 Million)**.** 35% subsidy was availed from the Govt. The plant invested **Rs 0.37 Million (USD 0.009 Million).** The simple payback period for the amount invested by the plant works out to 30 months.

Annual savings	**– Rs 0.15 Million (USD 0.00375 Million)**
Investment	**– Rs 0.37 million (USD 0.009 Million)**
Payback	**– 30 Months**

Contact Information of the plant

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Case Study : 10

OPTIMISATION OF MILL AND COOLER FANS BY REPLACING OLD INEFFICIENT FANS WITH NEW FANS OF HIGHER EFFICIENCY

Project Implemented by : Dalmia Cements, Dalmiapuram
Project Implemented in : 2005

Company Details

Dalmia Cement is old of the old cement plants in India having started in 1939, with an installed capacity of 250 Tonnes per day. The plant has continuously upgraded the equipment, systems and technology to such an extent that it is one of the most energy efficient units in the country.

Also, in the year 1991, a Regional Training Centre sponsored by World Bank was established at the unit to cater to all Cement Plants, located in South India. A major capacity expansion project was taken up by the unit enhancing the capacity to 4200 TPD .

Dalmia Cements produces Oil Well Cement, Airstrip Cement, Railway sleeper Cement, and special cements like Coastal Cement, Super roof Cement, Super foundation Cement, Ordinary Portland Cement and Portland Pozzolana Cement.

Back ground:

Fans are major energy consumers in Cement Industry. Fans in the cement industry usually have to handle large gas volumes as well as high pressure, high temperatures and high dust loading. The various applications of Fans include Raw and cement mill de dusting, Pre heater exhaust, Cooler exhaust and forced draft, Pre calciner and turbo separator and Coal grinding plants. Several parameters like selection of fans having lesser efficiency (due to lower capital costs) & operation of fans at points other than the design operating point, contribute to energy inefficiency.

In centrifugal fans, for the maximum operating efficiency the operating point should be very close to the design point . Any mismatch in terms of operating pressure or capacity with the design pa rameters, would result in lower operating efficiency and would result in higher power consumption.

The reasons for lower operating efficiency could be over sizing of the fan, ageing and wearing out of impeller. This would result in lower pressure development, lower quantity of air delivery and lower efficiency.

The latest centrifugal fans are available with operating efficiency as high as 80%. Hence there is a good potential to save energy by replacing the existing fans with correct size high efficiency fans.

Project details:

During a study to measure the actual efficiencies of the fan the following parameters were measured.

- Actual Flow delivered by the fan in M3/ sec
- Actual Head developed in mm Wc
- Actual Power consumed in kW

Based on the actual site measurements it was estimated that the actual operating efficiencies of the VRM (Vertical Roller Mill) fan and Cooler vent fan are 44% & 18% respectively. The typical benchmark for efficiencies for these applications is 75%.

Further it was observed that there was a mismatch in the design head of the fan & the actual operating head. This resulted in operating point of the fan shifting to an inefficient zone on its performance curve.

Thus, Plant team traced out that there is a very good potential for energy saving by installing a new correct size of high effic iency in place of existing VRM and cooler vent fan. New higher efficiency fans were installed in place of old fans.

FAN	Effi.old fan %	Effi. new fan %	Investment Rs(in Lakhs)	Power saving, Kwh / hr	Annual power saving Rs (in lakhs)
VRM fan	44	75	15	80	19.6
Cooler Vent fan	18	70	15	90	25.2

Issues faced during implementation

No major issues were faced during the implementation of the project. The fans were made ready and kept in the assembled condition at site . The fans were hooked up during the annual shut down maintenance.

Financing of the Project

The plant invested Rs 3.00 million (USD 0.075 Million) for implementation of the project. The investment was taken up fully with internal funds

Results of the Project

By installing new high efficiency fans energy savings to the tune of 80 kW was obtained in VRM fan and 90 kW in cooler vent fan. This translates to a financial saving of Rs 4.60 million (USD 0.115 Million). The investment incurred was Rs 3.00 million (USD 0.075 Million), with a pay back period of 8.0 Months.

Annual savings – Rs 4.60 million (USD 0.115 Million)
Investment – Rs 3.00 million (USD 0.075 Million)
Payback Period – 8 Months

Contact Information of the plant

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Case Study: 11

REPLACE EDDY CURRENT DRIVE FOR CANE CARRIER WITH VARIABLE FREQUENCY DRIVE

Project Implemented by : GMR Sugars, Sankili
Srikakulam District, Andhra Pradesh
Project Implemented in : 2004

Company Details

GMR Industries sugar division is a modern sugar plant which started its production in 1997. It has a cane crushing capacity of 5000 tons per day with 16 MW co-generation plant and 45 kilo litres per day (KLPD) capacity distillery unit. More significantly, this plant has brought rapid economic development to Srikalulam District, a remote area in the state of Andhra Pradesh. The company uses the most advanced technology to produce two grades of superior quality sugar i.e. M - 30 and S - 30. The unit also installed the first full fledged Co-generation plant in Andhra Pradesh state with an installed capacity of 16 MW.

Project Details:

Conventionally, Eddy current drives were used for varying the speed of cane carriers in sugar plants. Eddy current drive is an electromechanical device, which operates on eddy current principle. In the eddy current drive, speed is varied by varying, the field of the electromechanical clutch. Since the speed is externally controlled, the operating efficiency of eddy current drive is around 65 – 70% only. A 55 kW eddy current drive was used for varying the speed of the cane carrier at GMR Industries, Sugar Division.

Present trend is to use Variable Frequency Drives (VFD) for controlling the speed of induction motors. The speed of the induction motors is varied by varying the supply frequency. The operating efficiency of VFD's is around 96 – 98%. Hence, there is an improvement in operating efficiency of the equipment by replacing the Eddy current drive with Variable Frequency Drive.

The plant team has replaced the 55 kW Eddy current drive with 55 kW Induction motor with a variable frequency drive for the cane carrier during their planned shutdown of the plant. The maintenance and the project team of the plant were involved in implementation of the project.

Issues faced during implementation

No major issue was faced during the implementation of the project.

Comments by the plant team

VFD's have high potential for various applications in sugar industry. Cane carriers and conveyors are constant torque loads; the cooling of the motor gets affected if the speed of the motors is below 50% for longer time. If the speed of the motor is below 50% speed for a longer time, it is recommended to install one frame size higher motor or inverter duty motor.

Financing of the Project

The plant has invested about Rs. 0.46 Million for implementation of the project. This investment is for VFD and the motor. The investment was taken up fully with internal funds.

Results of the Project

Installation of the variable frequency drive for cane carrier has resulted in power saving of 27.1 kW. The power saved by implementing the project helped in increasing the export of power to the grid to the extent of 97,200 kWh/ year.

The monetary benefit to the plant is Rs 0.32 Million (USD 0.008 Million) considering 3600 hours of operation per annum and power export cost of Rs.3.32/kWh. The investment required for the project is Rs 0.46 Million (USD 0.112 Million). The simple payback period is 17 Months.

Replication Potential

Similar replacement is possible in several sugar plants, where Eddy current drives are used for cane carrier, Elevator cane carrier and feeding cane carriers.

Similar potential exists in other sectors like, Pulp & paper, Engineering, Automobile, ceramics etc, where Eddy current drives are used for various applications.

Annual savings	–Rs 0.32 Million (USD 0.008 Million)
Investment	–Rs 0.46 Million (USD 0.112 Million)
Payback	–17 Months

Contact information of the plant

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Case Study: 12

BIOMETHANATION (UASB) TREATMENT OF BAGASSE WASH WATER: AN ENVIRONMENT FRIENDLY PROCESS FOR GENERATING ENERGY FROM WASTE

Project Implemented by : Tamilnadu Newsprints and Papers Limited, Karur, Tamilnadu

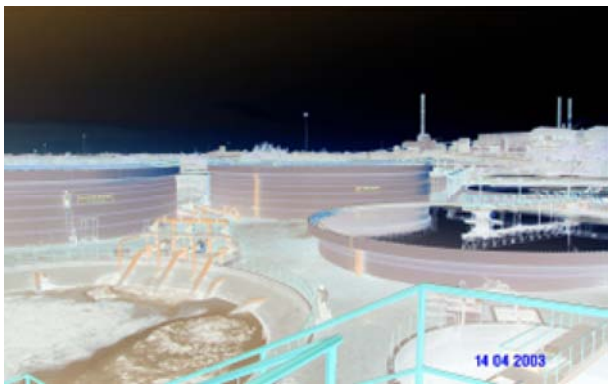
Project Implemented in : 2003

Company Details

TNPL was set up in 1984 to manufacture newsprint/fine paper using bagasse as primary raw material. TNPL is the largest integrated Paper mill in India, in a single location with a production capacity of 230,000 tpa. By utilising bagasse on a large scale, the mill conserves around 30,000 acres of forest land from commercial exploitation for pulping. TNPL is an ISO14001 and ISO9001; 2000 certified company.

Project Details

Bagasse is the primary raw material in paper making at TNPL. Substantial amount of waste water is generated from bagasse storage yards and bagasse preparation process. The waste water generated from this process is having high BOD (Biological Oxygen Demand) content.



Anaerobic Digestion:

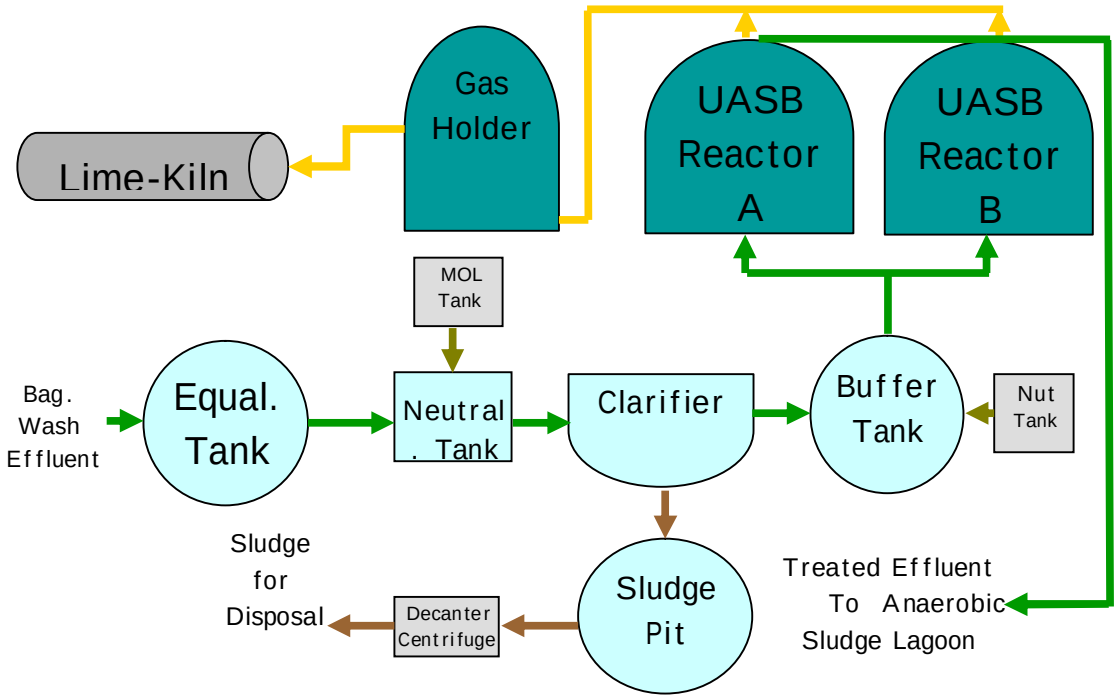
In conventional anaerobic digestion, the biodegradable pollutants in the wastewater are converted to biogas containing methane, carbon dioxide and biomass (little) in the absence of oxygen by Anaerobic microorganisms. The net energy generated during anaerobic digestion

process is in the form of methane (CH_4) bearing biogas and CO2. These gases are emitted in to atmosphere without any useful work.

Controlled Anaerobic Digestion (UASB - up flow anaerobic sludge bed)

This high BOD waste water is taken through a mechanical bar screen to a primary clarifier to settle suspended solids. It is then treated in a UASB (Upflow Anaerobic Sludge Bed) reactor followed by the process of settling in a secondary clarifier.

The process flow diagram of the system is given below:



The bio-gas generated from the plant is utilised in the Lime Kiln to partially replace the expensive Furnace Oil.

Financing of the Project

The plant was installed at a total cost of Rs.40 Million with 50% subsidy from Ministry of Non-conventional Energy Sources (MNES), Govt of India as a demonstration projects under GEF sponsored high rate biomethanation process for waste to energy Projects .

The plant invested remaining 50% of the project cost from its internal fund.

Issues faced during implementation

The pressure variation between furnace oil and biogas line disturbed the biogas firing in the kiln. This problem was solved by the addition of pressure control valve in biogas line and by regulating biogas flow the lime kiln.

The biogas generated from the UASB is having high moisture content. This has resulted in condensing of water in the pipe line. This problem was rectified by the addition of moisture trap at lime kiln.

The problem of sludge wash-out from reactors was observed due to variation in flow and COD. Additional Storage/Equalization tank was constructed to regulate the flow and COD.

Comments from the Plant team

Environment impact reduction should also be a key aspect of plant operation. Wherever possible, the industry should identify and implement environment impact reduction projects in a cost effective manner.

Results of the Project

Installation of biomethanation plant has resulted in both environmental and energy saving benefits.

Environmental Benefits

Description	Unit	Value
Reduction of Pollution Load		
Waste water treated	M^3/Year	3,052,431
COD Reduction	M^3/Year	9092
Reduction in GHG Emission		
Methane avoidance	MT CO2e/Y	47500
Fuel Saving	MT CO2e/Y	9500
Total	MT CO2e/Y	57000

Economical Benefits

Description	Value
Average Biogas Generation	15,000 M3/Day
Avg. F. Oil saving in lime -kiln	9,000 Lit/Day
F.Oil Cost	Rs. 11.50/Lit
Saving against F. Oil	Rs.103,500 / Day
Plant Operation Cost	Rs. 35,000 / Day
Net Saving	Rs. 68,000 / Day
Annual Saving	Rs. 24 Million

Annual savings – Rs 24 Million (USD 0.6 Million)
Investment – Rs 20 Million (USD 0.5 Million)
Payback Period –10 Months

Contact Information of the plant

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Case Study: 13

REPLACEMENT OF EXTRACTION CUM CONDENSING TURBINE WITH BACK PRESSURE TURBINE

Project Implemented by : Thai Acrylic Fibre Company Ltd. Thailand
Project Implemented in : 2003

Company Details

Thai Acrylic Fibre (TAF), the only manufacturer of Acrylic Fibre in the Asean region, is one of the flagship companies of the Aditya Birla Group. The company's installed capacity of acrylic fibre is 100,000 MT per annum. TAF is ISO 9001:2000, 14001 and OHSAS 18001 certified plant.

The plant has a total Co-generation capacity of 27 MW which is sufficient to meet the power requirement of the plant. The plant also exports power to national grid.

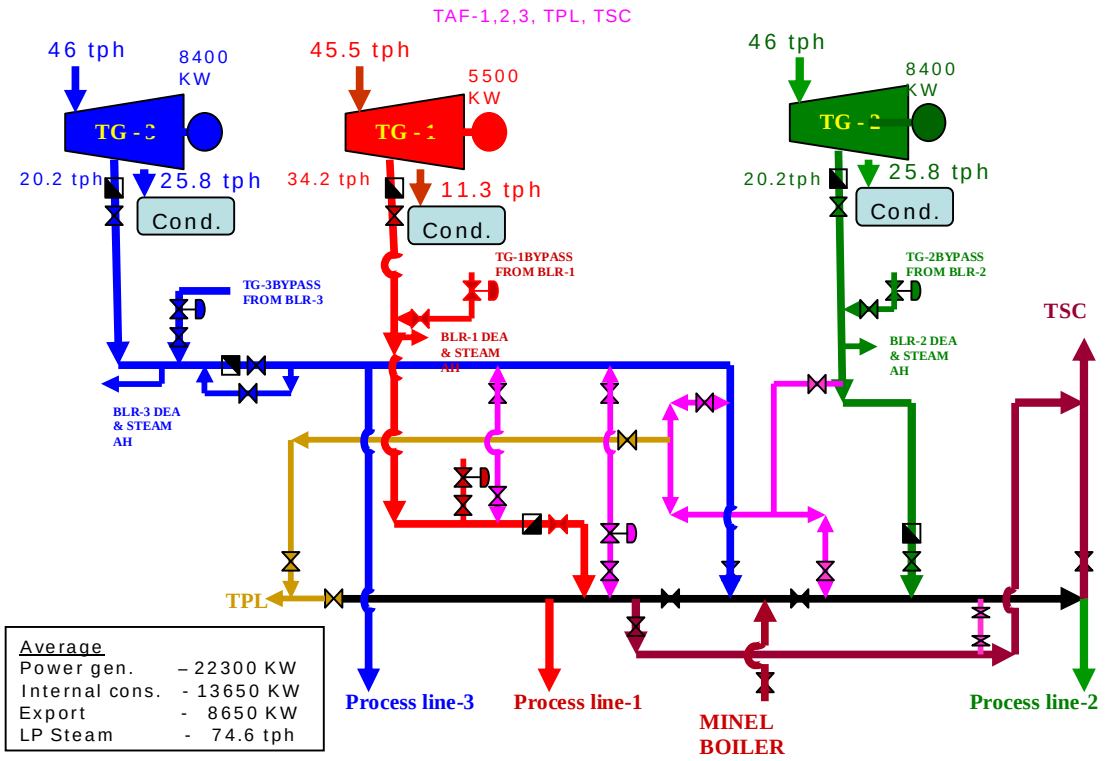
Project Details

Previous System

There were three numbers of spreader stoker fired boilers each rated for 65 kg/cm^2, 475 ^0C and 48 TPH. The total steam generation capacity was 144 TPH.

The details of condensing cum extraction turbines were as follows :

Equipment	Power Generation capacity	
TG-1	7 MW @ 40 TPH Extraction	
TG-2	7 MW @ 40 TPH extraction	10 MW @ 16 TPH extraction
TG-3	7 MW @ 40 TPH extraction	10 MW @ 16 TPH Extraction



The average power generation from the co-generation plant was 22300 MW. Out of which, 13650 MW of power was used for internal plant consumption and the remaining 8650 MW of power was exported to the grid. Any reduction in steam and power consumption in the plant meant increase in the power export to the grid and the revenue of the plant.

Need for Innovation

After the capacity expansion of the plant, there was a reduction in export by about 5 MW due to increased power consumption and steam requirement for the process. This created a revenue loss of Rs.396 Lakhs/annum. The plant team thought that the best way to maximize the revenue is by maximizing the electrical power export to grid.

Basic Project Philosophy / Strategy

Extensive data analysis like demand / supply variation & capacity correlated with product type, season, boiler & TG outages , etc. was carried out to look into various options for avoiding export losses.

Several options were discussed and the option of "Replacement of extraction cum condensing turbine with back pressure turbine" w as selected for implementation after detailed study.

Main problems faced/ Overcome during implementation

The following problems were faced during implementation

- Ø Old foundation bolts had to be removed to accommodate new machine on existing foundation. Due to existing 2 fixed points (front bearing & gearbox), there was very low deg ree of freedom available for machine alignment.
- Ø High pinion vibrations were observed after initial commissioning of new turbine.

Actions taken

Old pinion bearing was replaced and alignment was re checked but the problem persisted after turbine re-starting. Base frame temperature was measured at full load and it was found lower than predicted (40 against 60^0C) temperature.

Vibration analysis was confirmed for mis-alignment due to above. Data was analyzed in detail & new cold alignment values were obtained. After re-alignment, no vibration was found at full load.

Due to very narrow design margin available for allowable forces and moments, exhaust steam piping design was revised thrice to ensure turbine stability.

Financing of the Project

The plant has invested about Rs 55.3 million (USD 1.38 Million) for implementation of the project. The investment ha s been taken up fully with internal funds.

Results of the Project

Implementation of this project resulted in

- Ø Annual revenues of Rs 20 million (USD 0.5 Million) through additional power generation
- Ø Annual savings of Rs 2.15 million (USD 0.054 Million) due to reduction in auxiliary power consumption

The total annual savings achieved is Rs 22.15 million (USD 0.554 Million). The investment made for installation of new turbine was Rs 55.3 million (USD 1.39 Million). The simple payback period is 30 Months.

Annual savings	– Rs 22.15 million
Investment	– Rs 55.3 million
Payback	–30 months

Contact Information of the plant

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Case Study: 14

REDUCTION IN COOLING WATER CIRCULATION PUMP POWER CONSUMPTION DUE TO SIPHONING EFFECT

Project Implemented by : Asian Paints Ltd.
Cuddalore, Tamilnadu
Project Implemented in : 2003

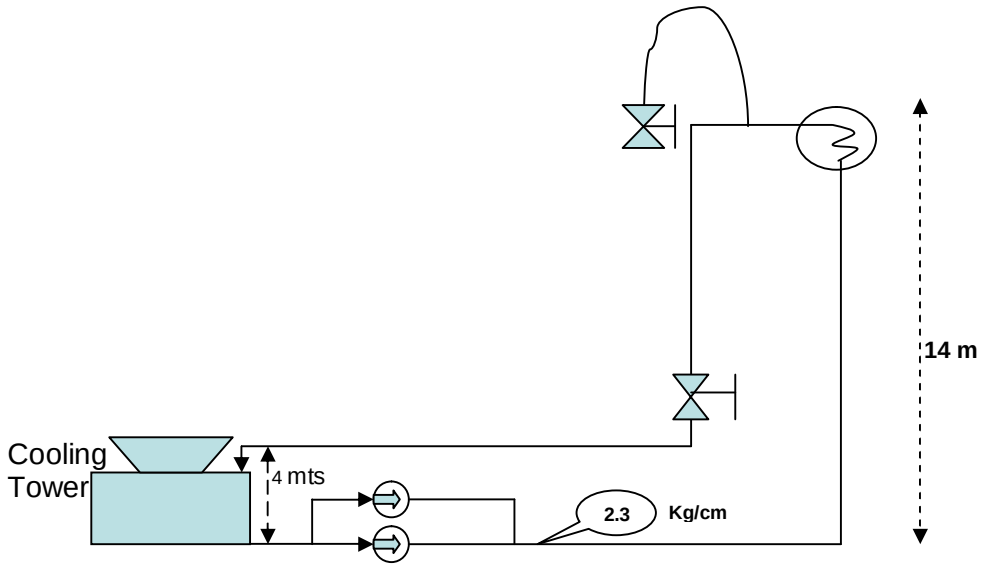
Company Details

Asian Paints Limited is one of the leading manufacturers of paint in India. It is a multi-national company of Indian origin having manufacturing facilities across the globe. Asian Paints Limited has its chemical division at Cuddalore, Tamilnadu; manufacturing various grades of Pentaerythritol, sodium format and formaldehyde. Asian Paints Limited, Cuddalore is an ISO 14001 certified company.

Project Details

Original System details:

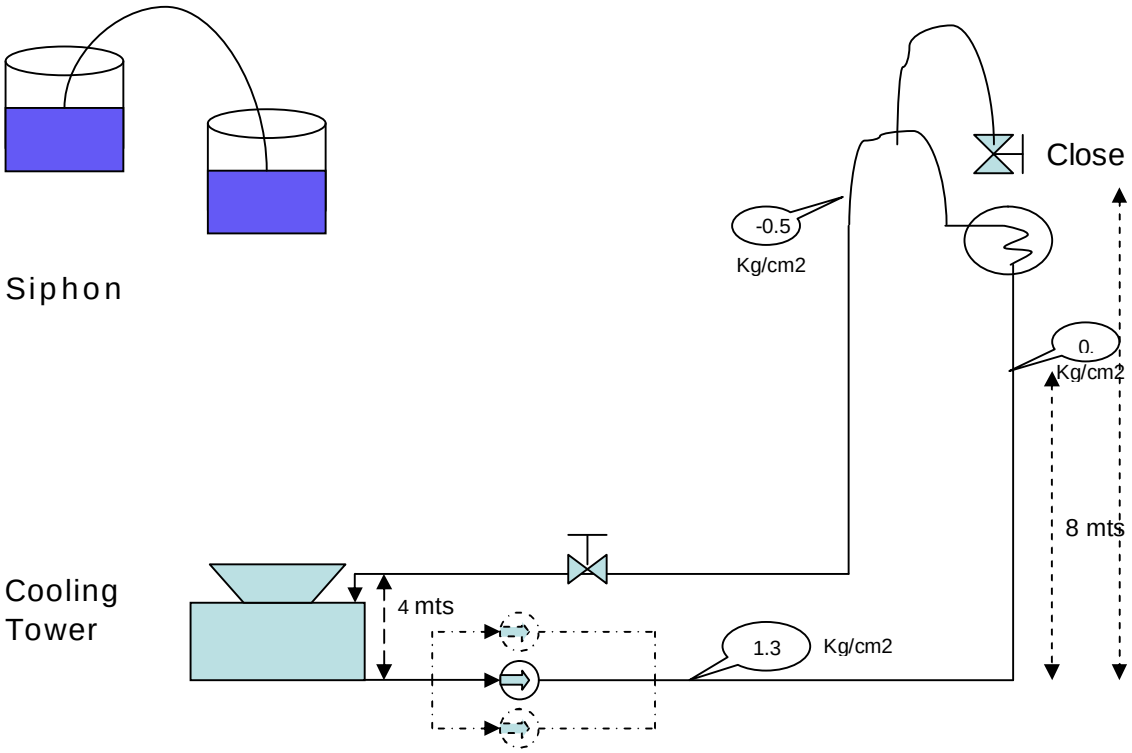
This project was implemented in the cooling water system of the plant. The cooling water system consisted of two pumps of 75 kW each, circulating 1600 m^3/hr of cooling water from the cooling tower sump to the process plant. The pumps were designed for 800 m^3/h capacity and 25 m head each.



The cooling water was supplied to the plant at a pressure of 2.3 kg/cm^2 and the pumps were consuming maximum of 150 KW of power.

Modified Scheme:

The plant team decided to use siphoning effect in the cooling water circuit and aimed for reducing pumps power consumption. Inducing of syphon helped in reducing the pump discharge pressure from 2. 3 kg/cm^2 to 1.3 kg/cm^2 and hence reduction in power.



Project Details:

- A new pump of 1600 m^3/hr and 15 m head was erected and connected to the common header of the above two pumps.
- The cooling water system was made air tight to eliminate pinhole leaks to prevent air ingress and water leakage from the system.
- Vent valves were provided at all elevated locations (top most points) in the cooling water circuit. Initially two pumps (each 800 m^3/h) were started with all the vent valves in open condition.
- When the air in the system is totally displaced, the water starts gushing through the vent valves and then the vent valves were closed. Then, the newly installed 1600 cu.m capacity pump was started.
- After ensuring the normal running of this pump, the two pumps of 800 m^3/h pumps were stopped. The cooling water was supplied to the plant at a pressure of 1.5 kg/cm^2 with the new pump of 1600 m^3/h capacity.
- As the air in the system got thoroughly evacuated, "syphoning" gets established in the system and the cooling water is syphoned through the heat exchangers to the cooling tower. Because of the syphoning, the cooling water system could work with an inlet pressure of 1.5 kg/cm^2 as against the old value of 2.3 kg/cm^2.

The result:

The new pump of 1600 m^3/h capacity and 15 m head consumes only 75 kW of power. The old system had consumption of 150 kW . The actual energy savings achieved was 75 kW.

Issues faced during implementation :

- Any slight leak in the flanges of cooling water line results in air ingress and disturbs the syphoning.
- The cooling water pump must run continuously. If it trips due to power failure or any other reason, the entire system would get disturbed and the syphon mechanism has to be re-established.

(In this case, pump motor was connected to captive power pla nt which provides uninterrupted power supply.)

Comments from the Plan t team

Syphoning effect can be gainfully utilized in several of the cooling tower pumping applications. The potential is immense in the Indian Chemical Industry.

Financing of the Project

The plant has invested about Rs 0.15 million (USD 0.0038 Million) for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Due to syphoning effect in the system, lower head pump of 1600 m3/h is continuously operated, which has resulted in an energy savings of 75 kW per hour. The cost saved by the company is Rs. 2.20 million per annum (USD 0.055 Million).

Annual savings	– Rs 0.15 million (USD 0.0038 Million)
Investment	– Rs. 2.20 million per annum (USD 0.055 Million)
Payback Period	– less than a month

Contact Information of the plant

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Case Study: 15

CONVERSION OF TRIPLE EFFECT EVAPORATOR TO FIVE EFFECT EVAPORATOR

Project Implemented by : Asian Paints Ltd.
Cuddalore, Tamilnadu

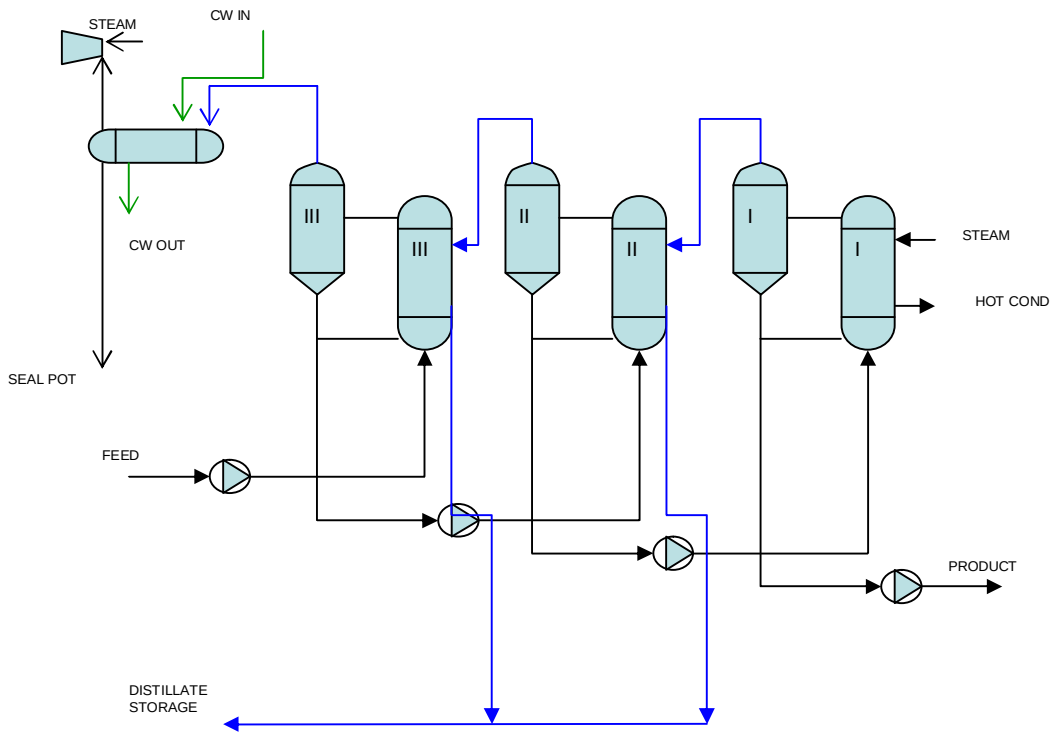
Project Implemented in : 2003

Company Details

Asian Paints Limited is one of the leading manufacturers of paint in India. It is a multi-national company of Indian origin having manufacturing facilities across the globe. Asian Paints Limited has its chemical division at Cuddalore, Tamilnadu , manufacturing various grades of Pentaerythritol, sodium format and formaldehyde. Asian Paints Limited, Cuddalore is an ISO 14001 certified company.

Project Details:

Original System:



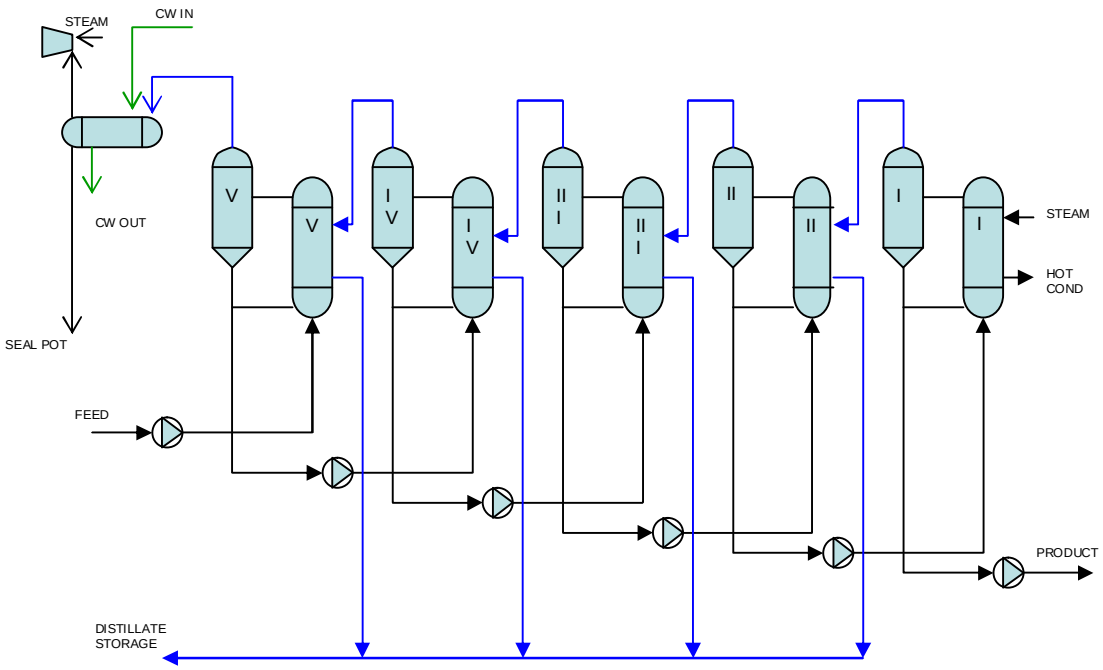
Triple Effect Evaporator (TEE) was used for concentrating the process stream from 14% TS to 55% TS. The steam economy rate of the evaporator was 2.50. The plant had installed a standby evaporator to ensure continuous running of the plant.

The steam flow requirement of the process was 3 TPH and the maximum feed flow rate was 145 LPM.

Conversion of triple effect evaporator to five effect evaporator:

- In view of the improved maintenance techniques, the need for the stand by evaporator almost got eliminated.
- The idea of five effect evaporator (FEE) conversion was proposed by the plant energy audit team. An external consultant hired by the plant confirmed the feasibility of conversion and energy saving.
- The idling standby evaporator components are used along with the newly designed vacuum system to convert the triple effect evaporator into five effect evaporator which helped to keep the cost of conversion to a bare minimum level.

Modified System:



Issues faced during implementation

There were no major issues faced during the implementation of the project. The implementation of this project was scheduled during the annual shut down maintenance.

Comments from the plant team

Fruitful utilisation of stand by equipment can provide opportunities for energy conservation

Financing of the Project

The plant has invested about Rs 0.80 million (USD 0.02 Million) for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project:

This project was implemented with a minimum investment and had resulted in maximum energy saving & improvement in productivity.

- Ø The steam economy for FEE : Increased from 2.4 to 3.4
- Ø Steam consumption: Reduced from 3000 kg/hr to 2000 kg/hr. i.e. 33% reduction in steam consumption
- Ø Feed flow: Increased from 145 LPM to 180 LPM i.e. 25% increase in the plant capacity

Energy and Cost Savings:

- Ø Reduction in Sp. Steam consumption : 2.24 MT
- Ø Fuel saving per annum : 1306 MT of 6000 GCV coal
- Ø Total cost savings : Rs 3.30 Million (USD 0.083 Million)
- Ø Overall investment : Rs 0.80 Million (USD 0.02 Million)
- Ø Pay back period : 3 Months

Annual savings	– Rs 3.30 Million (USD 0.083 Million)
Investment	– Rs 0.80 Million per annum (USD 0.02 Million)
Payback Period	– 3 Months

Contact Information of the plant

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Case Study: 16

REDUCTION IN GENERATING FREQUENCY IN CAPTIVE POWER PLANT DURING ISLAND MODE OPERATION

Project Implemented by : Asian Paints Ltd.
Cuddalore, Tamilnadu

Project Implemented in : 2003

Company Details

Asian Paints Limited is one of the leading manufacturers of paint in India. It is a multi-national company of Indian origin having manufacturing facilities across the globe. Asian Paints Limited has its chemical division at Cuddalore, Tamilnadu, manufacturing various grades of Pentaerythritol, sodium format and formaldehyde. Asian Paints Limited, Cuddalore is an ISO 14001 certified company.

Project Details:

At Asian Paints Ltd, a 500 kVA Turbo generator is generating power operating in island mode. The turbo generator was operating at a frequency of 49.5 Hz on a continuous basis. In case of any maintenance of turbo generator, power is drawn from the state Electricity Board (EB) grid, which supplies electricity at 49.9 Hz for most of the time in a day.

The plant team observed a wide variation in total power consumption between captive power plant operation and EB power for the same

production capacity of the plant. The detailed analysis of production and energy parameters indicated that the variation in supply frequency resulted in variation in power consumption.

At Asian Paints, Cuddalore 90% of the connected load in the plant are centrifugal loads like pumps and fans. In centrifugal loads, the speed of operation (RPM) is directly proportional to frequency of electrical supply. The power consumption of the centrifugal equipment is proportional to cube of speed (RPM^3). Therefore, whenever there is a decrease in operating frequency, there will be a reduction in power consumption. A 10 % reduction in frequency would result in 27% reduction in the Power consumption.

Majority of the centrifugal equipment were operated with excess capacity margins. This was indicated by throttling of control valves in the extent of 70% to 90%.

All electrical equipment is designed to operate at a frequency range of 47.5 to 51 Hz.

A detailed loading analysis (kW measurement) was carried out for all the equipment across various sections and it was concluded that all equipments had excess margins at least to the tune of 10 – 15 %.

Applying the above concept, plant team started reducing the generating frequency, in steps. At each step the plant operation was allowed to stabilize. Finally the turbo generator was operated at a frequency of 48 Hz. By reducing the supply frequency, the built in excess design margin of equipment was reduced to match the actual requirement of the process.

Issues faced during implementation

The plant team reduced the generation frequency in steps. At each step the plant was allowed to stabilize. There were no major issues faced during the implementation of the project.

There are few precautions to be considered before implementing this project:

- The optimization of frequency is applicable, only where generators are operated in island mode and not in parallel with the Grid.
- The level of reduction in frequency varies with respect to the actual capacity margins available in the various equipment spread across in the plant. In case there is no capacity margin available in

equipment, the frequency reduction could be counter productive. Also majority of the connected load should be centrifugal in nature.

- The electrical equipment are suitable for operating from 47.5 Hz to 51 Hz electrical supply. Hence operation of equipment within this range would not affect the electrical performance of the equipment. Any frequency other than the range mentioned above, is also not warranted even if extra margins are available.

Comments from the plant team

Optimization of operating frequency is an excellent method to skillfully utilise the margins available in individual equipment.

Financing of the Project

This project was implemented without any investment.

Result of the Project

Implementation of this project resulted in reduction of 35 kW of power saving and reduction in specific power consumption by 70 kWh/TPE.

The annual savings achieved was **Rs.1.03 Million (USD 0.082 Million)** without any investment.

Replication Potential

Similar saving potential is possible in several plants, especially the continuous process Industry, where captive power plants are operating in island mode.

Annual savings	**– Rs.1.03 Million (USD 0.082 Million)**
Investment	**– Nil**

Contact Information of the Plant

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Case Study: 17

HEAT TREATMENT FIXTURE WEIGHT REDUCTION

Project Implemented by : Bajaj Auto Ltd.
Waluj, Aurangabad

Project Implemented in : 2003

Company Details

Bajaj auto limited, Waluj, Aurangabad, is a division of Bajaj Auto Limited, Pune, a flagship company of Bajaj Group. Bajaj Auto is one of the leading manufacturers of two wheelers & three wheelers in India and also largest exporter of 2 & 3 wheelers. Bajaj Auto Limited, Waluj is ISO9001 and ISO14001 certified company. Bajaj Auto is also practicing Total Productive Maintenance (TPM) at all levels. In the process of introducing new products, emission requirements are being taken into consideration and products manufactured are meeting the regulatory requirements.

Project Details:

Heat Treatment is one of the major energy consumers of LPG at Bajaj Auto Limited, Waluj. Heat treatment is done for components like Gears, shafts and sprockets.

The heat treatment process involves carburising, hardening, nitridin g, annealing, induction hardening and carbo -nitriding.

Fixtures are used for holding the job pieces in heat treatment process. In the heat treatment process the temperature of the fixture is also raised to the same temperature of the job to be heated. The refore, considerable amount of energy is spent for heating the fixture.

The thermal energy required to raise the temperature of a substance in a furnace is proportional to the mass of the substance, specific heat of substance and temperature difference ($Q = mC_p \bullet t$). Any increase in mass of the fixtures increases the energy consumption in the process.

The plant team studied the possibility of reducing the mass of the fixtures without compromising the process requirement.

Details of Previous Fixture:

- Ø Weight - 25 kg
- Ø Height - 50 mm
- Ø Thickness -10 mm
- Ø Life of fixture -1 year
- Ø Temperature - 900 ^{0}C

As Cp is constant for a particular material, the thermal energy requirement depends on the mass (weight) of the substance and the temperature difference. Therefore, any reduction in weight of the fixture would reduce the thermal energy requirement. The plant team thought innovatively to reduce the weight of fixture. They created more pockets in the corner of fixture by removing the material which resulted in reduction of weight of the fixture. Also the height and thickness of the fixture was reduced to reduce the weight.

The plant team also optimised the temperature i.e. reduced from 900 ^{0}C to 860 ^{0}C.

Modified fixture:

- Ø Weight - 18 kg.
- Ø Height - 40 mm
- Ø Thickness - 8 mm
- Ø Life of fixture - 1.25 year
- Ø Temperature - 860 ^{0}C

Mass reduction was achieved by creating more pockets in the corners.

Before

Less pockets

After

Pockets increased

Height Reduction

Height of Old Fixture 50 mm

Height of new Fixture 40 mm

Reduction in weight of the fixture and optimisation of temperature reduced the requirement of thermal e nergy in heat treatment process which in turn resulted in considerable amount of saving in LPG consumption.

Issues faced during Implementation

There were no major issues faced during the implementation of the project. The modification of the fixture was tried in few numbers as a trial. After successful operation of the new fixtures, the old fixtures were replaced.

Comments from the Plant Team

Optimising the weight of jigs and fixtures can drastically bring down energy consumption in furnaces.

Financing of the Project

The project was taken up as a failure replacement policy. The life of the old fixtures was one year. After completion of old fixture's life, new low mass fixtures were used. Hence, there is no additional investment for this project.

Results of the Project

Reduction of weight of heat treatment fixture resulted in reduction of LPG consumption from 0.420 kg/kg of product to 0.303 kg/kg of product and the life of fixture increased from 1 year to 1.25 years.

35 fixtures out of 60 were replaced so far with new type of fixtures. This resulted in total LPG cost reduction of Rs 4.86 Millions (USD 0.121 Million) per annum.

Replication Potential

Replication potential of similar projects is high in Forging , Foundry and Automobile industries.

Annual savings	–Rs 4.86 Millions (USD 0.121 Million)
Investment	–Not Applicable

Contact Information of the plant

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Case Study: 18

USE OF POLYURETHANE FOAM SPRAY ON ROOF AND REDUCING AIR CONDITIONER LOAD

Project Implemented by : Bharat Heavy Electrical (BHEL) Equipment plant, Ranipur, Haridwar (U.A.)

Project Implemented in : 2003

Company Details

Bharat Heavy Electricals Limited (BHEL) is a Gas and Steam turbine manufacturer in India. It is one of the nine largest Public Sector Undertakings and a key player in power sector through erection, commissioning and servicing of power plants all over the world.

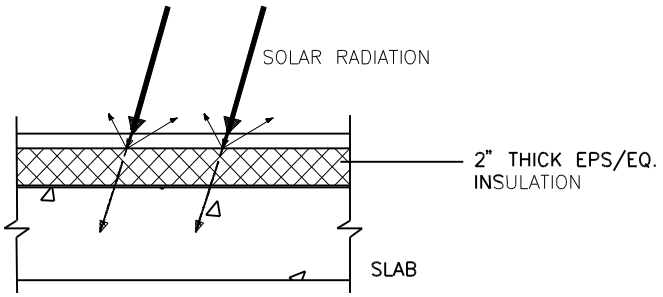
Bharat Heavy Electricals Limited (BHEL), established in the mid fifties has today emerged as the largest engineering and manufacturing enterprise of its kind in India and ranks amongst the top ten power generation equipment manufacturers in the world.

The Heavy Electricals Equipment Plant (HEEP) located in Haridwar, is one of the major manufacturing plants of BHEL. The core business of HEEP includes design and manufacture of large steam and gas turbines, turbo generators, hydro turbines and generators, large AC/DC motors and so on.

Project Details:

A modern air-conditioned production shop for manufacturing advanced design Turbine Blades for thermal set with higher efficiency & heat rate has been set up at BHEL Haridwar. The shop & annex Building was air-conditioned using a chiller of 300 TR capacity. The effective AC height of Blade Shop area was 4 Meter and that for Annex Building was 2.7 Meter.

Exposed roof was identified as a major contributor to heat impingement, resulting in higher air conditioning load. It was decided that usage of over deck / under deck insulation would reduce the heat impingement. Insulation with 50 mm thick Polyurethane foam sprayed directly on roof was provided. This has resulted in 10 % savings on AC load power consumption.



Salient features of the project:

Ø The AC plant, designed to run 24 Hours a day, was to fresh a available at lower than the return air temperature. B uildi management system (BMS) was provided to automatically contr the exact required temperature, thus saving energy.

Ø Automatic Temperature Control in air conditioned spaces w achieved by means of temperature, humidity sensors and 3-wa chilled water valve.

Ø Exposed roof has been protected from acting as heat sink an avoided transfer of heat to the conditioned space by insulation witl 50 mm thick Polyurethane foam sprayed directly on roof.

Ø Heat reflecting glass was installed on exposed windows to cut dov on the air conditioning cooling load by direct solar radiation.

Ø Energy efficient imported screw type water chillier of 150 TR havi totally automatic control features was installed.

Ø Environment friendly R-134 Freon Gas was used in the A conditioning System.

Ø Forward & Return air ductings have been provided in Return a duct to improve the energy saving of the overall Production shop.

Ø Building Management System is designed to allow controlled fres chilled air from out side during winter season .

Issues faced during Implementation

There is no major issue faced during the implementation of th project.

Comments from the plant team

Air conditioned space is on the rise in India. Effective insulation of th air conditioned space is a must to reduce heat ingress, thus increasin energy efficiency of air conditioning.

Financing of the Project

The plant has invested about Rs 0.9 Million (USD 0.022 Million) f implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Implementation of this project has resulted in saving of 10% of th power consumption. The annual savings achieved is Rs 0.69 Millio (USD 0.017 Million).

Replication Potential

Similar project is possible in all air conditioned buildings having larg roof area exposed to Direct Sun.

Annual savings	–Rs 0.9 Million (USD 0.022 Million)
Investment	–Rs 0.69 Million (USD 0.017 Million)
Payback Period	–16 Months

Contact Information of the Plant

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Case Study: 19

UTILISATION OF SOLID WASTE GENERATED IN THE PROCESS AS BOILER FUEL

Project Implemented by : Century Pup & paper
Lalkua, Uttaranchal

Project Implemented in : 2003

Company Details:

Century Pulp and Paper, a unit of Century Textiles and I ndustries Ltd., is a flagship company of B.K. BIRLA group of industries. The company is an ISO - 9001: 2000 and ISO - 14001 certificated unit and has established its brand very well in the domestic and overseas market; with the excellent quality of its pro ducts i.e. Writing & Printing Papers and Dissolving/ Paper Grade Pulp.

The company has the following installed capacities:

- Rayon Grade/ Paper Grade Pulp: 31320 TPA
- Writing & Printing Papers (wood): 37250 TPA
- Writing & Printing Papers (Bagasse): 84600 T PA

Project Details:

Bagasse, by a product of sugar industry has no w become one of the important cellulose raw materials, suitable for the production of various grades of paper. The bagasse produced contains substantial amount of pith, a substance with hi gh moisture and non-fibrous in nature. It is essential to remove pith , short fibres, from the bagasse before sending the bagasse to the paper industry.

Bagasse storage yard

Pith is a very light substance and occupies lot of sp ace and its disposal is a problem. The pith has calorific value of 1500 kCal/kg. So efforts were made to burn it in conventional coal fired boilers at Century Pulp and Paper, Lalkua. The conventional Boilers were not designed to handle such a light substance and burning of pith in them resulted in poor efficiency and frequent failures due to improper heat distribution.

It was concluded that Pith alone can not be used as a fuel. Therefore, to promote pith combustion it was necessary to provide certain amount of energy as heat from main fuel (Coal) to reduce the moisture content in the pith. Another requirement was to have sufficient residence time and turbulence in the furnace in order to get stable and efficient combustion. Hence it was decided to install a new boiler designed to fire coal cum pith as fuel. A control combustion zone Boiler (patented design of Babcock & Wilcox, USA) was designed to burn pith and coal with varying proportions of pith, max being 80% pith.

Pith Characteristics:

Bone dried bagasse has a composition of 60 – 65 % fibre, 15 – 25 % pith, 5 – 10 % water soluble. The pith contains 48 – 52 % moisture and a calorific value of around 1500 kCal / kg. The density of the pith with 50% moisture was approximately 180 kg/m^3.

Issues faced during Implementation

The technology of burning the substances like pith was not available and the manufacturers TBW had to do a lot of R & D with the pith.

Comments from the plant team

'Waste as a fuel' is good alternative to meet the growing energy demands in an environmentally healthy manner.

Financing of the Project

The plant has invested about **Rs 235 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Implementation of this project has resulted in annual saving of 42896 MT of coal which is equivalent to Rs 79.36 Million .

The annual savings achieved is **Rs 79.36 Million (USD 1.984 Million)**. The investment made for installation of new boiler is **Rs 235 Million (USD 5.875 Million).** The simple payback period of the project is **36 Months.**

Replication Potential

Similar project is possible in several paper plants, where bagasse is used for making pulp. Good potential exists in other sectors also for waste to be used as fuel in boiler s.

Annual savings	**– Rs 79.36 Million (USD 1.984 Million)**
Investment	**– Rs 235 Million (USD 5.875 Million)**
Payback Period	**–36 Months**

Contact Information of the plant

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Case Study: 20

USE OF LIGHT WEIGHT SPINNING POT MADE FROM REINFORCED CORBON FIBER

Project Implemented by : Century Rayon
Shahad, Maharashtra

Project Implemented in : 2003

Company Details:

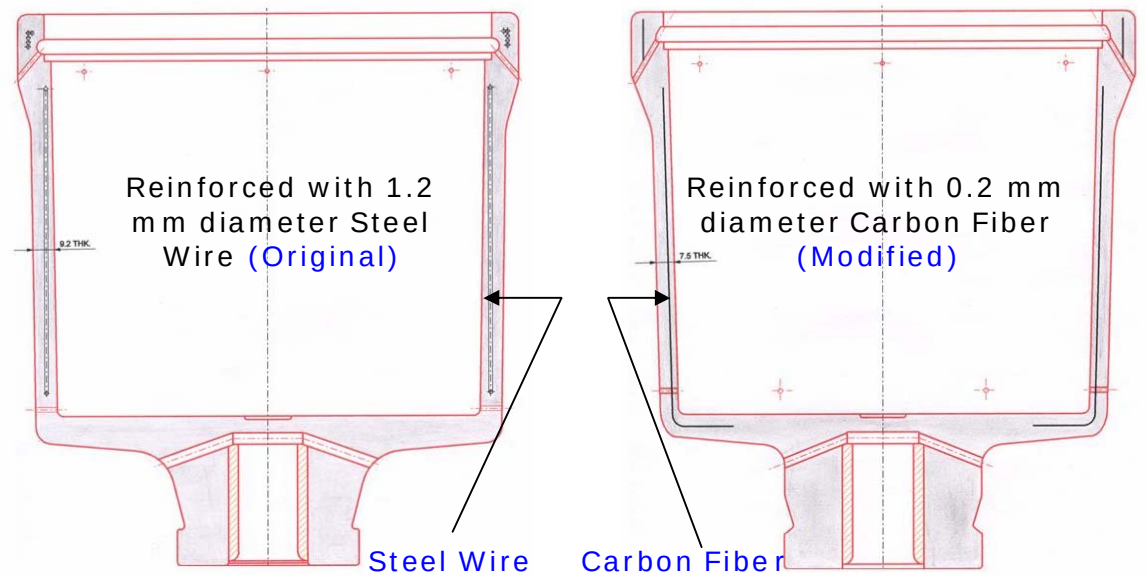
Century Rayon, Shahad (a B K Birla Group of company) is an ISO – 9001 certified company. It is a unit of M/s Century Textile & Industries Ltd. which commenced its operation in 1956 with an initial capacity of 5 Tons Viscose Filament Yarn (VFY).

Today after successive capacity expansion, Century Rayon is the largest Viscose Filament Yarn (VFY) producer in the country with a capacity of about 65 TPD and commanding 26 % of Indian VFY market.

Project Details:

Conventionally, steel reinforced spinning pots were used in synthetic fibre plants. At Century Rayon also steel reinforced spinning pots were used in spinning machines. The weight of steel reinforced spinning pot was 2.8 kg and the power consumption per spinning machine per day used to be 581 units. The in house team thought of an innovative idea - To use carbon reinforced spinning pot in place of steel reinforced pot.

The plant team has replaced steel reinforced spinning pots with carbon reinforced spinning pots. The weight of carbon reinforced pot is 2.2 kg. After replacing steel reinforced pots with carbon reinforced pots, the energy consumption per spinning machine per day has been observed as 549 units. The reduction in weight of spinning pot resulted in reduction in energy consumption by 32 units per spinning machine per day.



Comparison:

Sr. No.	Details	Spinning Pots		
1	Type of Spinning Pot	Steel Reinforced	Carbon Fiber Reinforced	Difference
2	Weight of Spinning Pot (kg)	2.80	2.20	0.60
3	Power consumption per Spinning M/c per day (kWh)	581	549	32
4	Total Number of Spinning Machines	118		-
5	No. of Machines running with carbon reinforced spinning pot	39		-

Issues faced during implementation

No major issues were faced during the implementation of the project.

Comment from the Plant Team

The idea of using carbon reinforced spinning pot in place of steel reinforced pot, was suggested by the plant team. This offers a good potential for energy saving in synthetic fibre units, in the spinning process.

Financing of the Project

The plant has invested about Rs 1.1 Million for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

	Units Millions	Rs Millions
Total Saving in 39 Machines	0.455	1.5
Potential Savings in balance 79 M/c's	0.92	3.05

Implementation of this project has resulted in annual savings of Rs 1.5 Million (USD 0.037 Million). This project has called for an investment of Rs 1.1 Million (USD 0.027 Million) which has a simple pay back period of 9 Months.

Replication Potential

Similar potential is possible in all 12 Rayon plants in India.

Annual savings – Rs 1.5 Million (USD 0.037 Million)
Investment – Rs 1.1 Million (USD 0.027 Million)
Payback Period –9 Months

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Case Study : 21

MODIFICATION OF CS2 FURNACES FOR HIGHER PRODUCTIVITY

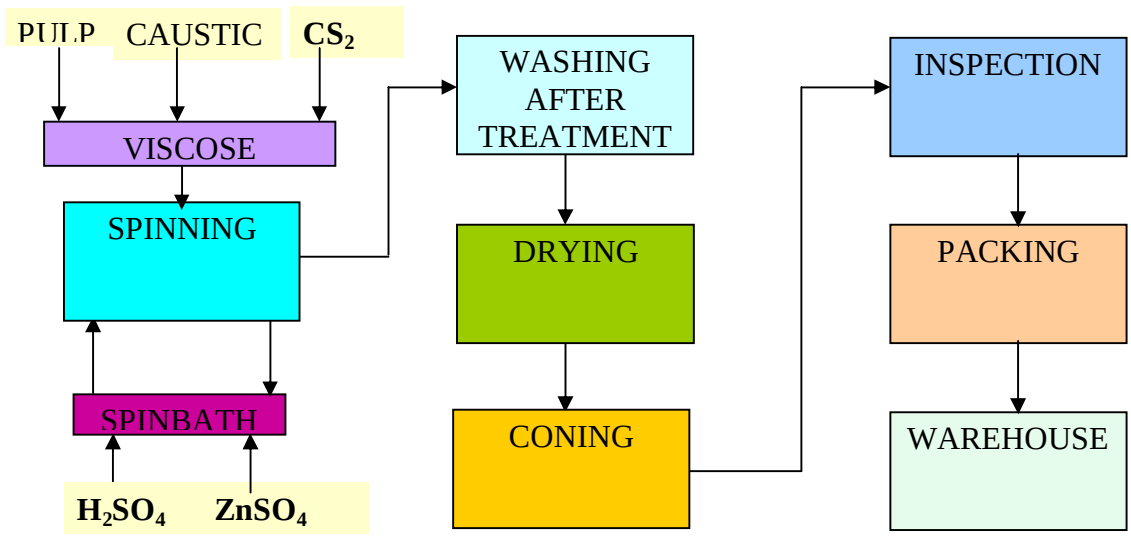
Project Implemented by : Century Rayon
Project Implemented in : 2003

Company Details

Century Rayon, Shahad, (an ISO – 9001 Certified company) is a B K Birla Group of company. It is a unit of M/s Century Textile & Industries Ltd. Century Rayon came into operation in 1956 with the viscose filament yarn capacity of 5 TPD.

At present, after successive capacity expansions, Century Rayon is the largest viscose filament yarn (VFY) producer in the country, with an approximate production of about 65 TPD. Century Rayon has a market share of 26 % of the total viscose filament yarn market in India.

Process Flow Chart



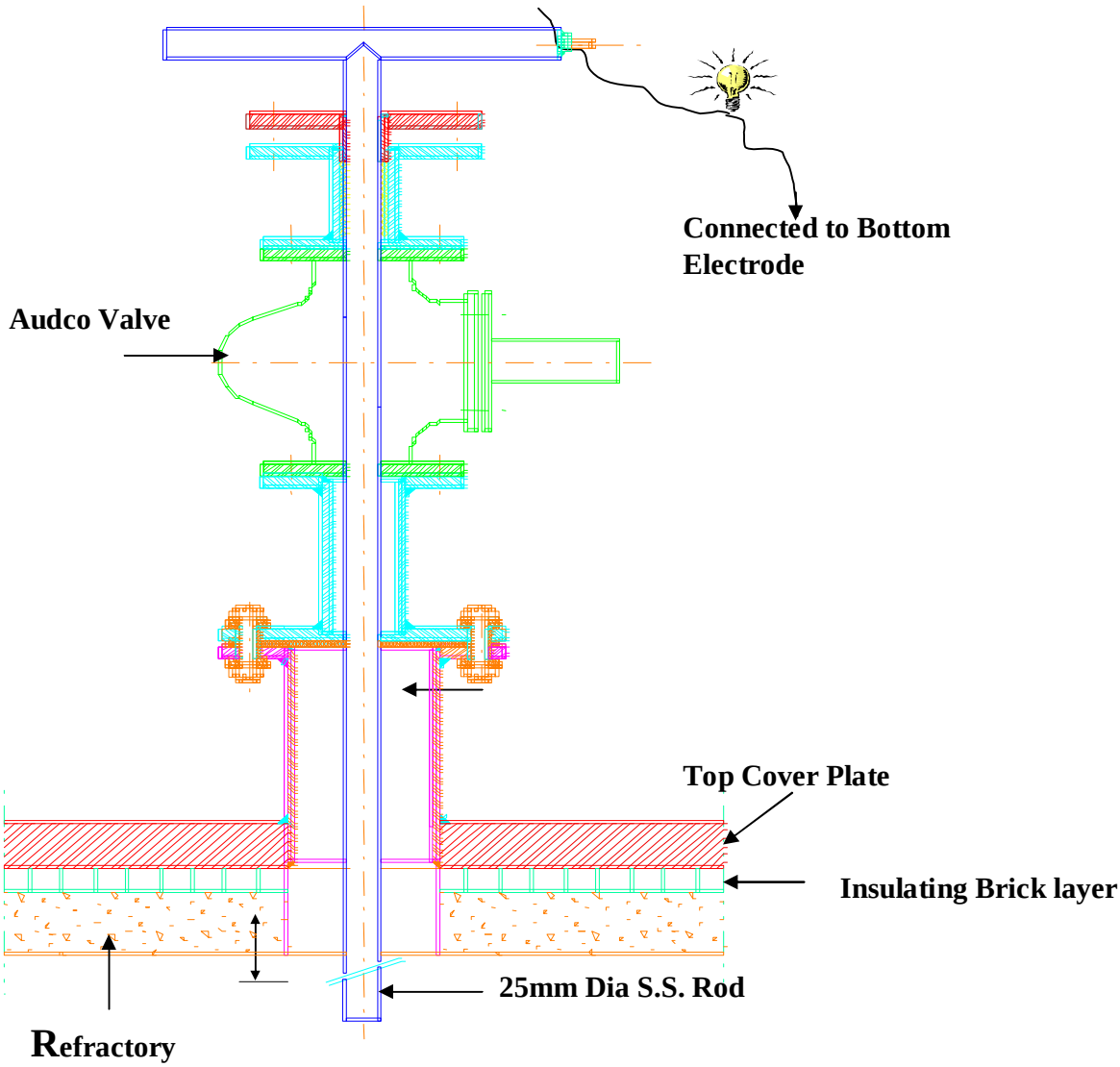
Project Details

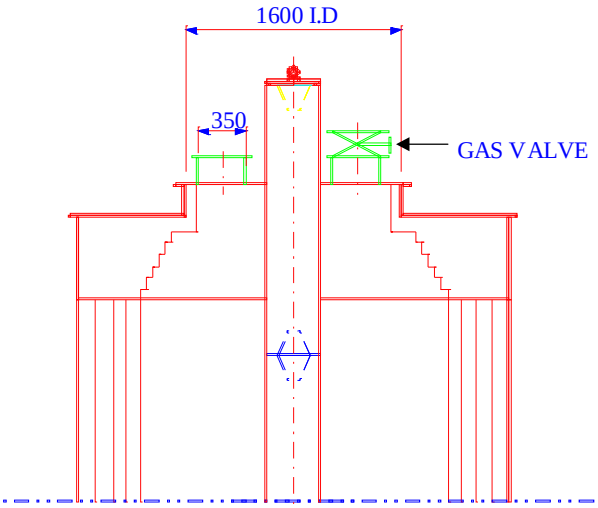
The CS_2 plant has eleven furnaces out of which normally seven to eight furnaces will be in operation. The plant produces about 35 tons of CS_2 per day.

Charcoal is fed from top of the furnace and molten sulphur is injected into furnaces through the eight feeding points provided in the furnace.

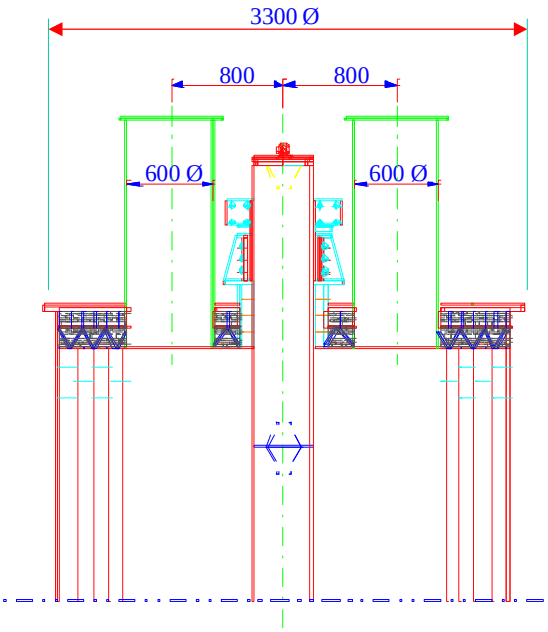
The plant team has taken up the following modifications in order to increase the production and reduce power consumption.

- In addition to the existing charcoal container one more container was installed for ensuring uniform flow of charcoal. A level indicator was installed in order to maintain constant charcoal level and thereby improve the reaction process.
- The effective furnace volume was increased by modifying the furnace top cover and insulating the same with insulating bricks for reducing the insulation losses.
- The height of the graphite rods were increased from 406mm to 500mm.


Connected to Bottom Electrode
Audco Valve
Top Cover Plate
Insulating Brick layer
25mm Dia S.S. Rod
Refractory



Furnace dimensions before modification



Furnace dimensions after modification

Implementation of the above measures had resulted in increased production and reduced specific energy consumption.

Issues faced during implementation

No major issues were faced during the implementation of the project.

Comments from the Plant team

Optimisation and fine tuning of both of design & operational aspects of CS2 Furnace can result in substantial benefits in operational efficiency and productivity.

Financing of the Project

The plant has invested about Rs 1.83 million (USD 0.046 Million USD) for implementing the project. The investment was taken up fully with internal funds.

Results of the Project

By carrying out the above modifications about 40 kWh /ton of CS_2 has been saved. Total power consumption reduction is about 1400 kWh/day.

Financial benefits

The annual savings achieved is Rs 1.91 million (USD 0.048Million). The investment made is about Rs 1.83 million (USD 0.046 Million). The simple payback period is 12 Months.

Annual savings	– Rs 1.91 million (USD 0.048 Million)
Investment	– Rs 1.83 million (USD 0.046 Million)
Payback Period	–12 Months

Contact Information of the Plant

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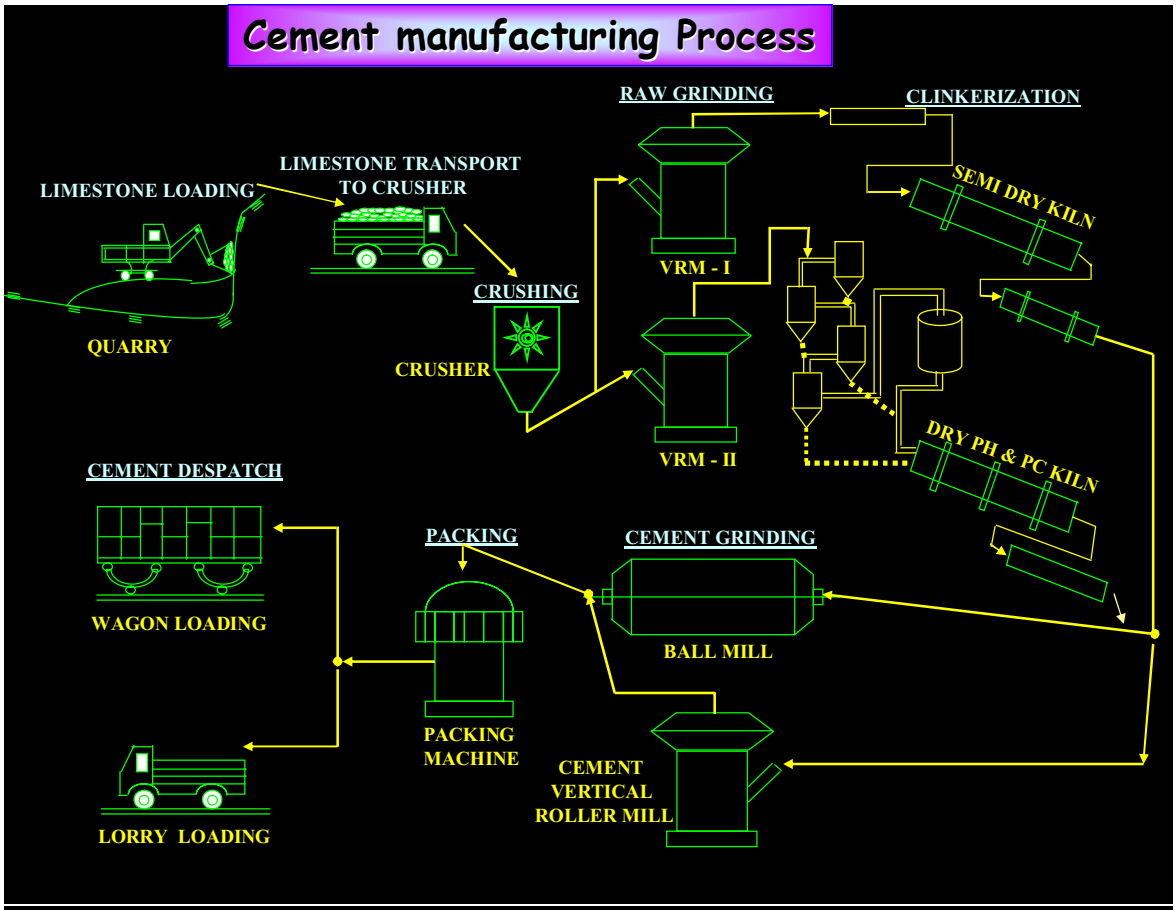
Case Study: 22

INSTALLATION OF DEMAND SIDE CONTROLLER FOR OPTIMISATION OF COMPRESSED AIR SYSTEM

Project Implemented by : Dalmia Cement (Bharat) Ltd.
Dalmiapuram
Project Implemented in : 2003 - 04

Company Details

Dalmia Cement (B) Ltd started cement production operations in 1939 at Dalmiapuram. Then, the capacity of this Polysius plant was 250 TPD clinker production. Presently the total capacity is 4600 TPD of clinker production, due to continuous up gradation. However, still the Old machinery of 1939 plant is in operation continuously.



Project Details

Over the years, 39 compressors (Reciprocating as well as Screw type) of different makes with a total installed capacity of 20081m^3/h were installed to meet compressed air demand for various applications. The total installed drive power is 1908.5 Kw.

Out of these, 20 compressors with total capacity 17,749 m^3/h and rated power of 1631 KW were in old plant (VRM-1, M.H, CVRM, PH and Polysius Line).

The compressors at old plant were initially installed near the user end. However, over a period of time these compressor lines were interconnected with the result that any compressor's air could be supplied for any application – resulting in un-optimized use of Air and consequent wastage of Energy.

To monitor the energy consumption, the plant team had installed energy meters for individual compressors in the old plant. The energy consumption was recorded on a daily basis. The total energy consumed by all compressors was approximately 2,41,000 units per month

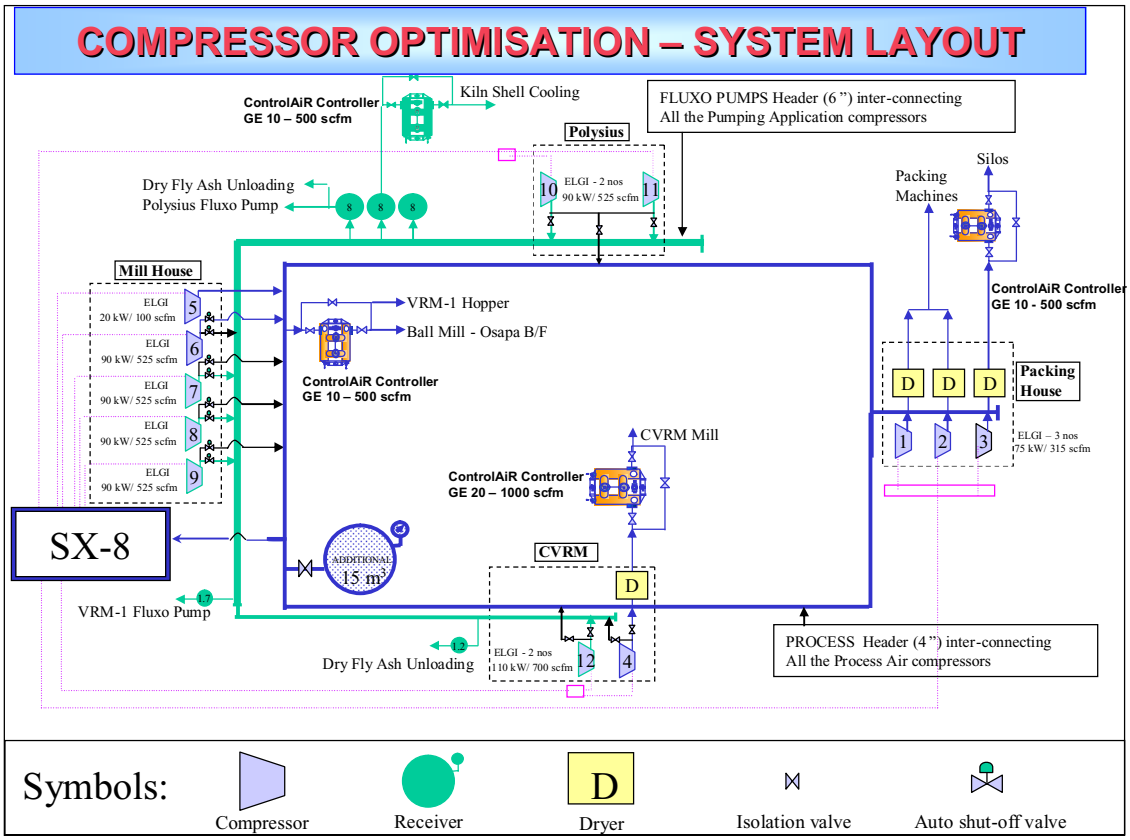
From the preliminary study conducted by the plant team based on compressed air requirement of various users, it was concluded that 12 Screw compressors with total installed capacity of 9507 m^3/h (and power consumption of 1003.5 kW) could meet the compressed air demand for all sections - VRM-1, CVRM, MH, PH and Polysius Line.

The plat team stopped the rest of the compressors. It was observed that excess capacity existed and that the continuous operation of 12 Screw compressors was also not required.

However, further optimization and consequent energy saving was possible only by installing supervisory monitoring and control system to operate all screw compressors.

Optimization System

Supply side and Demand side control systems were commissioned during Dec 2003 – Jan 2004, at Dalmia Cement (Bharat) Ltd., Dalmiapuram. The modified system lay out is as shown.



Basically this system classified plant a ir applications in two groups – one set of users that consumed compressed air at steady rate (process applications) and the other that consumes at cyclic pattern (fluxo pump applications). The compressed air lines were segregated forming t wo headers - one dedicated to each group.

Select applications were provided with pressure/flow controllers – where application pressure could be set. All twelve screw compressors were connected to central Controller – which can switch on and off each compressor depending on Demand.

All screw compressors supply air to process header at preset pressure. From this header, process app lications received air through f low controller at lesser but steady pressure. The compressors are run in such a manner that the header pressure is maintained within a set range.

Central Controller to control screw compressor operation

The Demand side controller systems are connected to 4 networks to meet the plant demand.

a) Demand side controller - 1000-SCFM was connected at CVRM Mill application and brought on-line; with the discharge set pressures at 62 psig (4.36 kg/cm^2).

b) Demand side controller - 500-SCFM was connected at Packing Silos application and brought on-line, with the discharge set pressures at 30 psig (2.10 kg/cm^2).

c) Demand side controller - 500-SCFM was connected at Ball Mill (O-sepa Bag Filter and Water Spray) application and brought on-line with the discharge set pressures at 71 psig (4.99 kg/cm^2).

d) Demand side controller - 500-SCFM was connected at Polysius Kiln Shell Cooling application and brought on-line with the discharge set pressures at 30 psig (2.10 kg/cm^2).

Demand side controller

The Supply side Controller was connected to process header and brought on - line for control and automation for all the 12nos. of screw compressors with optimized pressure setting of 73 psig to 78 psig (Average 75 PSIG – 5.27 kg/cm^2).

Issues faced during implementation

Commissioning of the entire system was done after a detailed feasibility study by the vendor. Segregation of compressed air lines and installation of new headers were taken up during planned shut down. The complete integration of the system with the existing system was done in a staggered manner as and when the respective plant was available for modifications.

Comments by the Plant team

Compressed air systems commonly referred to as the fourth utility in Industry offers good scope for energy savings through optimization, especially in those vintage plants where number of compressors have also gone up with capacity expansion of the plant. Due to advancements in automation, it is possible to precisely control the bandwidth of generation pressure, matching it with the demand, on a real time basis. All industries are users of compressed air & hence saving potential exists across industry.

Financing of the Project

The plant has invested about **Rs 1.83 Million** for implementing the project. The investment has been taken up fully with internal funds.

Results of the Project

The project resulted in reducing the Compressed air pressure variation was reduced significantly. The pressure variation was bought down to a narrow band - 4.97 to5.31 bar.

Only 12 compressors in operation at present as against the previous operation of 20 compressors. This had resulted saving the unload power consumption to a great extent and reduced maintenance cost.

Energy Savings with supply side & demand side controller - 3,060 kWh / day

% Energy Savings - 27.12%

Financial benefits

The annual savings achieved is **Rs 2.33 Million (USD 0.058 Million).** The investment made is about **Rs 1.83 Million (USD 0.045 Million).** The simple payback period is **10 Months.**

Annual savings	**–Rs 2.33 Million (USD 0.058 Million)**
Investment	**–Rs 1.83 Million (USD 0.045 Million)**
Payback Period	**–10 Months**

Contact Information of the Plant

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Case Study: 23

INCREASE IN CEMENT PRODUCTION BY INCREASING DRY FLY ASH ADDITION

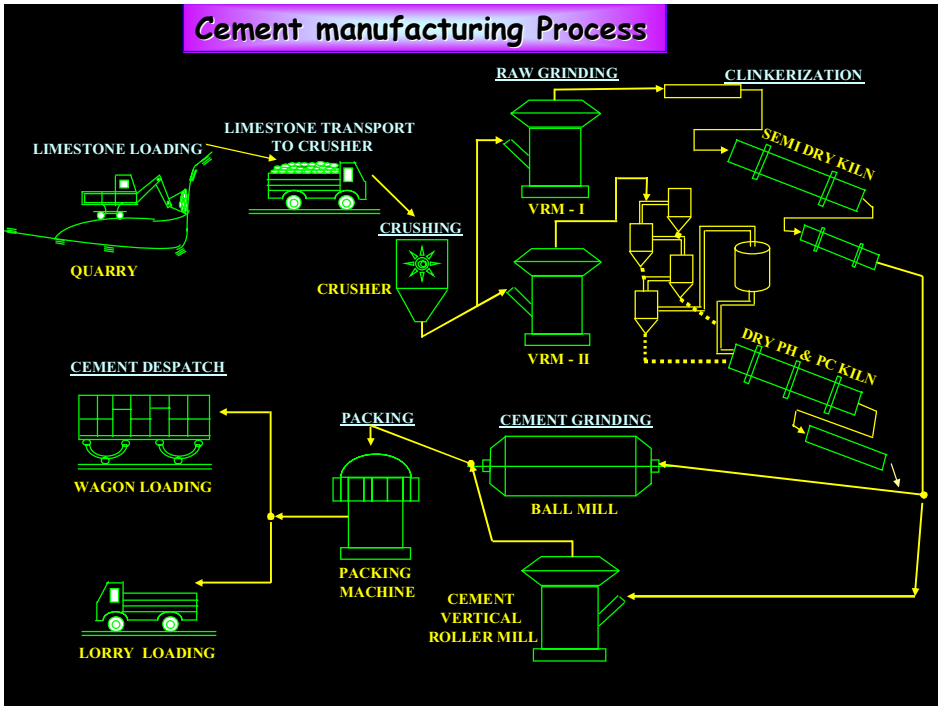
Project Implemented by : Dalmia Cement (Bharat) Ltd., Dalmiapuram

Project Implemented in : 2003-04

Company Details

Dalmia Cement (B) Ltd started cement production op erations in 1939 at Dalmiapuram. Then, the capacity of this Polysius plant was 250 TPD clinker production. Presently the total capacity is 4600 TPD of clinker production, due to continuous up gradation. How ever, still the Old machinery of 1939 plant is in operation continuously.

Dalmia cement manufactures a variety of cement – Ordinary Portland cement (OPC), Portland Pozzolona Cement (PPC), Oil Well Cement, Rapid Healing Cement etc.



Project Details

Back ground

Fly ash is being used as a pozzolonic material for producing Portland Pozzolona cement. This helps in material (limestone, clinker & Coke) conservation.

Previously out of the total fly ash addition, only 15% was dry fly ash. In the remaining wet flyash, the moisture content was as high as 25%. The higher moisture content has resulted in reduction of mill output.

In order to remove the moisture and increase the mill output the total heat requirement is about 14Mkcal/hr, out of which 11Mkcal is provided from the cooler vent and the remaining heat which is about 3Mkcal is provided by burning fuel.

The percentage dry fly ash addition was limited by the dry fly ash handling system.

Action taken

The plant team debated & brainstormed various aspects to identify and increase the utilization of fly ash. Various options including installing a new silo and a new fly ash handling system was one of the main aspects considered. How ever this scheme involved major capital investment & posed several layout related issues.

The unit, how ever had some old raw meal silos which were a part of the earlier plant configuration. This silo did not have any role in the modernized unit & hence the plant team decided to use this idle capacity available for storing fly ash. Using the pneumatic conveying system the dry fly ash from silo is transported to intermediate hopper. From the hopper the dry fly ash is fed to the mill feed chute in a controlled manner.

Dry Fly Ash Storage and Pneumatic conveying system

This resulted in increasing the dry fly ash addition from 15 to 40%, resulting in both electrical and thermal energy savings .

Issues faced During Implementation

No major issues were faced during the implementation of the project. The old raw meal silo was used for intermediate storage & a pneumatic conveying system was employed to convey dry fly ash.

Comments by the Plant Team

Flyash is a by product of thermal power generating station, having excellent binding properties, similar to cement. Higher flyash component clinker leads to resource conservation as well as energy efficiency.

Financing of the Project

The plant has invested about **Rs 1.50 Million** for implementing the project. The investment has been taken up fully with internal funds.

Results of the Project

Benefits achieved

- Electrical power savings of about 3,60,000 kWh, equivalent to a monetary saving of Rs 1.5 Million
- Coal saving of about 793 tons, amounting to about Rs 2.84 Million.
- Total saving of Rs 4.34 Million per annum
- Reduction in fugitive emissions

Financial benefits

The annual savings achieved is **Rs 4.34 Million (USD 0.108 Million).** The investment made is about **Rs 1.50 Million (0.037 Million).** The simple payback period is **5 Months.**

Annual savings	**– Rs 4.34 Million (USD 0.108 Million)**
Investment	**– Rs 1.50 Million (0.037 Million)**
Payback Period	**– 5 Months**

Contact Information of the Plant

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Case Study: 24

INSTALLATION OF WATER SPRAYING SYSTEM IN PRECALCINER DOWN COMER IN CEMENT PLANT

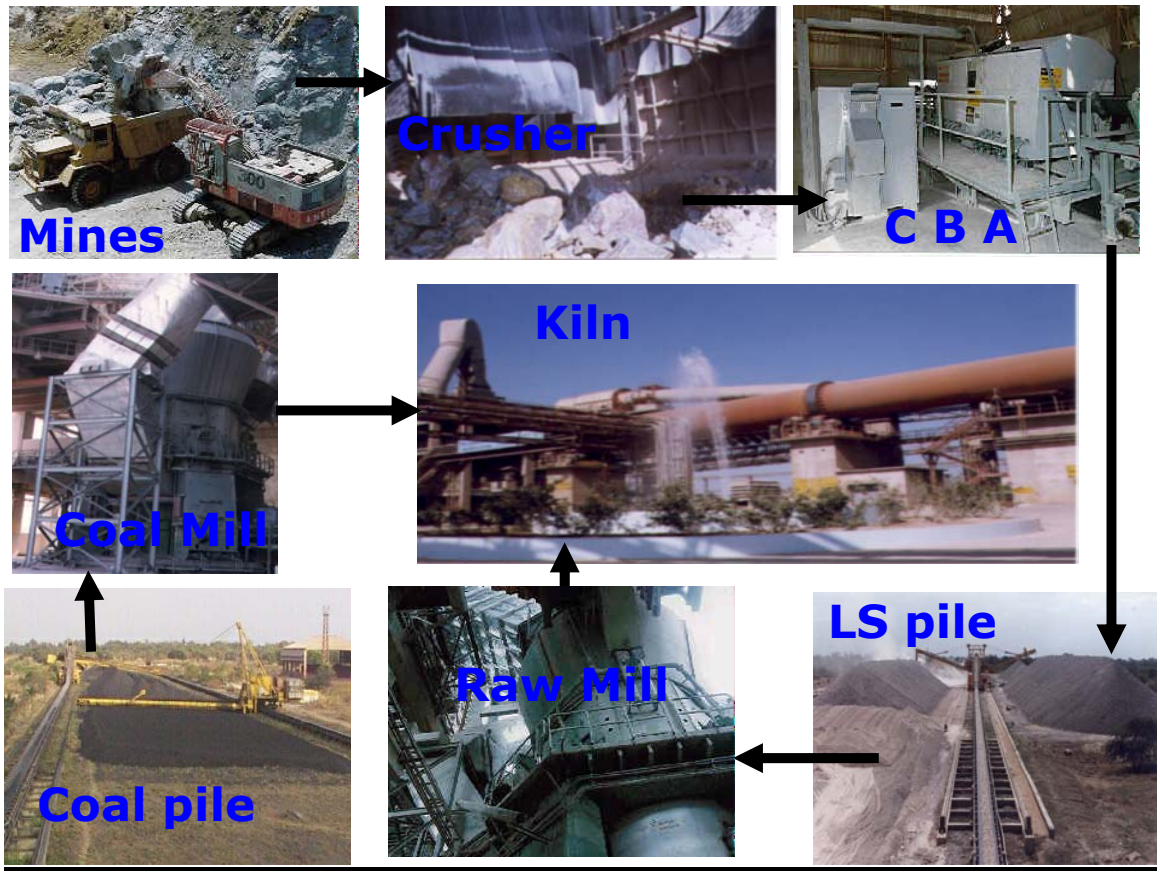
Project Implemented by : Grasim Cement, Raipur

Project Implemented in : 2003

Company Details

Grasim cement Raipur belongs to the cement division of Aditya Birla group and is one of the leading cement producers in the country. Grasim Cement Raipur, started operation in 1995. The present cement production capacity is about 1.2 Million MTPA (Million Tones Per Annum). Grasim, Raipur produces a wide variety of Cement including Ordinary Portland Cement (OPC 43 & 53 grades) & Portland Slag Cement (PSD).

Process details



Project Details

Back ground

During normal operation of the plant at about 4400 TPD, slight changes in coal and raw meal feed to the kiln had resulted in unstable operation.

It was observed that for 4400 TPD plant operation; the pre-calciner fan was operating at full speed. The pre-calciner fan outlet temperature was around 280^{o}C to 300^{o} and this resulted in frequent tripping of Electro static precipitator (ESP).

It was evident that the above problems were mainly because of the high temperature of the gas handled by the pre calciner fan.

Higher pre calciner gas temperature increases the volume of the gas handled by the pre caliner fan. Hence the fan was operating at full speed. Since the fan operation under these conditions did not have any additional margins, it was unable to respond to even slight changes in the kiln feed.

For the stable operation of the kiln, one solution available was to replace the existing precalciner fan with a new fan of higher capacity. This solution however would not have solved the problem of frequent ESP tripping.

The other possible solution was to reduce the volume of the air handled by the fan and thereby operate the fan at lower speeds. This option was preferred over the earlier one. To reduce the volume of air, a water spray system was installed in the pre-calciner down comer.

This resulted in reducing the temperature of the gases handled by the pre-calciner fan from around 290^{o}C to 250^{o}C.

This solution solved both the problems of kiln instability and frequent ESP tripping. At present the fan is operating at 95% of the rated speed for 4400 TPD operating capacity.

Issues faced during Implementation

No major issues were faced during the implementation of the project.

Comments from the Plant Team

Installation of water spray system in precalciner down comer helped in stabilising the klin operation, by reducing the volume of hot gases handled by the precalciner fan. This initiative also reduced ESP trip.

Financing of the Project

Investment requirement was very marginal. The investment has been taken up fully with internal funds.

Results of the Project

The per-caliner fan is operating at 95% speed for 4400 TPD operating capacity, resulting in reduction of fan power consumption by about **0.2 million kWh/year**.

Financial benefits

The annual savings achieved is **Rs 0.67 Million (USD 0.016 Million USD)**. The investment made is about **Rs 0.23 Million (USD 0.0056 Million).** The simple payback period is **5 Months.**

Annual savings	**–Rs 0.67 million (USD 0.016 Million USD)**
Investment	**–Rs 0.23 million (USD 0.0056 Million)**
Payback Period	**–5 Months**

Contact Information of the Plant

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Case Study : 25

REDUCTION OF LIME STONE RECLAIMER POWER BY AUTOMATICALLY CONTROLLING THE TRAVEL DRIVE SPEED BASED ON SCRAPPER LOAD

Project Implemented by : Grasim Industries Limited
Cement Division –South, Reddipalayam

Project Implemented in : 2003-04

Company Details

Grasim Industries Limited, Cement Division is one of leading manufacturers of cement in India. Grasim Cement, Reddipalayam is located in Tamilnadu and started its operations in April 2000. It is one of the modern plants with latest technologies like, robot lab & laboratory information management system. The production capacity of the plant is 1.16 Million TPA. Grasim Cement, Reddipalayam is an ISO 14001, ISO 9001:2000 and ISO 18001 certified company.

Project Details

Back ground

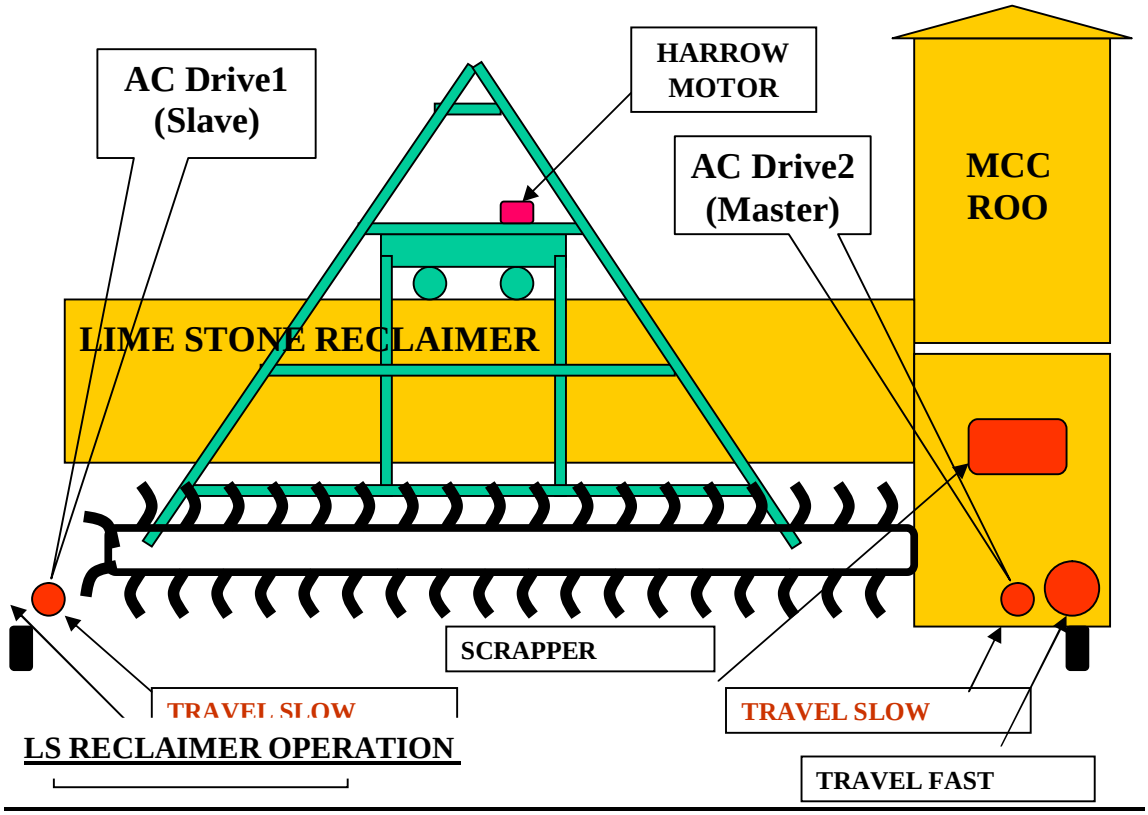
The limestone from the crusher is conveyed to the stacker and reclaimer for maintaining homogeneous raw material mix. Reclaimer is used to convey the raw material to raw mill hopper for further size reduction in raw mill.

The reclaimer system consists of scrapper drive, harrow drive, travel drive and belt conveyors. The travel drive is fitted with variable frequency drive and it moves in longitudinal direction. The travel drive was operated manually by adjusting the speed of motor.

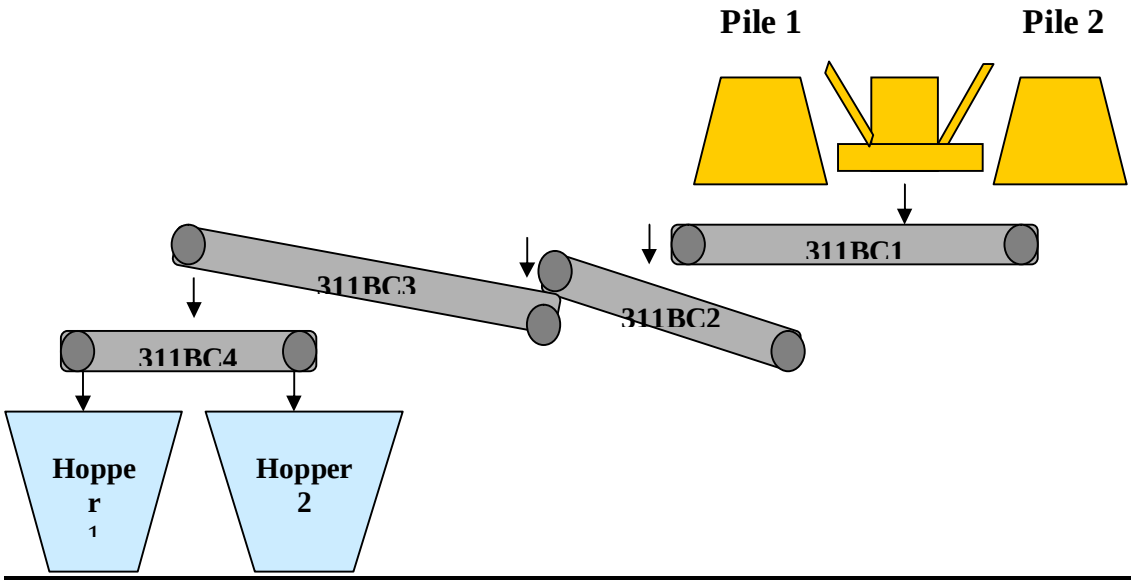
The plant team faced the problem of

- Raw mill stoppage due to want of material.
- Reclaimer stoppage due to scrapper chain overloading.
- Power Loss due to the idle running and frequent start/stop of the reclaimer and raw mill

The schematic of limestone reclaimer is given below.



LS RECLAIMER OPERATION



Action taken

To overcome the above problems and improve the efficiency of the system, the plant team interlocked the speed of travel drive with the load of the scrapper drive. The following action was taken:

- Analog Card was installed in Reclaimer PLC to have analog feed back like current
- Current Transducer installed for Scrapper Chain Load
- PID control programmed in PLC for control of Travel Drive speed with respect to Scrapper Chain Load

Issues faced during implementation

No major issues were faced during the implementation of the project.

Comments from the plant team

Automation of the limestone reclaimer system was done to eliminate the idle running of reclaimer, raw mill etc., and to increase productivity by avoiding raw mill stoppages that was previously happening due to shortage of material.

Financing of the Project

The plant has invested about Rs 0.04 Million for analog cards and current transducer. The investment has been taken up fully with internal funds.

Results of the Project

The implementation of the project has resulted in an energy savings of about 200 kWh per day. Apart from the direct energy savings, the following benefits were achieved:

- Frequent stoppage of raw mill, due to shortage of material avoided
- Reclaimer stoppages due to scrapper motor overloading reduced and overheating of slip rings was avoided.
- Output increased due to speed optimization .
- Operator intervention reduced.
- Idle operation of equipment eliminated.

Financial Benefits

The annual savings achieved is Rs 0.39 Million (USD 0.009 Million).
The investment made is about Rs 0.04 Million (USD 0.001 Million) .
The simple payback period is 2 Months.

Annual savings	–Rs 0.39 Million (USD 0.009 Million)
Investment	–Rs 0.04 Million (USD 0.001 Million)
Payback Period	–2 Months

Contact Information of the Plant

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Case Study: 26

INSTALLATION OF ENERGY EFFICIENT HYDROFOIL AGITATORS

Project Implemented by : Jubilant Organosys Ltd., Nanjangud
Project Implemented in : 2006

Company Details

Jubilant Organosys Limited is an Integrated Pharmaceutical Industry player with a wide range of products and services for global life sciences companies. The company is one of the largest custom researches and manufacturing services (CRAMS) and drug discovery services companies in India.

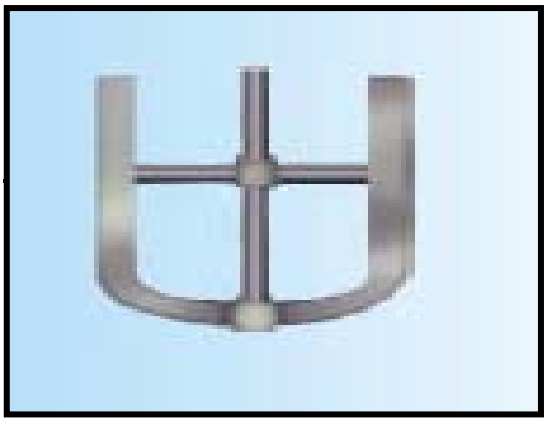
Jubilant Organosys is a group of company having annual turnover of Rs. 15,000 Million. Jubilant Organosys is an ISO 9001, ISO 14001 OSHAS 18001 Certified and CGMP compliant and USFDA approved plant. Jubilant Organosys manufactures wide range of nearly 30 Active Pharma Ingredients and markets globally. The plant follows six sigma approach and QC tools.

Project Details

Agitators are the key process equipment in any pharmaceutical unit, where major products form lots of solid suspensions during the reaction and needs thorough mixing. The final reaction and quality of product is depends upon the rate of mixing and bonding of ingredients.

Agitator is a mechanical device used in a spray tank to ensure uniform distribution and mixing of the product during dilution and to prevent sedimentation.

Conventional Agitators



Conventional / Anchor type impellers are generally used. It is most effective in squatty batches where vertical pumping is not as important as in tall batches.
The system specifications & advantages of conventional anchor type agitators are

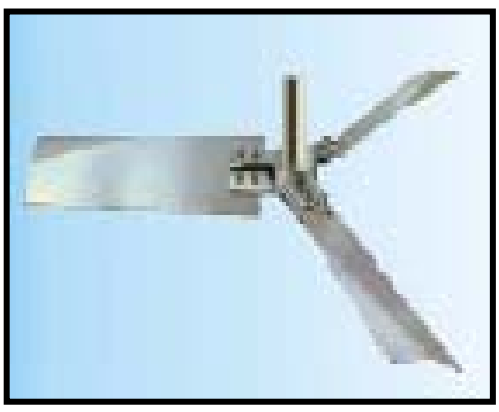
- Better Heat transfer in viscous media
- Most economical for laminar flow

Energy efficient Agitators

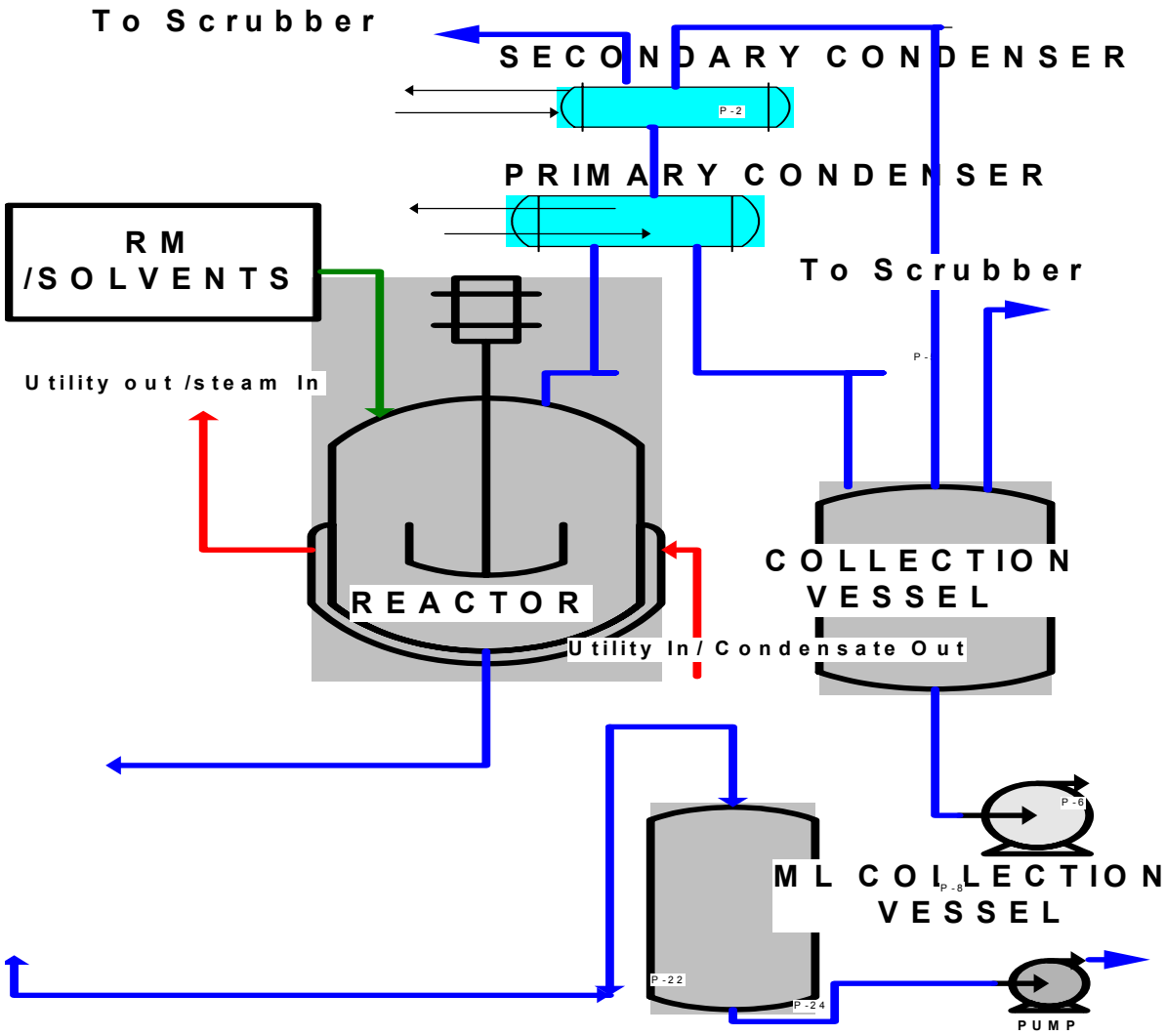
New energy efficient hydrofoil agitators are of axial fan type and are specially designed for low power consumption and high efficient mixing. It is ideal for blending (due to low shear forces), heat transfer and solid suspension. The fan axis/blades are very narrow so that better heat transfer will be take place.

Due to special aerofoil shape design, these hydrofoil agitators are extremely efficient and create greater fluid motion with less energy consumption.

Hydro foil agitators



Process flow diagram



Issues faced during Implementation

No major issues were faced during the implementation of the project. The project could be implemented in a short period of time.

Comments by the Plant Team

Installation of aerofoil agitators is a new concept to the pharmaceutical Industry. The project was taken up as a technology up gradation initiative after a lot of research. The agitators were installed after a trial run and are running successfully. Good

potential exists across chemical and pharmaceutical Industry for installing aerofoil agitators in various reactors.

Financing of the Project

The investment has been taken up fully with internal funds. The project required an investment of **Rs 2.2 Million (USD 0.053 Million)**.

Results

Installation of the new energy efficient agitators in place of conventional agitators led to more efficient mixing thereby increasing the yield as well as reduction in power consumption to the tune of 70 %. Replacement of 8 agitators together contributed to a monetary benefit of Rs. 2.12 million per annum. Apart from this yield increase by 18% resulted in saving of **Rs 40 Million/annum (USD 1 Million)**. Considering the energy saving aspect alone, pay back period works out to **13 months**.

Annual savings	**– Rs 40 Million (USD 1 Million)**
Investment	**– Rs 2.2 Million (USD 0.053 Million)**
Payback Period	**–13 Months**

Contact Information of the Plant

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Case Study: 27

MODIFICATION IN CO_2 SYSTEM TO REDUCE THE STEAM CONSUMPTION

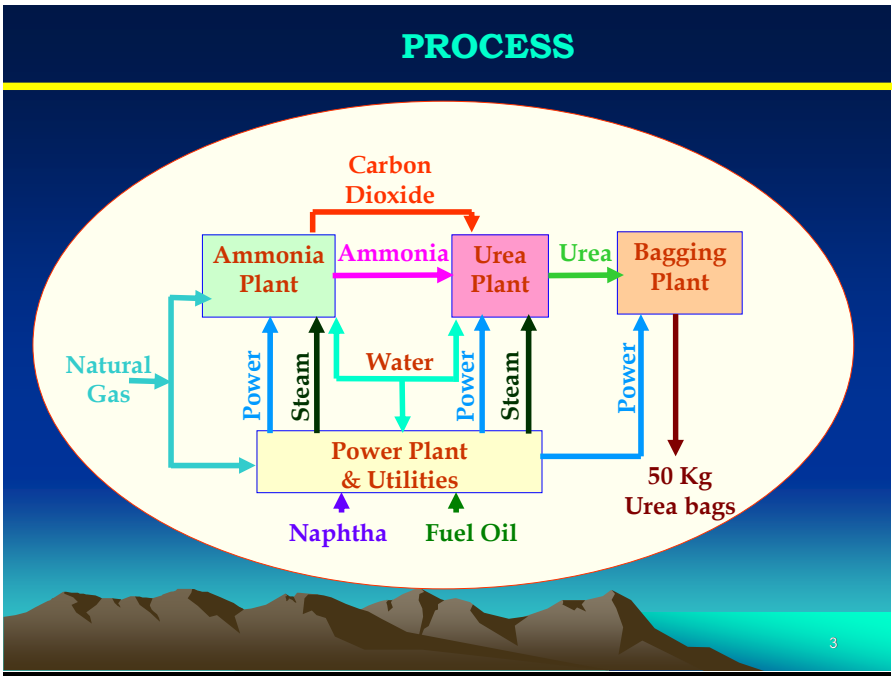
Project Implemented by : Indo Gulf Fertilizers Ltd, Jagdishpur

Project Implemented in : 2004

Company Details

Indo Gulf Fertilizers Ltd, the Fertilizer Division of the Aditya Birla Group is one of the largest and most cost-efficient producer of fertiliser in India in the private sector.

This Fertilizer unit Produces and markets urea, a nitrogenous fertilizer used in the agriculture-intensive Indo-Gangetic plain of India. This region contributes to over 40 per cent of the total urea consumption in India. The plant is in operation since 1998, the capacity of this plant is 8, 64,600 tones per annum (tpa).



Project Overview

The production of urea is through Natural Gas Reforming for Ammonia & urea is produced by ammonia stripping.

The CO_2 production is part of ammonia process and also it is later utilised for urea or nitrogenous fertilizer.

Co_2 removal system

The CO_2 removal system consists of an absorber tower in which **hot potassium carbonate solution** is circulated which absorbs carbon-di-oxide from the process gas, a high pressure regenerator which desorbs this CO_2 from the solution with the help of steam and pressure reduction, a low pressure tower where pressure is further reduced for proper regeneration of the solution. This regenerated solution is again circulated in the absorber.

The evolution of co_2 is part of the ammonia process; a detailed process diagram of ammonia process consisting of co_2 removal is given below.

Process Flow Diagram

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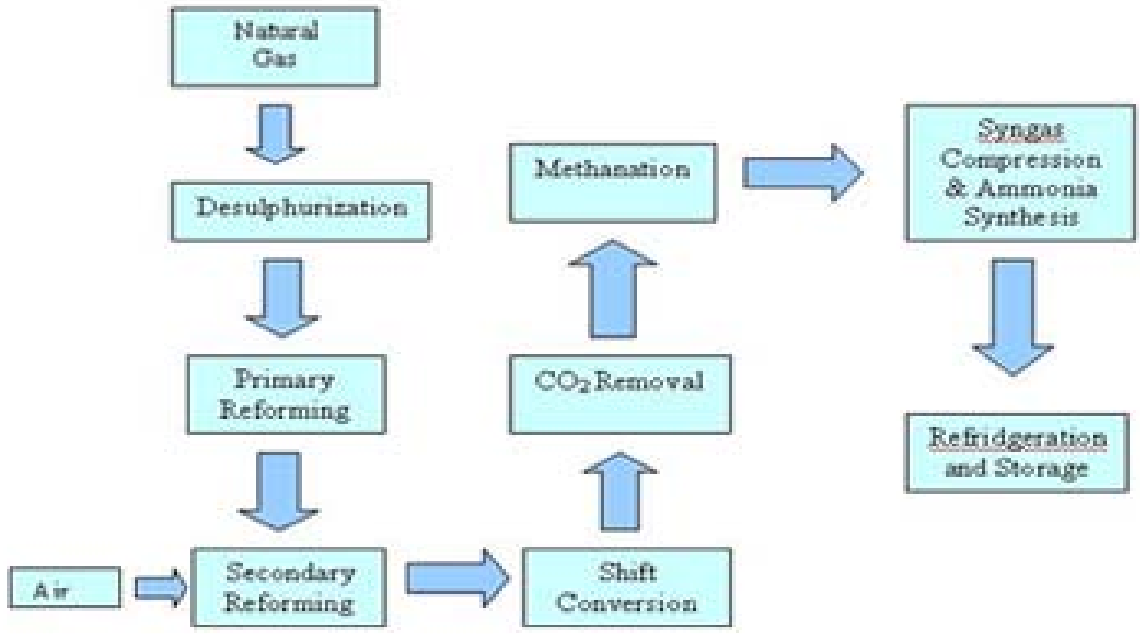


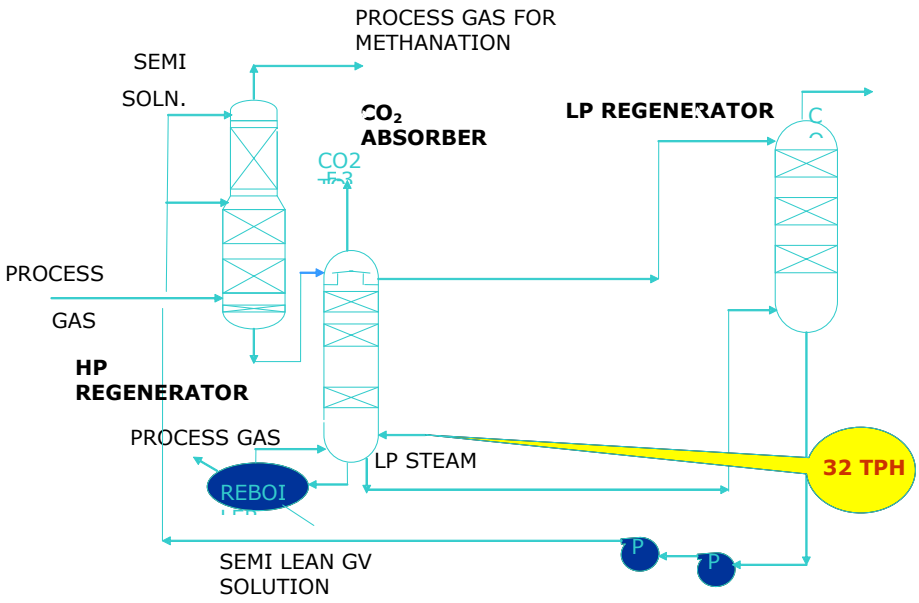
Description of the New Energy Efficient System

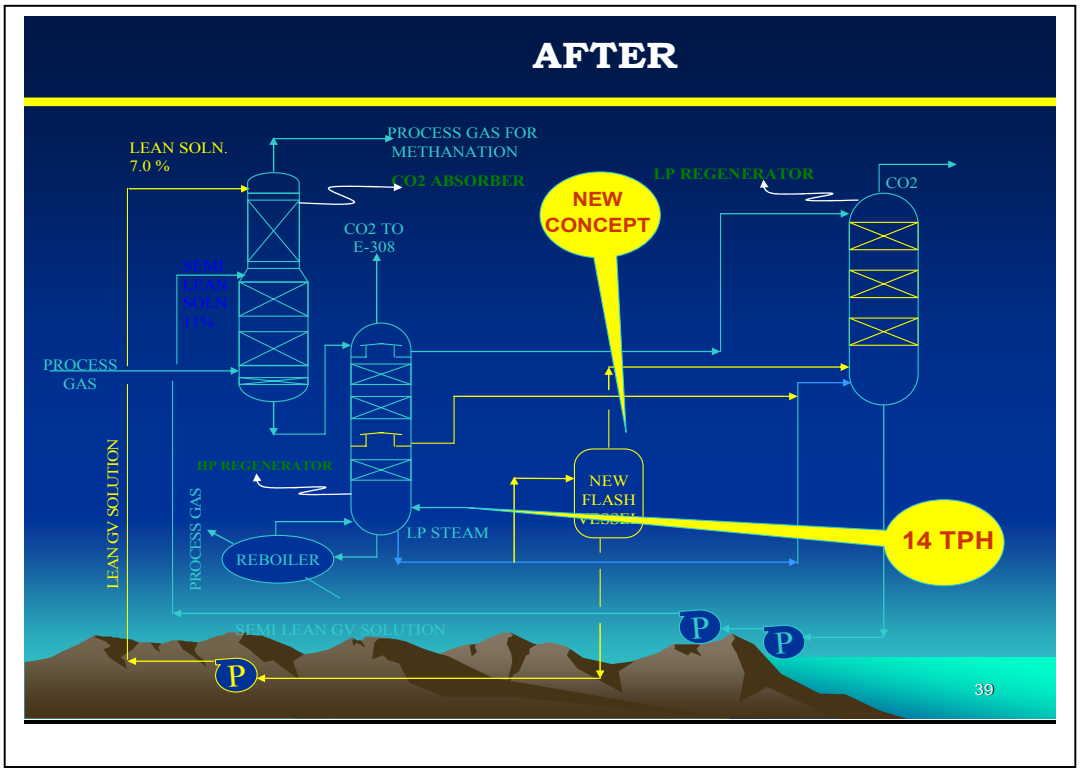
Usage of the older generation technology meant that 32 TPH of steam was required for regenerating CO_2 loaded K_2CO_3 Solution in IGFL. The comparative figure in latest Fertiliser plants is only 14 TPH.

To increase regeneration capacity of the **hot potassium carbonate solution** it is necessary that more of the solution should be flashed at lower pressure and less should be regenerated by the heat of steam. The flashing at lower pressure generates steam by itself which helps in better regeneration. To achieve the better regeneration of solution it was evident that load from HP tower should be shifted to LP tower.

The preliminary cost estimation by the plant team revealed that the cost for a new configuration would be around Rs.44.1 Million. The payback period of about 18 months was a good return on investment and the project was kicked off. The lateral thinking of IGFL technical team helped them in achieving the targeted figures.

The new system required additional equipment such as pumps, exchanger and a flash vessel which were procured and installed. The process diagram before and after implementation of the project is as shown.





Issues Faced during Implementation

This project was implemented as part of technology up gradation scheme. The project was implemented during the annual plant shutdown. No major problems were encountered during implementation of the scheme.

Comments from the Plant Team

The technology supplier was of the opinion that Modification in CO_2 removal section for an old Generation plant is not viable. Further this modification would involve a major revamp of the section along with new vessels, pumps and installation of one 60 Meter height Tower. The cost quoted by the Technology supplier was Rs 120 Million and the cost savings projected was around Rs 30 Million per annum which meant that the pay back period was around 4 years.

On receiving these comments the plant team carried out a detailed benchmarking study, comparing the existing equipment sizing / dimensions with those of latest plants In India.

The plant team concluded that an investment of Rs 44 Million would be required for the scheme developed in house and the same would give a saving of around Rs 26 Million per annum, which meant a pay back period of 18 Months. Hence it was decided to implement the in house scheme.

The successful implementation of the project shows that engineering capabilities of in house teams could be of immense potential in implementing energy saving schemes, especially with respect to systems which are slightly older.

Financing of the Project

The plant has invested about **Rs 44.1 Million (USD 1.102 Million)** for implementation of the project. The investment was taken up fully with internal funds.

Replication Potential

Applicable in fertilizer plants having old generation CO_2 removal system

Results of the Project

The annual savings achieved is **Rs 27.1 Million (USD 0.677 Million)**. The investment made for this project is **Rs 44.1 Million (USD 1.102 Million)**. The simple payback period is **18 Months**.

Annual savings	**–Rs 27.1 Million (USD 0.677 Million)**
Investment	**–Rs 44.1 Million (USD 1.102 Million)**
Payback Period	**–18 Months**

Contact Information of the Pant

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Case Study: 28

FLARE GAS RECOVERY SYSTEM IN REFINERY

Project Implemented by : Reliance Industries Limited, Jamnagar

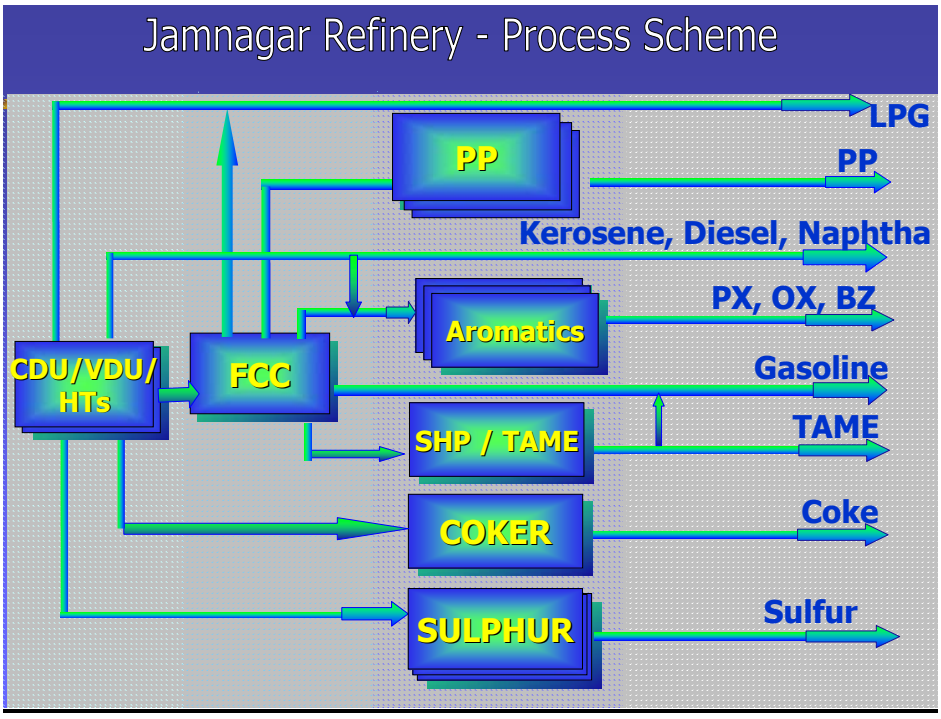
Project Implemented in : 2004

Company Details

The Reliance Group, founded by Dhirubhai H. Ambani is India's largest private sector enterprise. The flagship company, Reliance Industries Limited, is a Fortune Global 500 company and is the largest private sector company in India.

Reliance operates the third largest refinery in the world at any single location, with a capacity of 30 million tons per year or 0.6 million barrels per day of crude throughput, at Jamnagar, Gujarat. This is the world's Largest Grass Root Refinery which boasts of the World's Largest FCCU (Fluidised Catalytic Cracker Unit), World's Largest Coker, World's Largest Aromatics Complex of capacity 1.6 MMTPA (PX + OX) and World's Largest PP of capacity 750,000 MTPA.

Process Flow Chart



Project Overview

A gas flare or flare stack is an elevated vertical stack found in oil rigs, refineries etc used for burning off unusable waste gas or flammable gas and liquids released by pressure relief valves during unplanned over-pressuring of plant equipment.

The primary purpose is to act as a safety device to protect vessels or pipes from over-pressuring due to unplanned upsets.

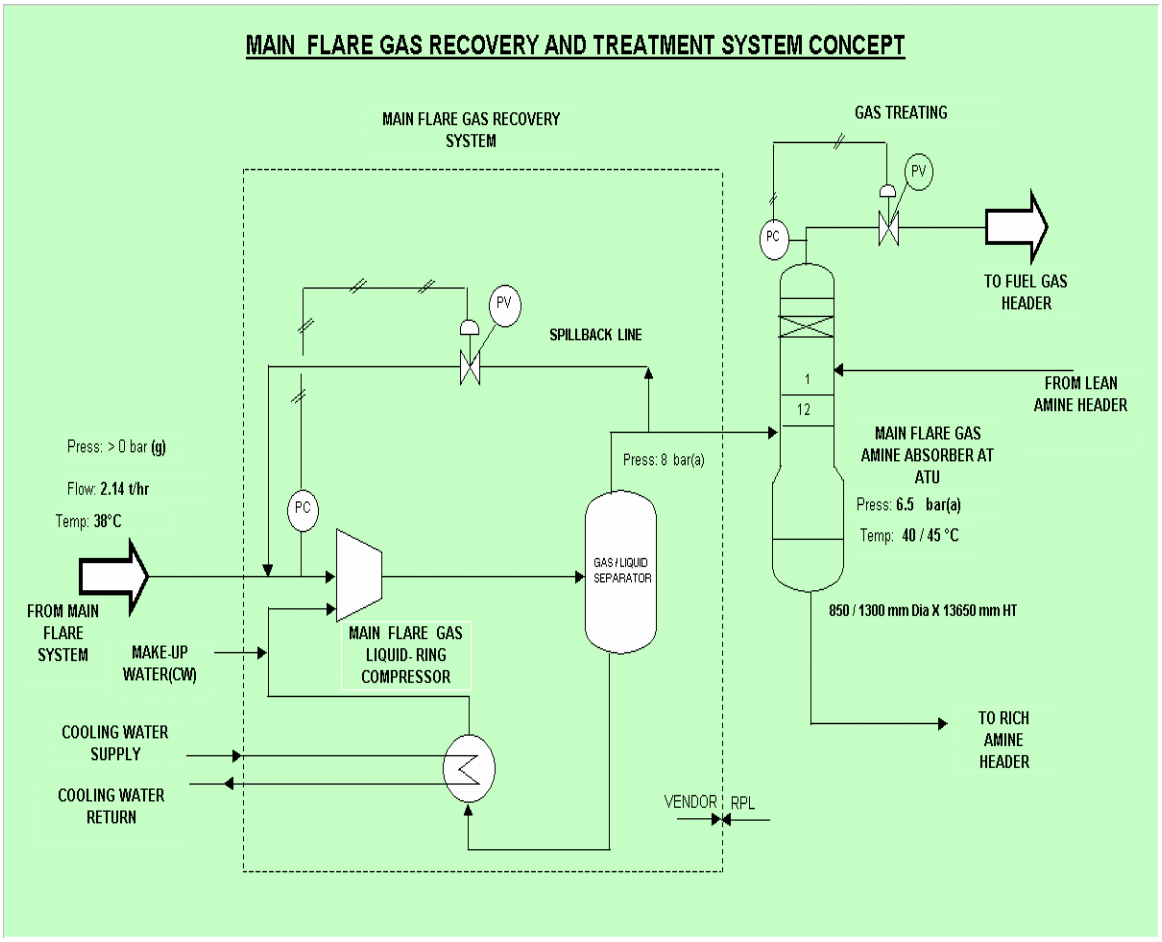
Whenever plant equipment items are over-pressured, the pressure relief valves on the equipment automatically releases gases (and sometimes liquids as well) which are routed through large piping runs called flare headers to the flare stacks. The released gases and/or liquids are burned as they exit the flare stacks.

In order to keep the flare system functional, a small amount of gas is continuously burned, like a pilot light, so that the system is always ready for its primary purpose as an over-pressure safety system. Some flares have been used to burn flammable "waste" gases or by-products that are not economical to retain. The industry is moving to flare-gas recovery systems to decrease waste and reduce emissions.

This as a progressive approach towards energy efficiency

In the Plant the Flare System consisted of Main Flare, Low Pressure Flare, Acid Gas Flare and PP Flare. The plant has been undertaking various efforts to minimise flaring including checking of passing valves by Acoustic Flare meter. In spite of the above efforts to reduce flaring, Main Flare flow was 52 TPD of Hydrocarbon.

Process Diagram



Description of the Project

The Process consists of two compressors which take suction from the flare gas header upstream of the Liquid Seal Drum, compresses the gas and cools it for reuse in the Refinery Fuel Gas system.

Normally the flare gases bubble through water seal in the seal drum upstream of the flare stack. The liquid level in the seal drum imposes a positive backpressure in the flare header and thus ensures that air is not drawn into the flare system. For providing a better suction pressure while avoiding air ingress to suction of flare gas recovery compressor, modifications are required to be carried out to increase the water level in the water seal drum.

FGRS is located downstream of knockout drums as all flare gas from various units in the refinery is available at this single point. It is located just upstream of the seal drums as pressure control at the suction to compressor will be maintained precisely, by keeping increased height of water column in the drum.

The arriving flare gas enters the compressors at 1.1 bar and at 380C. A continuous reticulating flow of process water enters the compressors for compression, sealing and cooling of gas.

After leaving the compressors the gas, water and hydrocarbons mixture runs into the horizontal Gas/Liquid separator where the compressed gas is separated from the water and condensed hydrocarbons by gravity due to lower gas speed. The separated flare gas runs through demister before leaving the G/L separator in order to have a minimum water and condensed hydrocarbons content in the outlet gas stream and leaves from the top at 8.0 bar and about 500C. The process water leaves the G/L separator from the bottom where it is pushed back to the compressors due to the pressure differential between G/L separator and compressor inlet (liquid ring).

The normal operating liquid ring flow rate is about 32 m3/hr at 380C. A common shell and tube cooler on the liquid ring line assures the continuous cooling of the ring and therefore isothermal gas compression. The cooler is designed for the duty of the two compressors.

The flare gas is dry but during compression process it becomes saturated with water. This causes a continuous water decrease in the system. Due to this fact and to clean up the liquid ring process water from hydrocarbons, there is a process water line in the compressor suction line for continuous water make up.

The condensed hydrocarbons overflow into OWS from where they are discharged by means of level control valve. The process water overflows through a weir into a collecting compartment. The level into the compartment is guaranteed by the control valve that is controlled by the level transmitter. The excess water is sent to OWS.

The unit has a bypass between the inlet and outlet of the unit to control the inlet line pressure. If the inlet pressure decreases below a certain value the valve starts opening till full recycle is established (no gas available).

The gas stream from the G/L separator is routed to the Flare gas Amine Absorber where the gas is amine treated to remove H2S present in the gas. The treated gas from the Amine Absorber goes to the Fuel Gas header.

If the volume of gas relieved into the flare system exceeds the capacity of FGRS, the excess gas volume will flow to flare stack. If the volume of gas relieved into the flare system is less than the full capacity of the recovery unit, a spillback valve will divert the discharged gas back to the suction header, to maintain the capacity of FGRS.

Issues during Implementation

This project was implemented as part of technology up gradation during annual plant shutdown.

Comments by the Plant Team

Flare gas recovery systems present a good opportunity for waste heat recovery in most of the refineries.

Replication Potential

Replication potential in all petrochemical plants

Financing of the Project

The plant has invested about **Rs 100 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

The annual savings achieved is **Rs 140 Million (USD 3.5 Million).** The investment made for this project is **Rs 100 Million (USD 2.5 Million).** The simple payback period is **9 Months**.

Annual savings	**– Rs 140 Million (USD 3.5 Million)**
Investment	**– Rs 100 Million (USD 2.5 Million)**
Payback Period	**–9 Months**

Contact Information of the Plant

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Case Study: 29

INLET AIR FOGGING SYSTEM FOR GAS TURBINE CAPACITY AUGMENTATION & PERFORMANCE IMPROVEMENT

Project Implemented by : Reliance Industries Limited, Jamnagar

Project Implemented in : 2004

Company Details

The Reliance Group, founded by Dhirubhai H. Ambani is India's largest private sector enterprise. The flagship company, Reliance Industries Limited, is a Fortune Global 500 company and is the largest private sector company in India.

Reliance operates the third largest refinery in the world at any single location, with a capacity of 30 million tons per year or 0.6 million barrels per day of crude throughput, at Jamnagar, Gujarat. This is the world's Largest Grass Root Refinery which boasts of the World's Largest FCCU (Fluidised Catalytic Cracker Unit), World's Largest Coker, World's Largest Aromatics Complex of capacity 1.6 MMTPA (PX + OX) and World's Largest PP of capacity 750,000 MTPA

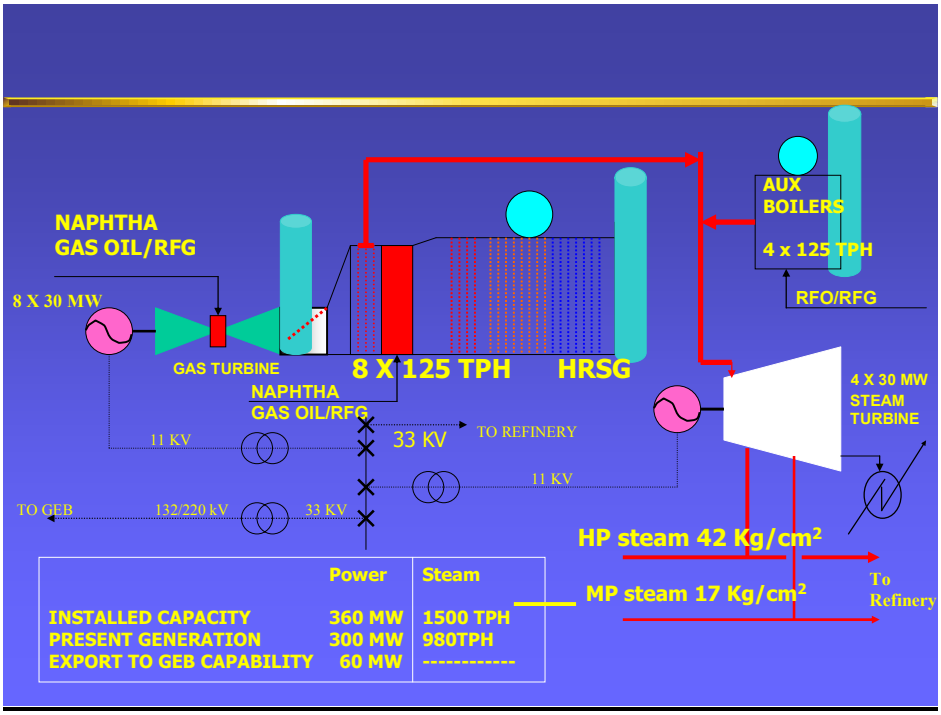
Project Overview

Gas turbines utilise combustion air thorough an inlet air system which consists of a compressor for compressing air so that density of air is higher for the same inlet volume.

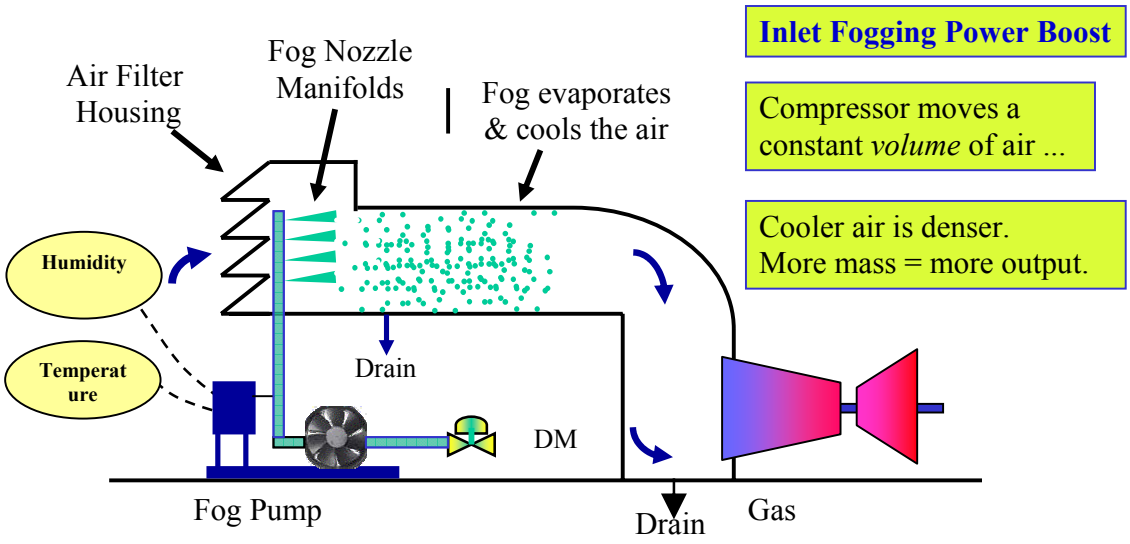
The density of the air (or the total amount and number of air molecules) increases as the temperature decreases. This results in a greater amount of air which then flows through the turbine resulting in higher efficiency, which means more power is produced.

The compression of the air inside the turbine is more efficient at lower temperatures. Gas turbines operate at higher efficiencies when the inlet air is cooler. When cooler air is provided to the turbine, additional power is generated by the turbine. Inlet air cooling for Gas Turbines can be achieved by Evaporative cooling or Air Chilling.

Process Diagram of the Captive Power Plant



GT Inlet Air Fogging Diagram



Cooler inlet air reduces
Compressor sp.work ➜ increased output.

Weather data was studied for the entire year for deciding the cooling parameters. Wet bulb depression was found varying from 0-16oC.

Accordingly maximum cooling capability was selected as 16oC in steps of 1oC. Under cooling set point was kept at 1oC. The system incorporates provision for reduction of set point during the part load.

The following Modifications carried out as part of the modification. Each GT was provided with DM water connection. Fogging Nozzles were installed in GT inlet air duct. High pressure pumps are put in operation for fine spray. The pressure is maintained at 2000 psig. Laser drilled spray nozzles with size of 0.006" was utilised for producing spray size of 14 micron.

Interconnecting pipes were installed from pump skid to fogging module. The drain connection was provided from the duct at the location of Fog nozzle. The skid was to be operated from the DCS and Instrumentation for operation control was also installed.

Weather computer has been utilised for auto operation of the entire system.

Issues during Implementation

This project was implemented as part of technology up gradation during annual plant shutdown.

Comments from the Plant Team

Inlet air fogging is a proven method to enhance the Power generation of Gas Turbines. The scheme can be implemented involving a combination of in house engineering expertise and overall guidance of the OEM.

Financing of the Project

The plant has invested about **Rs 95 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Replication Potential

The project has Replication potential in all gas turbine based power plants, in various sectors. The potential varies with the geographic location of the Plant.

Results of the Project

Inlet air fogging in Gas turbines (8 Nos) has increased the Total power generation increased by 7.32 MW. Since gas turbine Power generation was enhanced, the condensation load of the Steam turbine generators was reduced there by resulting in a saving of 28.8 TPH of HHP steam.

This steam was being generated by HRSGs (Heat recovery Steam Generators). The supplementary fuel firing in HRSGs was bought down. The net fuel saving (Decrease in supplementary firing of HRSGs compared to Increase in Fuel consumption in GTs) works out 1.76 TPH.

The Total annual savings due to implementation of the project works out to **Rs 227 Million (USD 5.675 Million)**. The investment is **Rs 95 Million (USD 2.375 Million)** with a Payback period of **5 months**.

Annual savings	**–Rs 227 Million (USD 5.675 Million)**
Investment	**–Rs 95 Million (USD 2.375 Million)**
Payback Period	**–5 Months**

Contact Information of the Plant

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Case Study: 30

USE OF RADIANT RECUPERATIVE HEATING IN PLACE OF ELECTRICAL HEATING

Project Implemented by : Tata Motors, CVBU, Pune

Project Implemented in : 2004

Company Details

The Tata Group is one of India's oldest, largest and most respected business conglomerates. The Group's businesses are spread over seven business sectors. It comprises 96 companies and operates in six continents. It employs some 2,46,000 people and collectively has a shareholder base of over two million and market capitalisation of $57.6 billion.

Established in 1945, Tata Motors is India's largest automobile company, with revenues of Rs 24,000 crore (USD 5.5 billion) in 2005-06. The company is the world's fifth-largest medium and heavy commercial vehicle manufacturer.

Tata Motors' product range covers passenger cars, multi-utility vehicles as well as light, medium and heavy commercial vehicles for goods and passenger transport

Project Overview

Heating applications could be based either on Electrical Source (electric Heaters) or on Thermal source (LPG, FO etc). Comparison of cost of heating between various sources is done by comparing the values of Rs/ kCal.

Electrical heaters are utilised for heating in heat treatment furnaces. Based on electricity cost of Rs 4.00/unit, the cost of electrical heating is about Rs 4700/MMkCal. (USD 118 / MM kCal)

The cost of thermal heating is only about 50% of the cost of electrical heating (with furnace oil as fuel). The cost is about Rs 2400 /MMkCal (USD 60 / MMkCal)

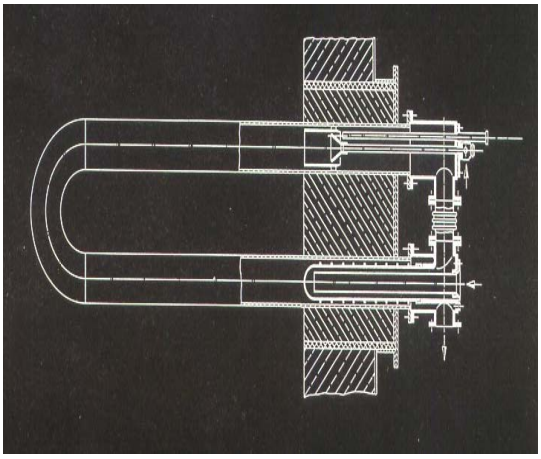
There is a good potential to reduce the energy cost used for heating, by utilising thermal heating in place of electrical heating.

One of the ways this can be achieved with the help of radiant recuperative heaters.

Earlier, for all applications involving material to be heated to the range of 1000^{o}C to 1200^{o}C, electrical heaters used to be the only alternative available. Usage of thermal heating meant direct impingement of flue gas on the material to be heated up. This interfered with the material properties.

Radiant recuperative heaters help overcome this limitation. In radiant recuperative heaters, the flue gas doesn't come in contact with the product. The heat transfer takes place by radiation. Also The combustion air can be preheated up to the temperature of 600^{o}C.

The schematic diagram of the radiant recuperative heater is given below.



Issues During Implementation

During the project implementation no issues were faced.

Comments from the Plant team

The idea of using thermal source of heating instead of electrical energy came from the operation team. With the improvement in technology and the advent of radiant recuperative furnaces, thermal heating using sources like Furnace Oil are of comparatively lesser cost.

Financing of the Project

The plant has invested about **Rs 0.375 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Replication Potential

Replication potential is very high for most of heat treatment furnaces in engineering and automobile industries.

Results of the Project

The annual savings achieved is **Rs 0.251 Million (USD 0.006 Million).** The investment made for this project is **Rs 0.375 Million (USD 0.009 Million)**. The simple payback period is **18 Months.**

Annual Savings	**–Rs 0.251 Million (USD 0.006 Million)**
Investment	**–Rs 0.375 Million (USD 0.009 Million)**
Payback Period	**–18 Months**

Contact Information of the Plant

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Case Study: 31

IMPROVEMENT IN LOADING OF PAINT SHOP AND ELECTRO DEPOSITION BY MODIFYING THE SKID

Project Implemented by : Tata Motors, Jamshedpur

Project Implemented in : 2004

Company Details

Tata Motors is India's largest automobile company, with revenues of Rs 24,000 crore (USD 5.5 billion) in 2005-06.

The company is the world's fifth-largest medium and heavy commercial vehicle manufacturer.

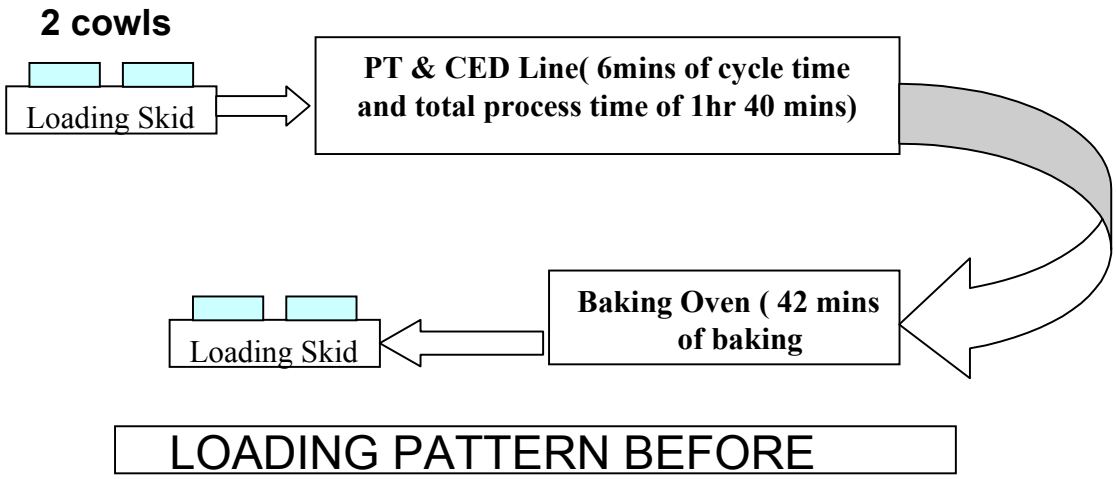
Tata Motors' product range covers passenger cars, multi-utility vehicles as well as light, medium and heavy commercial vehicles for goods and passenger transport

Project Overview

Pre-treatment & Electro Deposition of the automobile bodies are carried out in the paint shop through skid assembly in batch process. The earlier assembly line it was possible to load only 2 Cowl bodies on a loading skid.

Increasing the loading and capacity utilization minimizes the energy consumption. Hence various options were explored for improving the loading of the skid.

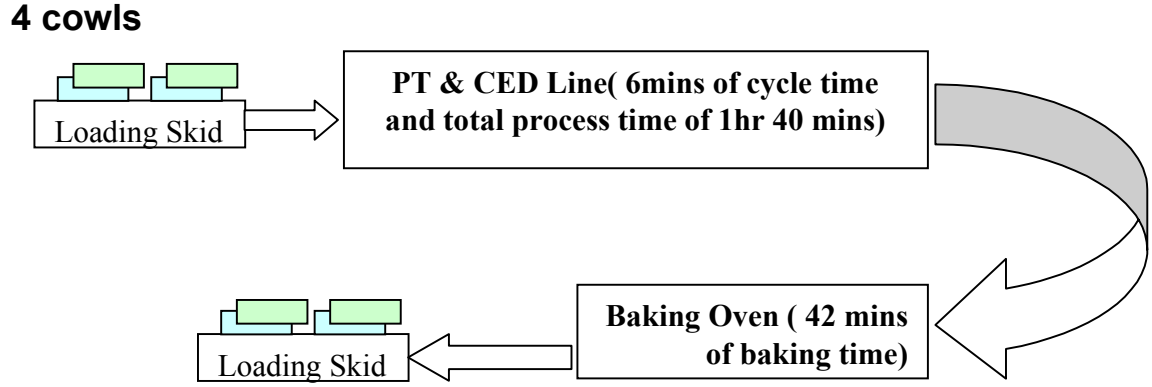
Before Modification



LOADING PATTERN BEFORE

With very small modification made, the loading of the skid increased from 2 cowl bodies to 4 cowl-bodies within the conveyor space constraint.

After Modification



LOADING PATTERN AFTER

This increased the number of cowls by 20 per shift or 40 nos/day reduced the number of shifts operation. This has resulted in saving fuel & electrical power with an improvement of 18% in production and thus reducing specific energy consumption.

Issues during Implementation

This project was implemented and no issues were faced during implementation.

Financing of the Project

The plant has invested about **Rs 0.004 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Replication Potential

Replication potential in all automobile plants

Results of the Project

The annual savings achieved is **Rs 1.14 Million**. This also resulted in additional fuel saving of **Rs 1.54 Million**. A total annual savings of **Rs 2.72 Million (USD 0.068 Million)** by implementing this project. The investment made for this project is **Rs 0.004 Million (USD 0.0001 Million)**.

Annual Savings –Rs 2.72 Million (USD 0.068 Million)
Investment –Rs 0.004 Million (USD 0.0001 Million)
Payback Period –Less than a Month

Contact Information of the Plant

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Case Study: 32

PRODUCTIVITY IMPROVEMENT IN BANBURY MIXER

Project Implemented by : JK Tyre, Kankroli

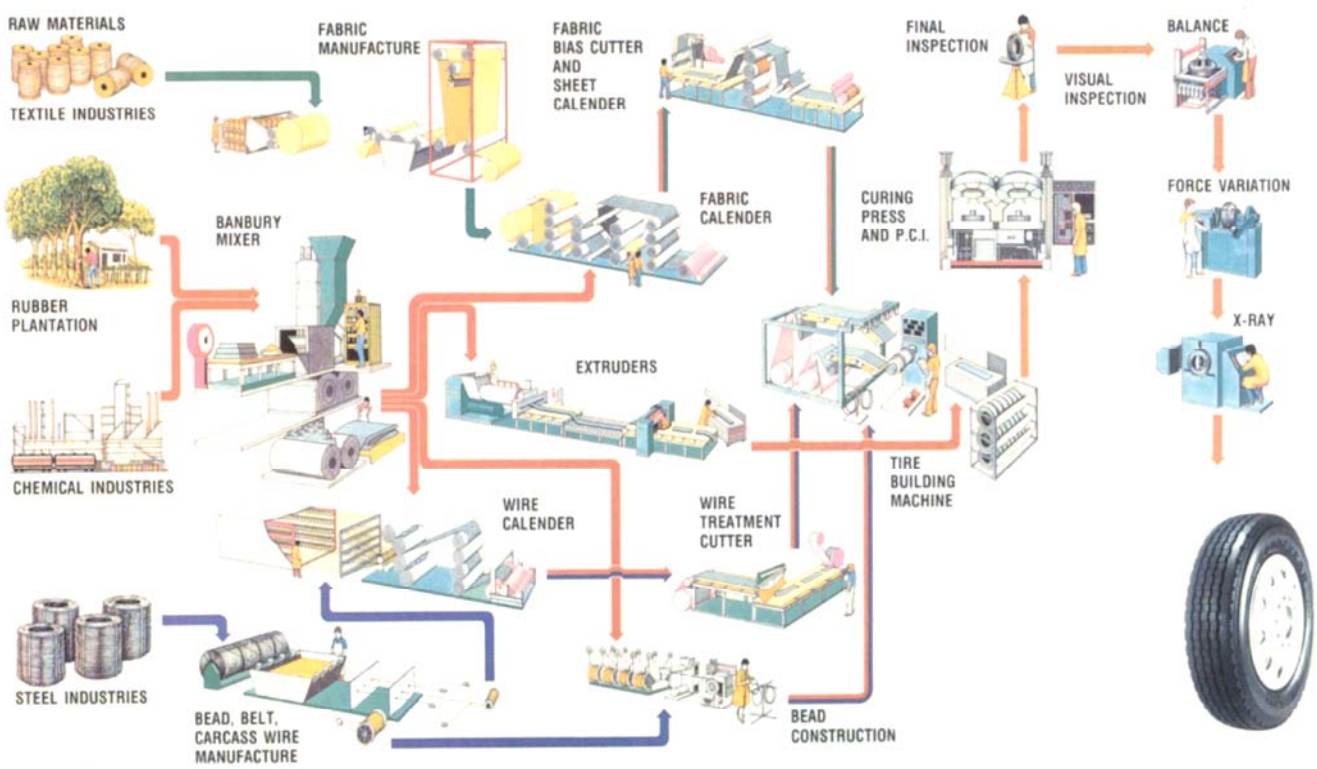
Project Implemented in : 2006

Company Details

J.K. Industries Ltd. started manufacturing tyres in 1977 and today is a leading tyre manufacturer in India, retailing its products under the brand names 'JK Tyre' and 'Vikrant'. The Company manufactures Radial and Bias 4-wheeler tyres for trucks, buses passenger cars, LCVs, tractors etc. It has four modern plants in India, located in the states of Rajasthan, Madhya Pradesh and Karnataka. The combined capacity across plants is 7.2 million tyres per year.

JK tyre is a leading automotive tyres, tubes and flap manufacturing company in India. JK tyre was established in 1976 with a starting capacity of 55 TPH. Today the total production capacity is increased to 210 TPD. JK tyre is one of the TS-16949 and ISO-14001 certified company. JK tyre achieved nearly 20 national and international Quality Circles awards and only tyre company in India having Super Brand status for 2003- 2005.

The process Diagram is as shown.



The tire manufacturing process.

Project Details

Banbury Mixer is one of the key and major power intensive upstream equipment in tyre industry. It consumes approximately 30% of total plant power. The purpose of Banbury Mixer is to produce the rubber compounds, which will go into tyre production.

Under utilization of any equipment compared to its rated value results in higher specific energy consumption and higher expenditure. Maximising the capacity utilisation of equipment in terms of production exceeding rated values, results in equipment operating with lower specific energy consumption (SEC).

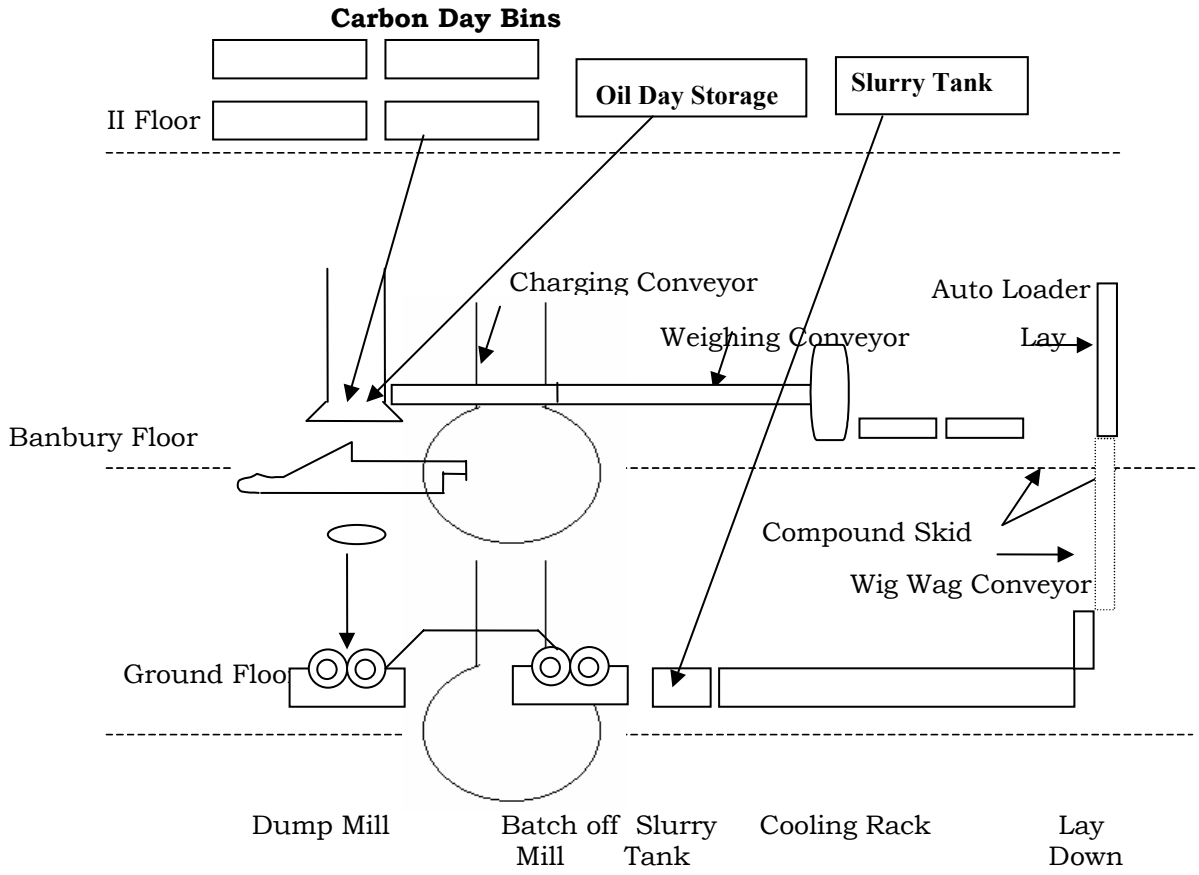
The plant decided to go in for a capacity expansion, maximising the margins available in the equipment. The Banbury Mixer was found to be the bottleneck for capacity improvement.

Banbury Mixer

Banbury Mixer has a wide range of applications, includes mixing and refining of raw materials, such as raw rubber, synthetic rubber, resin, asphalt, celluiese, PVC into even mixed stock. It is widely used in the plasticization of rubber and plastics and in the mixing of various sizing materials and plastics. The body and structure of this machine is strong and durable, making it suitable for heavy-duty mixing and refining operations.

Banbury line Diagram

Process flow diagram of Banbury Mixer is shown below



Productivity enhancement in Banbury Mixer

Once the plant team decided to go in for productivity enhancement, the first step was to identify any non productive part of the mixing cycle.

A cycle time analysis (time motion study) was conducted to identify the various cycle time elements. All these elements were subjected to critical review. The study was done for all the 4 ban burry mixers.

JK tyre deployed Single Minute Exchange of Die (SMED) technology for quick changeovers in the mixer and also arrived at internal best benchmarks for each operation.

Progress assessment and review of the process was done on a fortnightly basis.

Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Comments by the Plant Team

The idea of enhancing productivity by maximizing the capacity of existing banbury machines was taken up by the plant team as a productivity improvement exercise. A cycle time analysis (time motion study) was conducted to identify the various cycle time elements & then actions were suggested to minimize the non productive time of operation.

TPM approach is a structured approach which can ensure improvements in productivity in a structured manner, also ensuring lower specific energy consumption.

Financing of the Project

The investment was taken up fully with internal funds.

Results of the Project

The project contributed to enhancement of the productivity by reducing the cycle time by 8 %. The other benefits include reduction in loading / unloading time and optimization of mixer Speed, increased capacity utilization of various equipments in the downstream process etc. The specific power consumption (kWh/Kg) also reduced by 6-7 %. The total monetary gains including productivity improvement, amount to around **Rs. 3.0 Million /Year (USD 0.075 Million)**.

Annual savings	**–Rs 3.0 Million per Year (USD 0.075 Million)**
Investment	**–Negligible**

Contact Information of the Plant

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Case Study: 33

BACK FLUSHING OF INTERCOOLER AND AFTER COOLER IN AIR COMPRESSORS TO IMPROVE PERFORMANCE

Project Implemented by : Tata Motors, CVBU (Commercial Vehicles Business Unit) Pune

Project Implemented in : 2004

Company Details

Tata Motors is India's largest automobile company, with revenues of Rs 24,000 crore (USD 5.5 billion) in 2005-06.

The company is the world's fifth-largest medium and heavy commercial vehicle manufacturer.

Tata Motors' product range covers passenger cars, multi-utility vehicles as well as light, medium and heavy commercial vehicles for goods and passenger transport

Project Overview

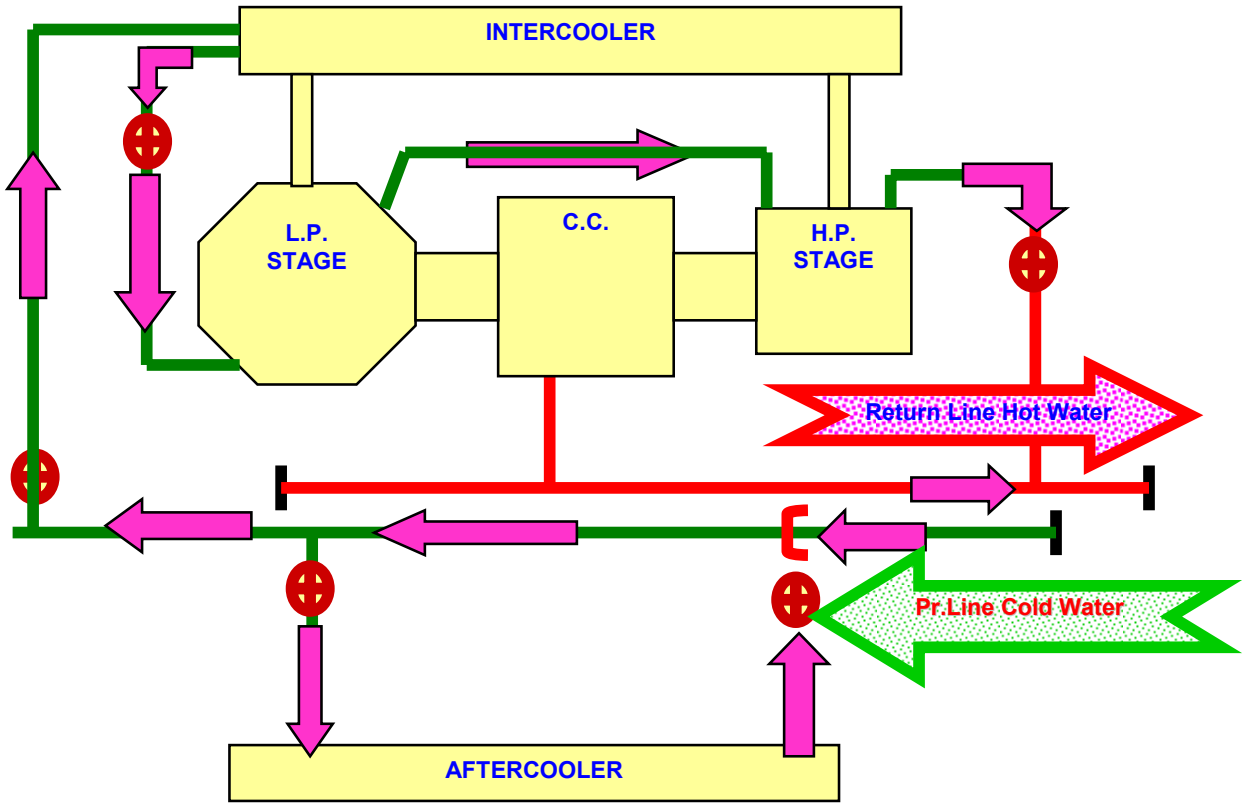
Two stage compressors are being used of compressed air generation in the plant. The compressed air system generation consists of both inter cooler & after cooler for cooling the air in stage and after compression level.

Water is used a medium for cooling the system and over a period of time due various reasons such as scaling etc the heat transfer rate reduces. This resulted in increased power consumption due to ineffective cooling of air.

Before Modification

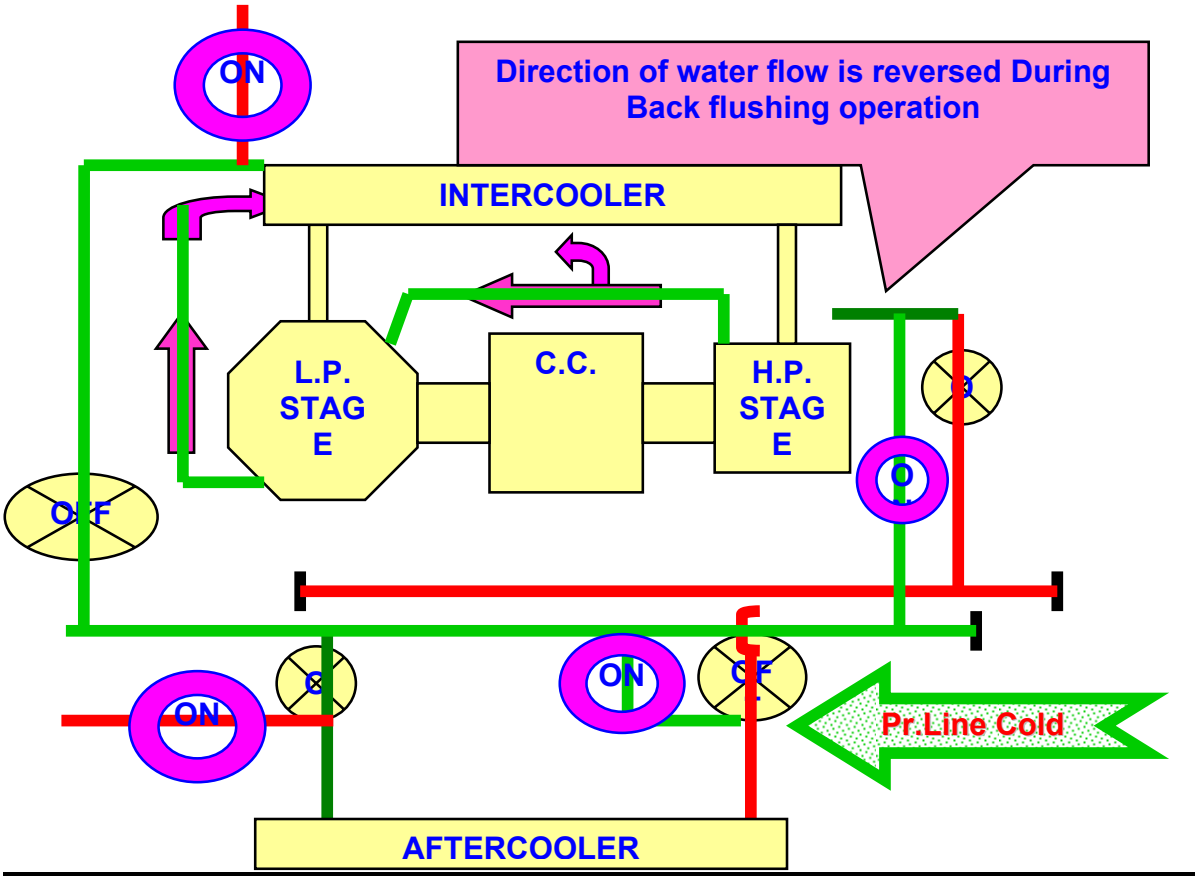
- Cleaning of Inter-cooler / after-cooler was done whenever the plant team noticed an increase in the 2nd stage inlet & outlet temperature. The Time required for Maintenance of Intercooler & after-cooler was typically around 18 mandays.

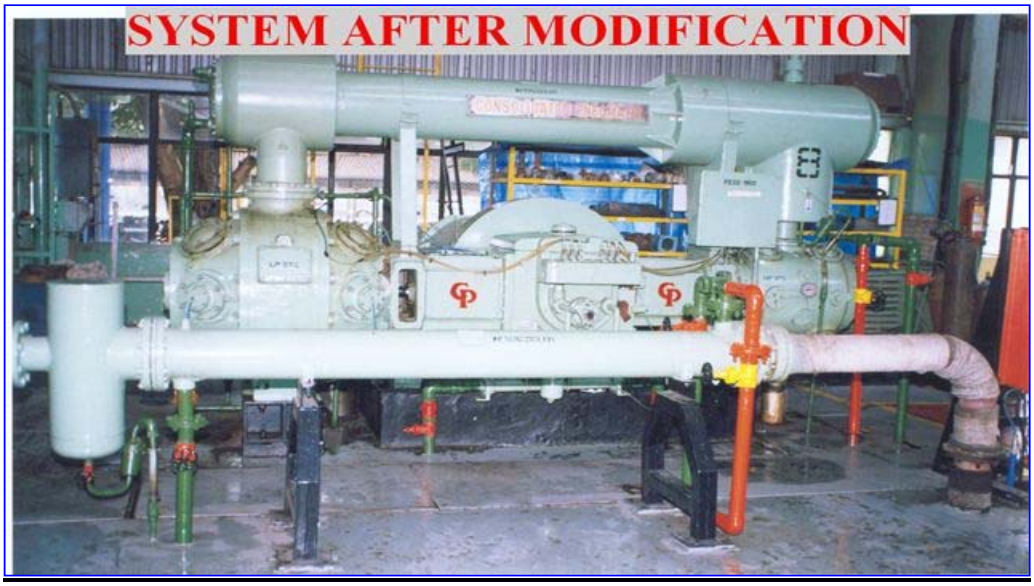
- Sometimes in case the compressor was not available for scheduled maintenance, due to tight production schedules, the compressed air delivery was at a higher temperature, resulting in higher specific energy consumption of the compressor



After Modification

The plant team installed a back flushing system, in both the intercooler and the after cooler, improving the heat transfer. This translates into improved efficiency of compressor, reduced maintenance and better quality of compressed air. The instances of unscheduled maintenance of the compressor reduced significantly.


ON
Direction of water flow is reversed During Back flushing operation
INTERCOOLER
L.P. STAG E
C.C.
H.P. STAG E
OFF
ON
ON
Pr.Line Cold
AFTERCOOLER


SYSTEM AFTER MODIFICATION

Benefits

- Automatic back flushing system prevents choking and enables the Inter-cooler & after-cooler of compressor gets cleaned periodically, resulting in lesser periodic maintenance during shut down.
- Significant drop in temperature of 3ºC before 2nd stage of air compression, resulting in approx. 0.6% reduction in specific energy consumption of the compressor
- Improved quality of air.
- Fatigue -less operation
- Saving in Energy consumption by 8424Kwh/annum/Compressor

Issues during Implementation

This project was implemented during a regular shut down maintenance and no issues were faced during implementation.

Financing of the Project

The plant has invested about **Rs 0.004 Million (USD 0.0001 Million)** for implementation of the project. The investment has been taken up fully with internal funds.

Comments from the Plant Team

Compressed air is an area where there is a good saving potential. In 2^{nd} stage reciprocating compressors, automatic back flushing system of the intercooler and after cooler enables reduction in specific energy consumption of the compressor.

Replication Potential

The scheme has replication potential in compressors in Engineering and automobile plants

Results of the Project

The annual savings achieved is **Rs 0.004 Million (USD 0.0001 Million)** with a pay back period of **12 months**.

Annual Savings –Rs 0.004 Million (USD 0.0001 Million)
Investment –Rs 0.004 Million (USD 0.0001 Million)
Payback Period –12 Months

Contact Information of the Plant

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Case Study: 34

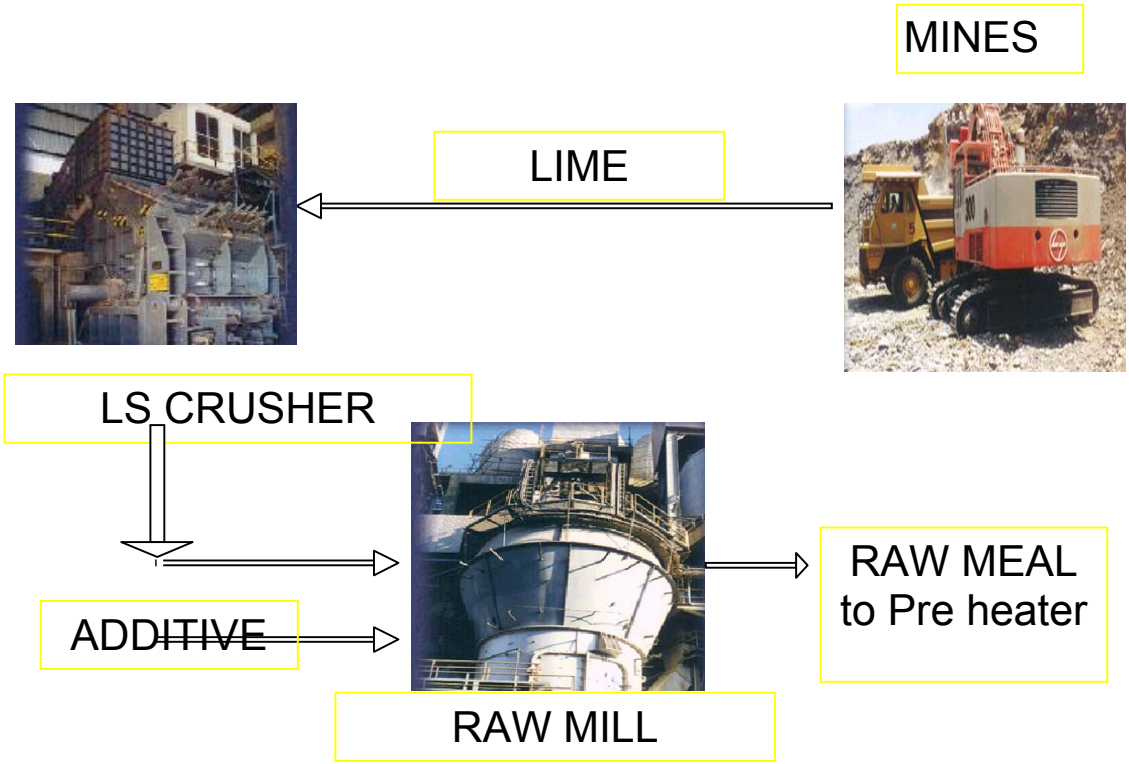
INSTALLTION OF VFD FOR REVERSE AIR FAN AND OPERATING AT OPTIMUM BAG HOUSE PRESSURE

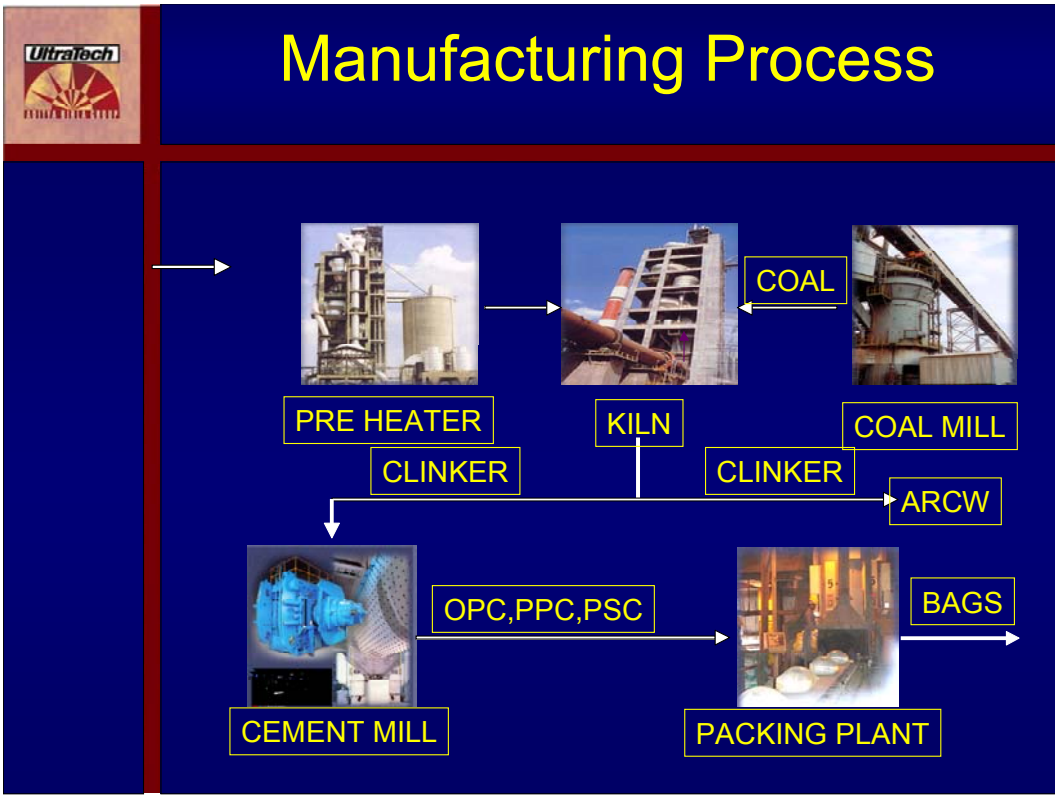
Project Implemented by : Ultratech Cement, Tadipatri

Project Implemented in : 2003

Company Details

Ultratech Cemco, AP Cement Works, Tadipatri belongs to the Aditya Birla group of companies. The plant is having a single large kiln with a production capacity of 2.5 million tones per annum. It produces different variety of cements namely OPC (Ordinary Portland Cement) PPC (Portland Pozzolana Cement) and PSC (Portland Slag Cement). It has implemented several energy saving projects. Ultratech Cement, Tadipatri is an ISO 9001, ISO14000 and OHSAS 18001 certified company.





Project Overview

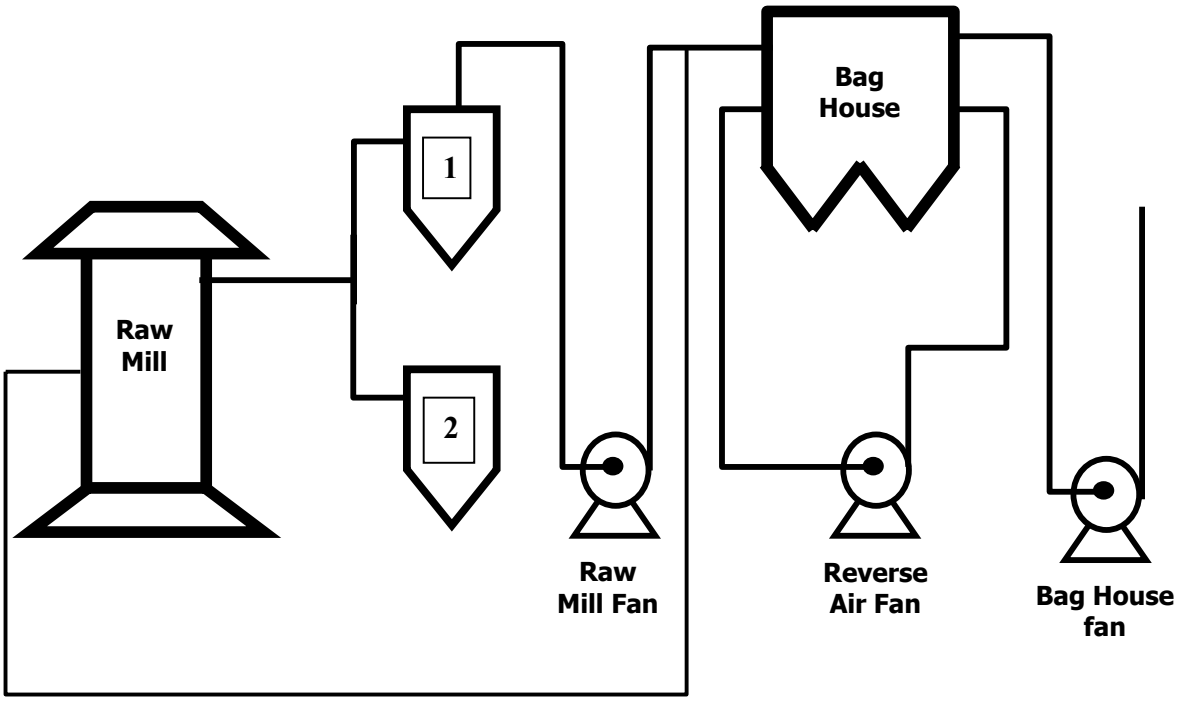
Ultratech, Tadipatri utilizes a bag house for raw meal collection apart from cyclones in the raw mill section. The bag house is provided with reverse air fan. The operation of reverse air fan is to remove the bag house dust, which operates based on the pressure drop across the bag house. The operation of reverse air fan was ON/ OFF control based on the pressure drop across the bag house.

The analysis of the power consumption is carried out on daily basis by the plant team. On the discussion it was observed that the power consumed by the reverse air bag fan was intermittently high due to variation in dp and start / stop of reverse air fan. A detailed study was carried out for the power consumption pattern in Bag House Fan and reverse air fan.

The Reverse Air fan was ON when the pressure drop across the bag house was 130 mm WC and switched-off OFF when the pressure drop is 90 mm WC. The reverse air fan was in operation for 40% – 50% of time.

The bag house fan is fitted with Slip Power Recovery System (SPRS), a speed control device. Any decrease or increase in the ∆P across the bag house is sensed by SPRS and varies the speed of the fan accordingly.

The trend analysis of ∆P across the bag house and the corresponding power consumption of the bag house fan were studied.



The trend analysis indicated the following:

- The variation in ∆P (pressure difference) across the bag house was between – 94 mm to – 142 mm WC
- The power consumption of the bag house fan also varied in accordance with the bag house ∆P. Whenever the bag house ∆P increases the SPRS control of bag house fan senses the ∆P and increases the speed of bag house fan to maintain same flow rate leading to increased power consumption and vice versa.
- The power consumption of the bag house fan was varying significantly during different operating conditions like Coal Mill & Raw Mill in operation and Raw Mill alone in operation.

- When both Coal Mill & Raw Mill was in operation ∆P across the bag house varied between – 94 mm WC to – 134 mm WC. The Bag house fan power consumption varied between 690 kW to 854 kW

- When Raw Mill alone was in operation the ∆P across the bag house varied between – 104 mmWC to – 137 mmWC and the Bag house fan power consumption varied between 1021 kW to 1175 kW

- When Reverse air fan was operation the Bag house fan power consumption reduced by 80 kW to 170 kW

Based on the above observations, the plant team optimised the operation of reverse air fan and achieved a significant reduction in power consumption in bag house fan.

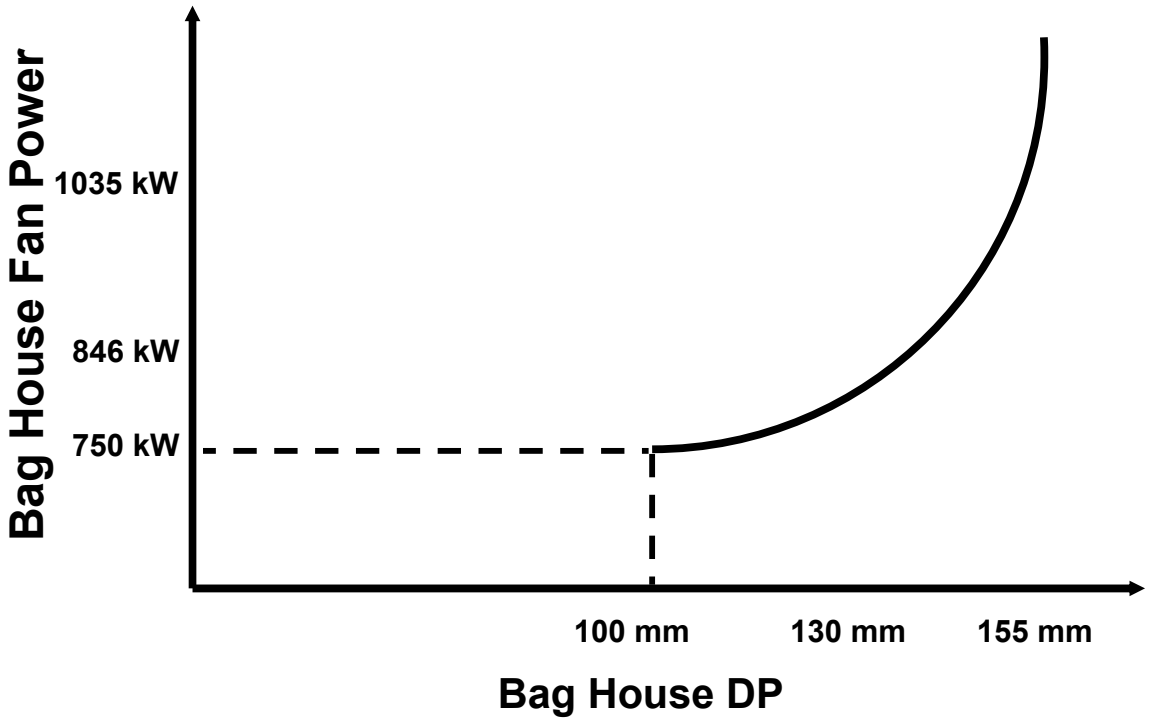
Action Taken

The plant team installed a Variable Frequency Drive for the reverse air fan and operated in closed loop control with bag house ∆P as the feedback to VFD. Several trials were conducted to set the optimum flow rate of reverse air and ∆P settings across the bag house, so as to achieve minimum overall combined power of reverse air fan & bag house fan.

The speed was reduced by installing VFD:

- At 20% speed the power consumption of the fan was 6.5 kW
- At 80% speed the power consumption of the fan was 55 kW

The pressure drop across the Bag house is maintained at 100 mm throughout the operation of the plant.



Benefits

The following benefits were observed after implementing the project:

- There was a reduction in the combined power consumption (RA Fan + Bag House Fan) to the extent of 40 kW
- The bag life also increased due to optimum ΔP across the bag

Issues Faced during Implementation

The project involved study of the stability of operation. Various trials were carried out to determine optimum operating parameters, without affecting the over all plant stability. This project was implemented in steps, observing various operating parameters. Optimum process parameters were arrived at based on several trials.

Comments by the Plant Team

Many cement plants have a bag house in their raw mill circuit. Rather than following ON/ off control scheme for the Reverse air Fan, attempts to optimize the total power consumed (RA Fan + Bag house fan) can result in most energy efficient operation.

Financing of the Project

The plant has invested about **Rs 0.9 Million** for a variable frequency drive and other process controllers. The investment has been taken up fully with internal funds.

Replication Potential

This project can be implemented in all cement plants having bag house in raw mill circuit.

Results of the Project

Implementation of the project had resulted in reduction in energy consumption by 40 kW per hour. The annual savings achieved was **Rs 1.08 Million (USD 0.027 Million)**. The investment made for this project was **Rs 0.90 Million (USD 0.022 Million)**.

Annual Savings	**–Rs 1.08 Million (USD 0.027 Million)**
Investment	**–Rs 0.90 Million (USD 0.022 Million)**
Payback Period	**–10 Months**

Contact Information of the Plant

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Case Study: 35

INSTALLATION OF VFD FOR CHILLED WATER & CHILLED BRINE PUMPS

Project Implemented by : Jubilant Organosys Ltd., Nanjangud

Project Implemented in : 2006

Company Details

Jubilant Organosys Limited is an integrated pharmaceutical industry player with a wide range of products and services for global life sciences companies. The Company is one of the largest custom researches and manufacturing services (CRAMS) and drug discovery services companies in India. Jubilant Organosys Ltd. is an ISO 9001, ISO 14001 OSHAS 18001 Certified and CGMP compliant and USFDA approved plant.

Jubilant Organosys manufactures wide range of nearly 30 Active Pharma Ingredients and markets globally. Six sigma and QC tools are the major management strengths in Jubilant Organosys. The business products and services to meet the demands of the Pharmaceuticals, Agrochemicals, Construction, Food & Beverages, Textile, Tyres and Paper & Packaging industries

Project Details

Chilled water pumps, chilled brine pumps, cooling tower pumps and fans are the critical process equipments in Jubilant Organosys. Mainly these equipments are over designed with excessive margins, with the result that during most part of the operation; they run in under loaded condition.

In such equipment, if the control mechanism is not properly designed, the efficiency of particular equipment / system reduces and specific energy consumption increases.

Controlling Mechanisms

General controlling mechanisms used in most of the industries are

- Recirculation
- Throttling using Control valves
- Damper or any other manual control.
- Automated Valve control based on feed back
- Variable Frequency Drives

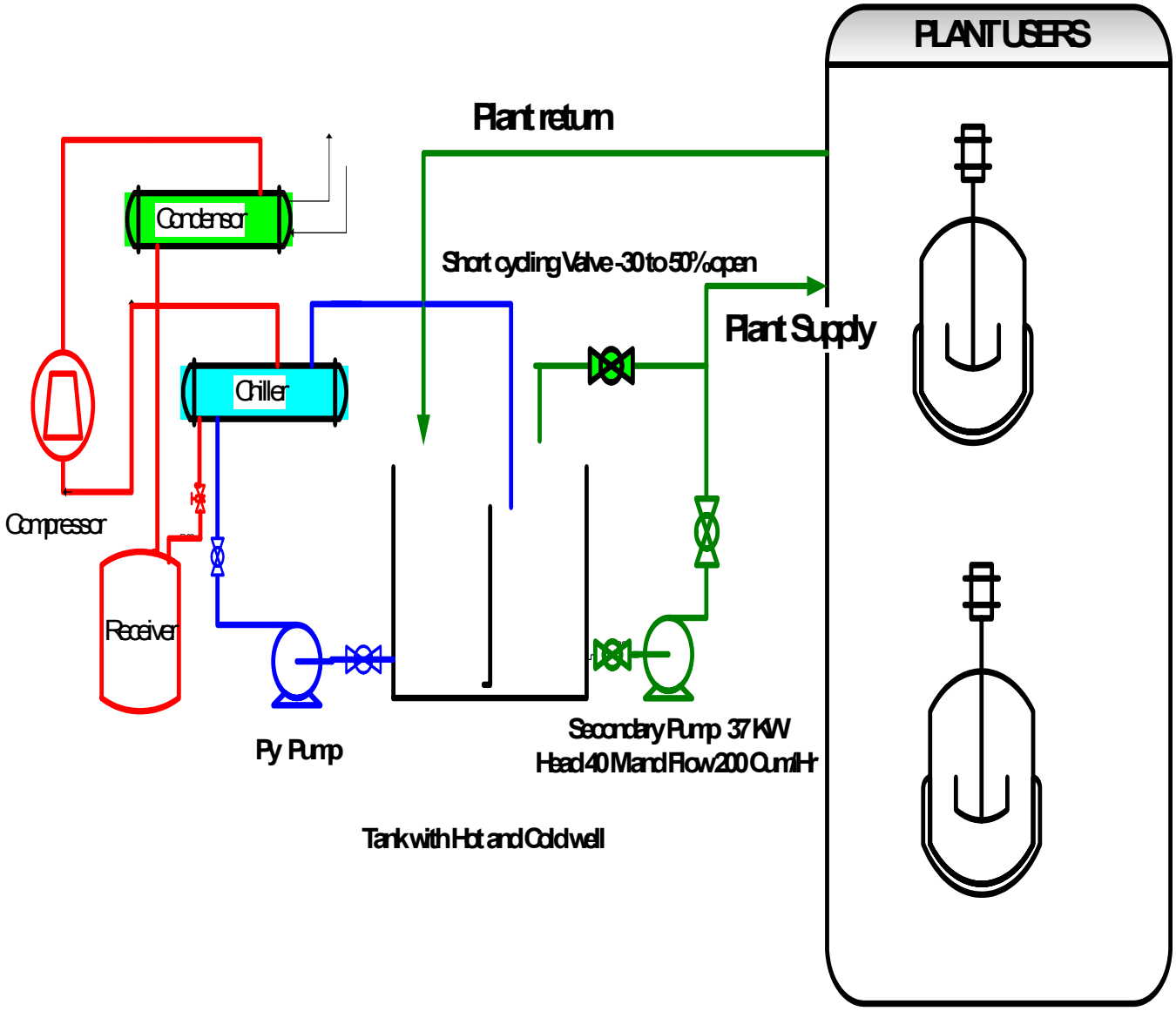
Among all the controlling mechanisms, feed back control is the efficient operation and recirculation is inefficient.

In feed back control using a variable Frequency Drive, the flow or pressure is controlled, based on the user requirement.

Chilled Water and Chilled Brine Circuit Diagram

Before VFD Installation

The water flow diagram consisting of chilled water pumps and chilled brine pumps is shown.



In Pharmaceutical Industry, the chilled water / chilled brine system consists of a Hot well & cold well. The Primary pump pumps the hot water through the chiller, to the cold well. The secondary chilled water pump / chilled brine pump, pumps the same to the process and the water from the process is collected in the hot well.

In the unit both Chilled water pumps and Brine secondary pumps were running at full load continuously with a continuous re circulation of around 30%. The Power consumption of each pump in Chilled water system was 39.6 kW and in brine system, 35.5 kW.

Since recirculation is an inefficient method of control, the plant team decided to control the quantity of water pumped taking header pressure as the feed back signal to a Variable speed drive, which in turn would modulate the operating conditions of the Pump, depending on the requirement at that point in time. A PID controller was installed for giving the feed back signal. The recirculation valve which was open to the extent of 30 – 50 % was closed completely.

VFD Panel and Control System at Pump

The VFD panel and valve control mechanism is shown below

Cooling Tower Pumps and Fans

Issues faced during Implementation

No major issues were faced during the implementation of the project. The project could be implemented on short period of time.

Comments by the Plant Team

The supply of chilled water & chilled brine are crucial to the reaction process in the pharmaceutical industry. Most of the reactors operate on batches and hence the requirement of chilled water and brine is highly varying in nature. Recirculation method of control being inefficient mode of control, new applications like installation of Variable Frequency drive can improve efficiencies in pumping systems.

Financing of the Project

The plant invested about **Rs 2.29 Million** (**USD 0.057 Million**) for implementation of various projects. A total of 16 VFDs were installed. The investment was taken up fully with internal funds.

Results of the Project

Total 16 VFDs were successfully installed in the plant for various applications saving 0.563 million kWh. The annual savings achieved is **Rs 3.36 Million (USD 0.084 Million)**. The simple payback period for this project is **less than 8 Months.**

Annual Savings	**–Rs 3.36 Million (USD 0.084 Million)**
Investment	**–Rs 2.29 Million** (**USD 0.057 Million**)
Payback Period	**–Less than 8 Months**

Contact Information of the Plant

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Case Study: 36

ELIMINATION OF COOLANT CHILLER & ACCESSORIES IN GRINDING MACHINES

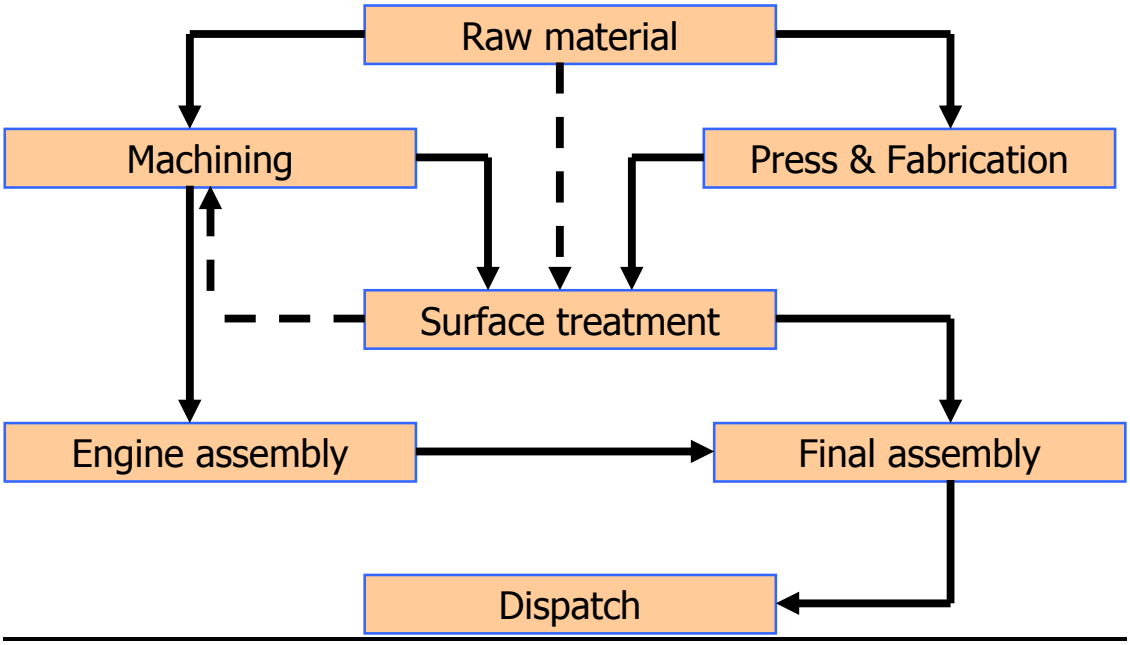
Project Implemented by : Bajaj Auto Limited, Aurangabad

Project Implemented in : 2003

Company Details

Bajaj auto limited, Waluj, Aurangabad, is a division of Bajaj Auto Limited, Pune, a flagship company of Bajaj Group. Bajaj Auto is one of the leading manufacturers of two wheelers & three wheelers in India and also largest exporter of 2 & 3 wheelers. Bajaj Auto Limited, Waluj is ISO9001 and ISO14001 certified company. Bajaj Auto also practicing Total Productive Maintenance (TPM) at all levels. In the process of introducing new products, emission requirements are being taken into consideration and products manufactured are meeting the regulatory requirements.

Manufacturing Process

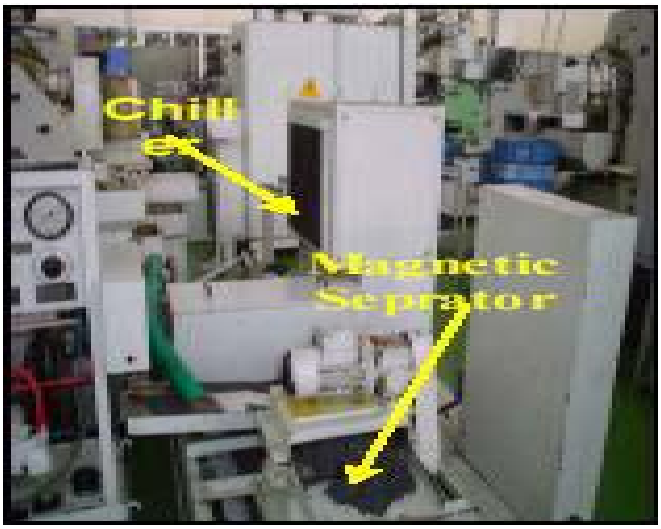


Project Overview

At Bajaj Auto Limited, Aurangabad one of the major consumers of electrical energy is the machining equipment like, grinding machines, lathes, CNC machines, drilling machines, presses etc. In all these equipment there are a large number of lower capacity electrical motors.

Grinding machines require coolant liquid circulation during the operation to reduce the heat generated during grinding. There are about 16 grinding machines of identical capacity. Each of These grinding machines were fitted with a coolant chiller (3.2KW), coolant circulation pump(1.2 kW) and a magnetic separator (0.22 kW) each for removing the magnetic dust. The coolant systems were in operation for several years.

Under Total Productivity Maintenance, the plant team had taken up the activity of reducing the power consumption in grinding machines. The overall system and operational requirement of the process were studied in detail. The outcome of the study indicated that the requirement of low temperature coolant liquid circulation during the process has become redundant. Coolant at room temperature is sufficient to take care of the process.



The plant team avoided the operation of coolant chiller and modified the pipe line. This has resulted in an energy saving of about 49 kW from the 16 grinding machines.

The magnetic separator was also avoided and fine steel mesh was installed to separate the fine metal dust generated during the process.

Issues during Implementation

No issues were faced during implementation. After avoiding the use of chiller in coolant liquid system, the process parameters and quality were checked for various products. There were no changes in the quality of the product.

Modified Condition

Comments by the Plant Team

The idea of avoiding the chiller for coolant came from the grinding machine operations team during the regular roundtables conducted as part of the TPM activity. A detailed study was conducted on one machine, for various components that were processed in the grinding machine. Based on the study it was decided to eliminate the coolant chiller. Cooling water was supplied directly, by passing the chiller.

All engineering and automobile industry has large no of machining equipment like, grinding machines, lathes, CNC machines, drilling machines, presses etc. Any energy saving possibility could be established only after a large no of trials involving various components. TPM approach is a structured approach which can ensure that this opportunity is tapped in a phased manner.

Financing of the Project

This required no major investment except for modifications after the chiller & removal of magnetic separators. The modification was taken up by the plant team with internal resources.

Replication Potential

This product can be replicated in several engineering and automobile plants where grinding machines are used. Before implementing this project, the actual process requirements and quality parameters are to be examined in detail, by each plant, on a case to case basis. The feasibility of avoiding chilled coolant water may vary with products & the actual geographic location of the plant.

Results of the Project

The implementation of this project has resulted in an energy saving of about 49 kW, which is equivalent to an annual cost savings of **Rs 1.39 Million (USD 0.034 Million)**. The investments are negligible.

Annual savings	**–Rs 1.39 Million (USD 0.034 Million)**
Investment	**–Negligible**

Contact Information of the Plant

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Case Study: 37

MODIFICATION OF VACCUM JET EJECTORS TO UTILISE PROCESS WASTE STEAM

Project Implemented by : The Bombay Dyeing & Mfg. Co. Ltd., Raigarh, Maharashtra

Project Implemented in : 2002

Company Details

The Bombay Dyeing & Mfg. Co. Ltd., DMT division, Maharashtra is a part of the Wadia Group of companies. This plant commenced its operation in the year 1985 with a capacity of 60,000 MTPA of Di Methyl Terephthalate (DMT). Presently Bombay Dyeing & Mfg. Co. Ltd. is the largest producer of Di Methyl Terephthalate in India.

After successive capacity expansions from the year 1985 to 2001, The Bombay Dyeing & Mfg. Co. Ltd. is operating with an approximate production of about 1,65,000 MTPA. With excellent efforts towards energy conservation, the plant has reduced its specific energy consumption from 689 kWH/MT (1994 – 95) to 477 kWH/MT (2002- 03).

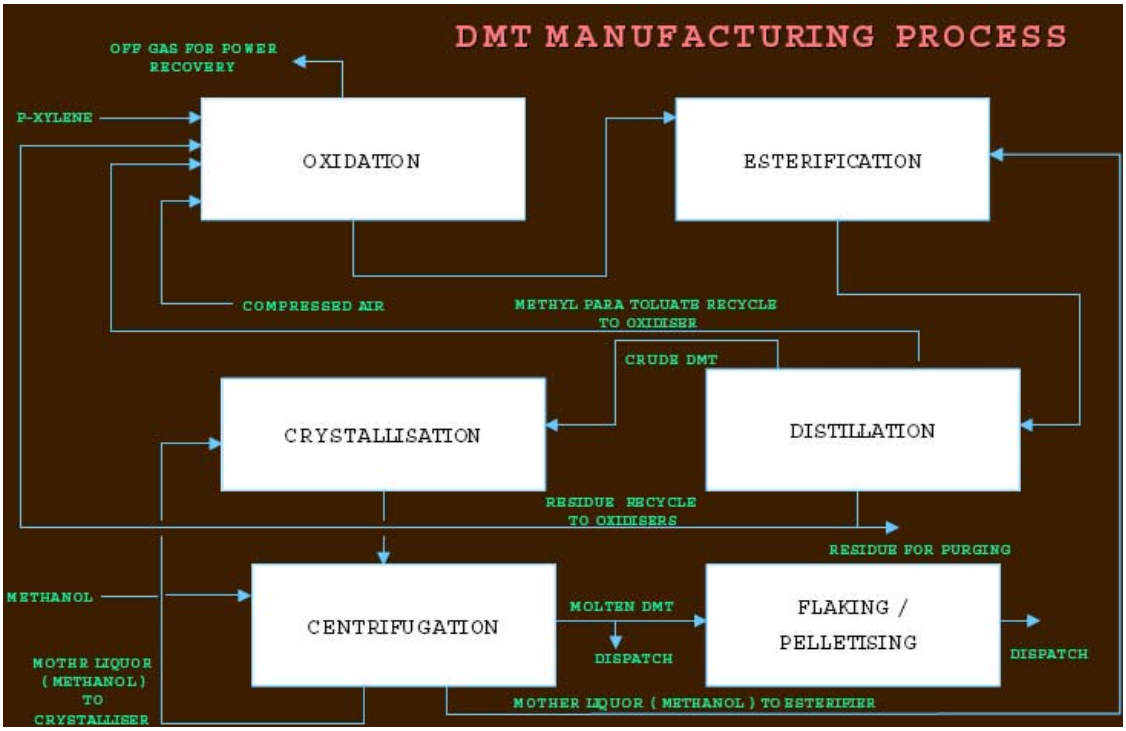
The company is also certified for ISO 9001 – 2000, ISO 14001, OHSAS 18001, BVQI – SAFETY CERT standards.

Project Details

Back ground

DMT manufacturing process:

Di-methyl Terephthalate (DMT) is the raw material for Production of Polyester Fibre yarn and resins. The DMT is produced in a series of process stages including Oxidation, esterification columns, flaking machine, centrifuge reaction, distillation and crystallization.



Mostly in DMT Plants, three different types of steams are available i.e. High Pressure (HP), Medium Pressure (MP) and Low Pressure (LP) steams, in the plant. This distinction is made purely based on the steam pressure and its requirement in the process.

In such steam systems, some energy saving schemes are possible by substituting the HP steam requirement with MP steam and MP steam users with LP steam. The attractiveness of such proposals depends on the differential costs of HP (Highest cost), MP (medium costs) & LP Steam (Lowest cost).

HP steam at The Bombay Dyeing & Mfg Co Ltd was being produced by firing LSHS (Low Sulphur Heavy Stock) Oil. Use of HP steam was costly and plant team reviewed the overall steam balance to explore opportunities to reduce the use of HP steam in the process.

The plant was using the 2.2 MT/hr of HP steam in vacuum jet ejector systems in the main plant. After analyzing the steam availability in the plant the team carried out modifications of the Steam jet ejector to suit for LP and MP steam.

Steam Jet Ejector:

Steam jet ejectors offer a simple, reliable and low cost way of producing vacuum. They are especially effective in chemical industry where high pressure motive steam is available.

Two main functions of the ejectors are as follows:

1) Thermo compressors: Thermo compressors are ejectors applied to recompressing the spent steam and process fluids
2) Vacuum producers: Ejector–based systems are particularly more appropriate as primary vacuum producers, particularly where motive steam is always available. They are applied in processes such as crystallization, deaeration, drying, cooling, high vacuum distillation and deodorization.

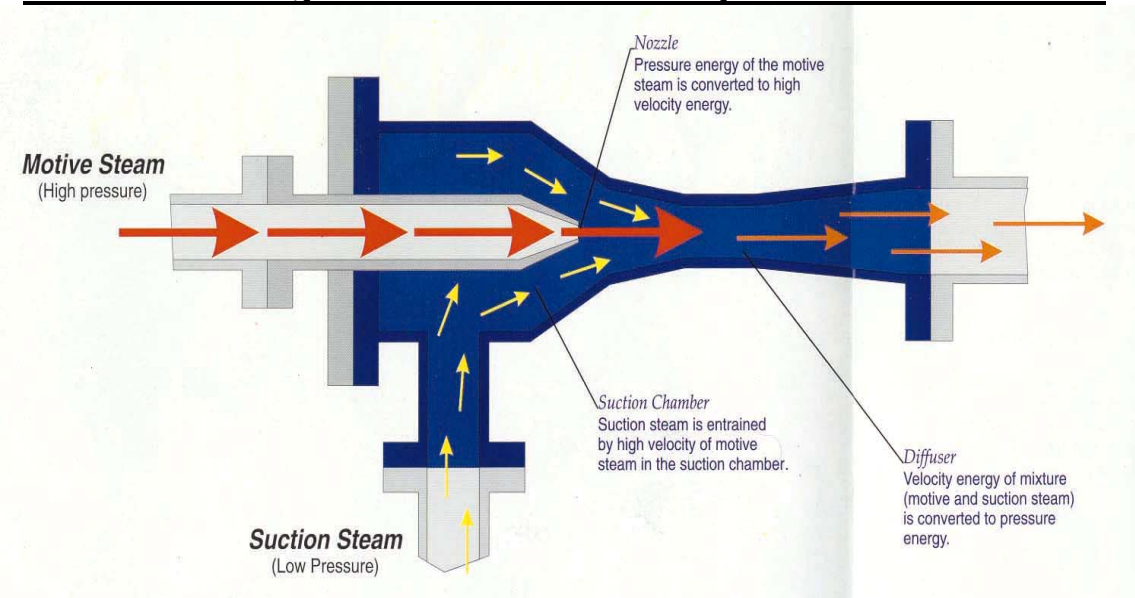
Ejector Operation

High pressure motive gas enters the steam chest at low velocities and expands through the converging – diverging nozzle. This results in decrease in pressure and increase in velocity. Meanwhile the suction fluid enters at suction inlet.

The motive fluid, which is now at high velocity entrains the suction fluid and combines with it. The two fluids are then recompressed through diffuser. Potential energy is converted to kinetic energy, thus velocity increases and pressure decreases. The mixture reaches its maximum velocity and low pressure at the throat.

The fluid then discharges at an intermediate pressure, which is higher than the inlet suction fluid pressure, but lower than inlet motive fluid pressure.

Schematic of Single Nozzle Vacuum Jet Ejector is Shown Below



Modifications Carried Out:

1) Replacement of the Ejectors/boosters to suit LP/MP steam.
2) Replacement/swapping of condensers
3) Pipe layout to suit the above requirement.

Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Financing of the Project

The plant had invested about **Rs 4.86 Million** for implementing the project. The investment was taken up fully with internal funds.

Results of the Project

The annual savings achieved is **Rs 11.6 Million (USD 0.29 Million).** The investment made is about **Rs 4.86 Million (USD 0.121 Million).** The simple payback period is **5 Months.**

Annual savings	**–Rs 11.6 Million (USD 0.29 Million)**
Investment	**–Rs 4.86 Million (USD 0.121 Million)**
Payback Period	**–5 Months**

Contact Information of the Plant

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Case Study: 38

USAGE OF WASTE STEAM PREHEATER FOR INSTRUMENT AIR DRYER REGENERATION

Project Implemented by : The Bombay Dyeing & Mfg. Co. Ltd.

Project Implemented in : 2002

Company Details

The Bombay Dyeing & Mfg. Co. Ltd., DMT division, Maharashtra is a part of the Wadia Group of companies. This plant commenced its operation in the year 1985 with a capacity of 60,000 MTPA of DiMethyl Terephthalate (DMT). Presently Bombay Dyeing & Mfg. Co. Ltd. is the largest producer of Di Methyl Terephthalate in India.

After successive capacity expansions from the year 1985 to 2001, The Bombay Dyeing & Mfg. Co. Ltd. is operating with an approximate production of about 1,65,000 MTPA. With excellent efforts towards energy conservation, the plant has reduced its specific energy consumption from 689 kWh/MT to 477 kWh/MT

The company is also certified for ISO 9001 – 2000, ISO 14001, OHSAS 18001, BVQI – SAFETY CERT standards.

Project Details

Back ground

The plant had two centrifugal compressors in the plant to meet the compressed air demands. The compressed air is mainly used of process and utility.

Compressed air was used at The Bombay Dyeing & Mfg. Co. Ltd. for pneumatic operation, instrumentation and other applications. Compressed air for instrumentation requires efficient filtration for removal of moisture and oil.

To carry out effective filtration of compressed air, an extensive range of Air filters and dryers are available. Regeneration dryer is one of the commonly used dryers for this application.

Regeneration Dryer:

Regenerative desiccant dryers use a desiccant medium to remove moisture from the compressed air stream. Wet air passes directly through the desiccant medium, which then adsorbs the moisture. The desiccant medium has a finite capacity for adsorbing moisture before it must be dried out, or regenerated. To do this, the tower containing saturated desiccant medium is depressurized and the accumulated driven off using purge air, heat or a combination of both.

Desiccant dryers are generally of a twin-tower construction, with each tower containing its own desiccant bed. This allows one bed to dry compressed air as the other undergoes regeneration.

The energy cost associated with operating a desiccant dryer depends primarily on how the desiccant is regenerated - using purge air, heat or a combination of both. Desiccant dryers are categorized by their method of regeneration, the three primary types of which are:

- Heatless, which uses only, compressed air as a purge.
- Heated, this uses both heat and compressed air to purge moisture.
- Blower purge, which uses air from an external blower, heat and minimal compressed air.

The energy cost to operate each of these dryers depends on the amount of purge air used, the heater size and the blower motor size.

Electrical Heating in Dryers:

A heating element supplements the drying action of the purge air. The heater can be mounted internally to heat the desiccant bed directly or externally to heat the purge air that's blown through the bed.

The amount of purge air an externally heated dryer requires is typically about 7% of the dryer's rated flow capacity. The combination of heat and purge air is more energy efficient than purge air alone.

In the plant, electrical heaters were used for the desiccant heating application. The electrical heaters were consuming about 53 kW at The Bombay Dyeing & Mfg. Co. Ltd.

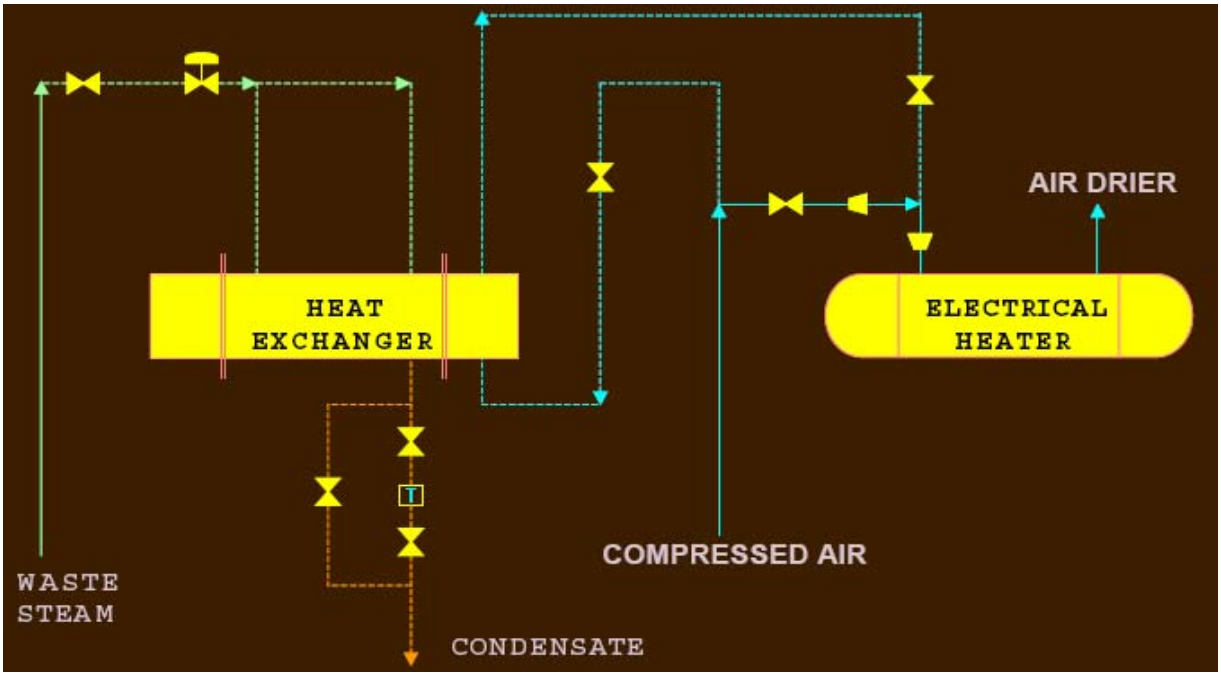
Detailed study was carried out by the plant team to analyze the heating and cooling time sequence for regeneration and the cost of electrical heat for regeneration. The plant team carried out the steam balance and also compared the cost of electrical heating and thermal heating. Operating cost with electrical heaters is much higher compared to thermal heating.

The steam availability in the plant was assessed. For the desiccant heating application steam heating can be utilised

It was found that there exists an excellent opportunity for energy saving by replacing the electrical heaters with the steam heaters using MP steam.

One waste steam heat exchanger was installed at the upstream of electrical heater for heating drier regeneration air.

The schematic is as follows.



Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Financing of the Project

The plant has invested about **Rs 0.19 Million** for implementing the project (for steam coils). The investment has been taken up fully with internal funds.

Results of the Project

After installation of the waste steam heat exchanger the plant team switched one of the electrical heaters, which resulted in about 28 kWh saving.

Financial Benefits

The annual savings achieved is **Rs 0.9 Million (USD 0.022 Million)**. Investment required for implementing this proposal is **Rs. 0.19 Million (USD 0.004 Million)**. The simple payback period is **3 Months.**

Annual savings –Rs 0.9 Million (USD 0.022 Million)
Investment –Rs. 0.19 Million (USD 0.004 Million)
Payback Period –3 Months

Contact Information of the Plant

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Case Study: 39

ENERGY SAVING IN AFTER TREATMENT DRYER

Project Implemented by : Century Rayon, Shahad

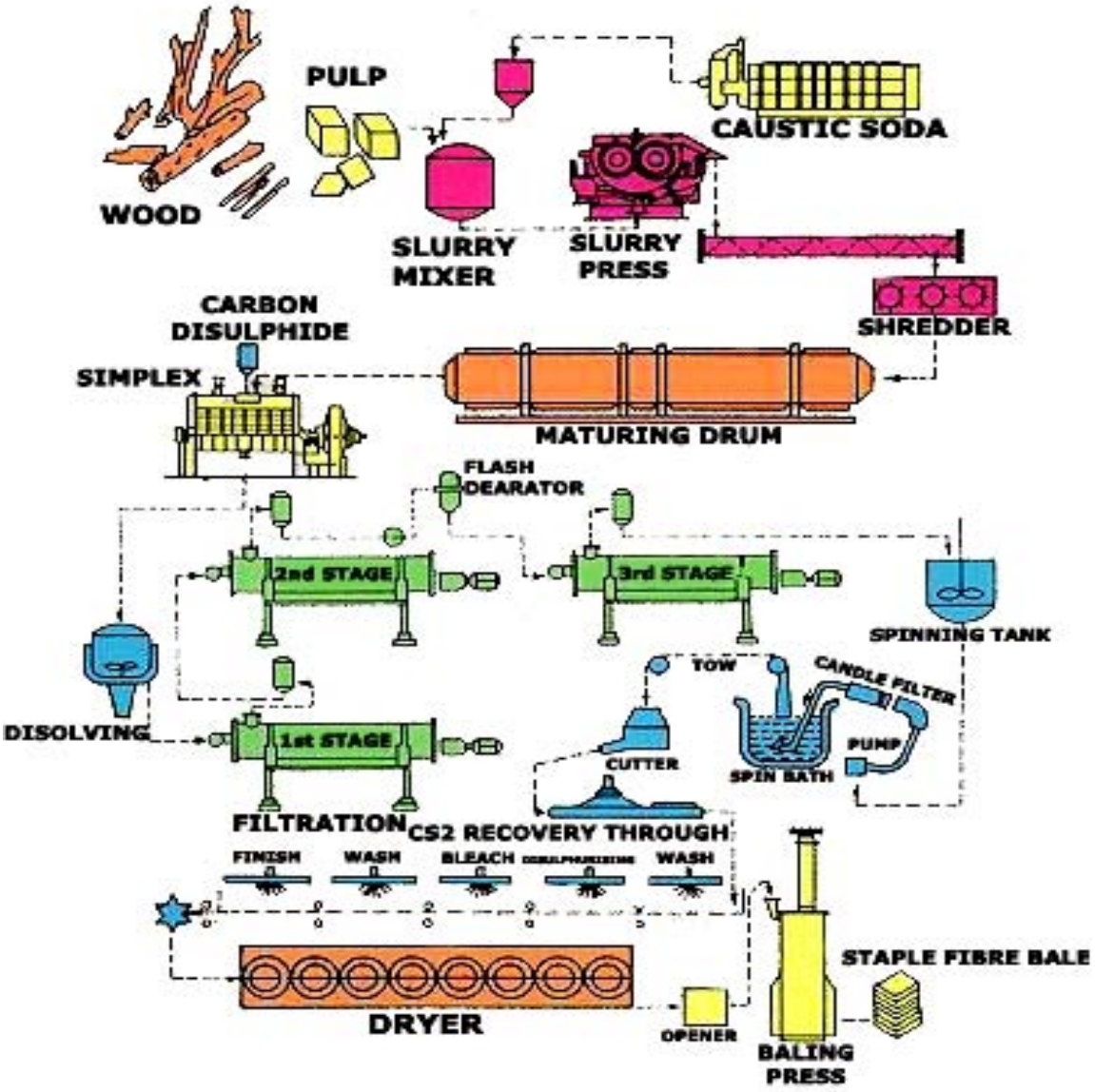
Project Implemented in : 2006

Company Details

Century Rayon, Shahad (a B K Birla Group of company) is an ISO – 9001 certified company. It is a unit of M/s Century Textile & Industries Ltd. which commenced its operation in 1956 with an initial capacity of 5 Tons Viscose Filament Yarn (VFY).

Today after successive capacity expansion, Century Rayon is the largest Viscose Filament Yarn (VFY) producer in the country with a capacity of about 65 TPD and commanding 26 % of Indian VFY market.

SCHEMATIC FLOW DIAGRAM



Project Overview

The raw material for cellulose fibre production (rayon) is wood pulp which is inexpensive and renewable resource, however the processing of the wood pulp in to rayon is a highly energy & water intensive process.

The production of rayon involves three stages

1. Dissolution of the wood pulp
2. Extrusion of the yarn
3. Purification of yarn by bleaching & washing.

The purified rayon is dried using hot air driers for removal of moisture.

Present System:

The drying process of the yarn cakes is the final stage of rayon production and it is carried out using air driers used which circulates hot air removal of moisture from yarn cakes.

The drying is carried out in stages in various zones of the dryer as shown below

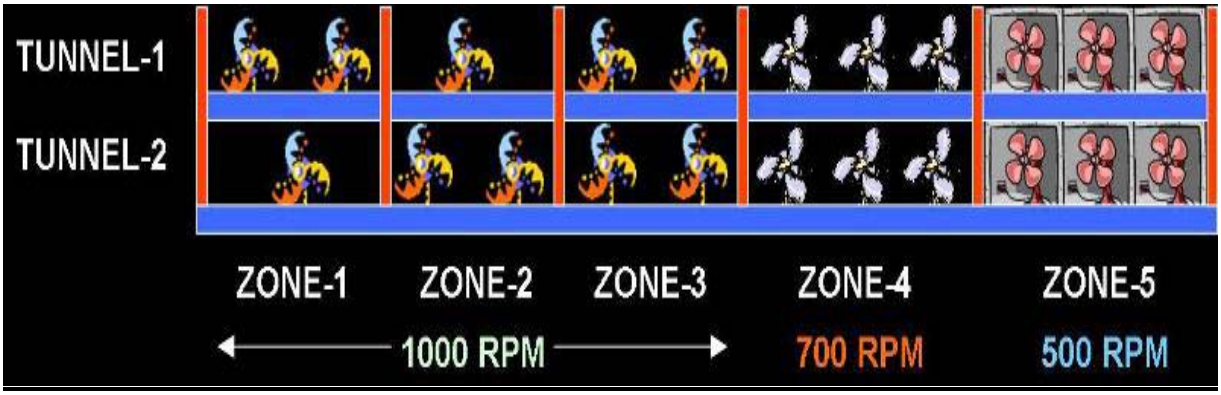
ZONES IN AN AFTER TREATMENT DRYER

Maximum drying occurs in first two zones, and the requirement of drying gradually reduces in subsequent zones. In the last zone, the moisture removal rate is very low. This is due to the fact that diffusion mass transfer is independent of velocity and rather depends on the concentration gradient of moisture.

Hence the speed of air circulation fans in last zone, where drying rate is independent of velocity, can be reduced.

Modified System

The new system consists of installation of Variable Frequency Drive (VFD) for a group of motor driven hot air fans and these fans are grouped based on the zones as shown in the figure below.



In initial stage (zone 1, 2, &3) where the amount of moisture is high the VFD's are operated at higher speed (RPM) to deliver more flow of hot air and thus reduce the moisture content.

As the yarn passes through the second stage (zone-4) the speed of the motors is reduced as the moisture removal is not the extent as it is in initial stage.

In the final stage (zone -5) the amount of moisture is very minimal and thus the speed of hot air fans is further reduced as shown in the figure.

The speed reduction using a Variable Frequency Drive for a group of motors has resulted in tremendous energy saving.

Other Advantages:

The operation of the driers can vary depending upon product requirement. Ease of operation is also ensured.

Issues during Implementation

During the project implementation no issues were faced.

Comments by the Plant Team

The idea of operation of drier fans based on their location in particular zones, was suggested by the plant team. In many of the driers the requirement of drying and the air circulation required, is variable in nature. Such opportunities where variation of process parameters is required can ensure energy savings also.

Financing of the Project

The plant has invested about **Rs.1.54 Million** for implementation of the project. The investment has been taken up fully with internal funds.

Replication Potential

Replication potential is very high drying units where zone wise drying is carried out.

Results of the Project

The annual savings achieved is **Rs 1.59 Million (USD 0.039 Million).** The investment made for this project is **Rs 1.54 Million (USD 0.038 Million).** The simple payback period is **12Months.**

Annual savings	**–Rs 0.9 Million (USD 0.022 Million)**
Investment	**–Rs 0.19 Million (USD 0.004 Million)**
Payback Period	**–12 Months**

Contact Information of the Plant

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Joint President

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Case Study: 40

INSTALLATION OF VFD FOR CLEAR COAT AIR SUPPLY FAN

Project Implemented by : Ford India Limited, Chengalpattu

Project Implemented in : 2002

Company Details

Ford India is one of the leading automobile manufacturing industries in India. The company has operations all over the world focusing in six continents. The company's world headquarters is in Dearborn, Michigan.

Ford, India manufactures four wheeler passenger cars. Plant has a capacity to manufacture up to 50,000 vehicles per annum.

With consistent efforts towards energy conservation, the plant has reduced its specific electricity consumption from 1.752 MW/Car (2000 – 01) to 1.181 MW/Car (2002- 03). The company is certified for ISO 9001 – 1991, ISO 14001. Ford is a 6-Sigma company.

Project Details

Paint booth is one of the most critical areas in any automobile manufacturing unit.

There are two air supply unit fans in the paint booth at Ford India, one for Base coat booth and the other for Clear coat booth. Both the fans are rated for 200 kW each and are fully loaded.

Base coating is applied on the components first before applying the clear coat. The thickness of the paint coating depends on the type of paint used. Air Supply Unit (ASU) is used to maintain a slight positive pressure inside the paint booth and to avoid external dust entering into the paint booth.

There is an exhaust system which removes air from the booth. Both the fans of the system are fixed drives. The air flow can vary due to change in the system static pressure. As filters become loaded with the dirt, the static pressure increases. This causes a decrease in the air flow that affects air balance between the supply and the exhaust in the booth.

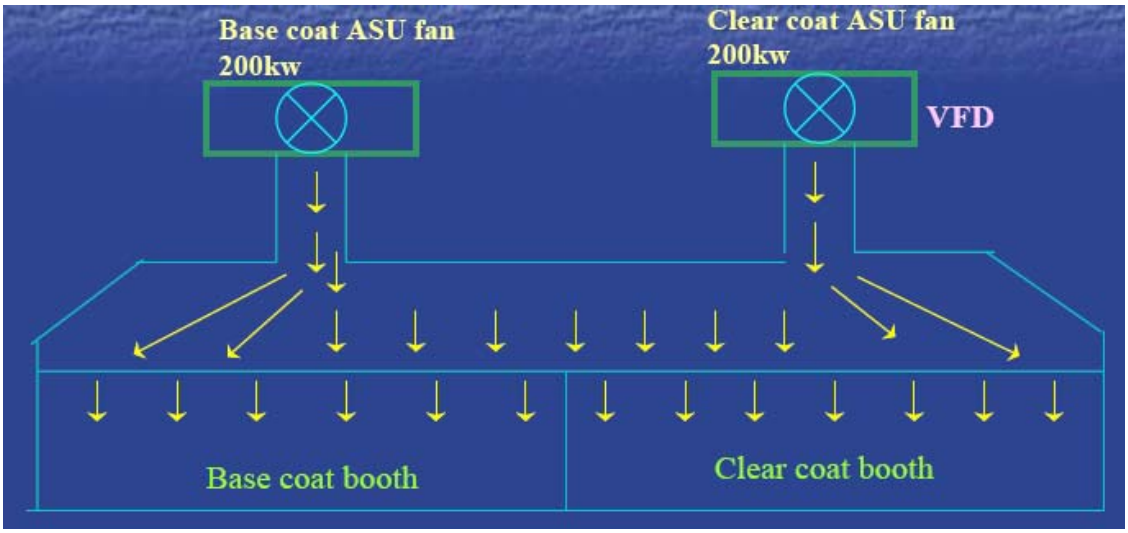
Action Taken:

The plat team concluded that the air balance between supply and exhaust fans needs to be maintained.

This could be achieved by converting the fan from a fixed speed system to a variable speed system. A variable speed drive is best suited for this control, controlling the speed based on system static pressure.

VFD increases the speed of the fan when the filters are choked and on the other hand, the speed of the fan could be automatically reduced once the filters are cleaned.

The Schematic Layout of the Paint Booth is shown below



Results:

Earlier both Base Coat and Clear coat ASU fans were fully loaded. After installation of VFD, the operating hours and the percentage of loading of Clear coat ASU fan has decreased as shown below

Before Modification:

Base coat ASU 100 % loaded for 24 hrs.
Clear coat ASU 100 % loaded for 24 hrs.

After Modification:

Base coat ASU 100 % loaded for 24 hrs.

Clear coat ASU 90 % loaded for 10 hrs and 50 % loaded for 14 hrs.

Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Financing of the Project

Ford India has invested about **Rs 1.7 Million** for implementation of the project. The investment was taken up fully with internal funds.

Results of the Project

Installation of the VFD has resulted in improvement in operating efficiency. This has resulted in electrical saving of about 4.8 Lakh kWh/ annum.

Financial Benefits:

The annual savings achieved is **Rs 1.3 Million (USD 0.032 Million).** The investment made for installation of VFD is **Rs 1.7 Million (USD 0.042 Million).** The simple payback period is **9 Months.**

Annual savings	**–Rs 1.3 Million (USD 0.032 Million)**
Investment	**–Rs 1.7 Million (USD 0.042 Million)**
Payback Period	**–9 Months**

Contact Information of the Plant

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Case Study: 41

INCREASE IN PRODUCTION OF CLINKER GRINDING MILL BY SUITABLY MODIFYING THE WIDTH OF THE STATIC FLAPS OF THE CLASSIFIER AND ROTOR DIAMETER

Project Implemented by : Madras Cements Limited , Alathiyur

Project Implemented in : 2002

Company Details

The manufacturing unit at Alathiyur was set up in two phases. Line I was designed for 2,200 TPD and Line II for 3000 TPD. Line II comprises the South Asia's first SF cross bar cooler and largest Vertical Roller Mill for clinker grinding commissione d in the year 2001.

This is one of the very few energy efficient plants in the world and is very friendly to ecology and environment.

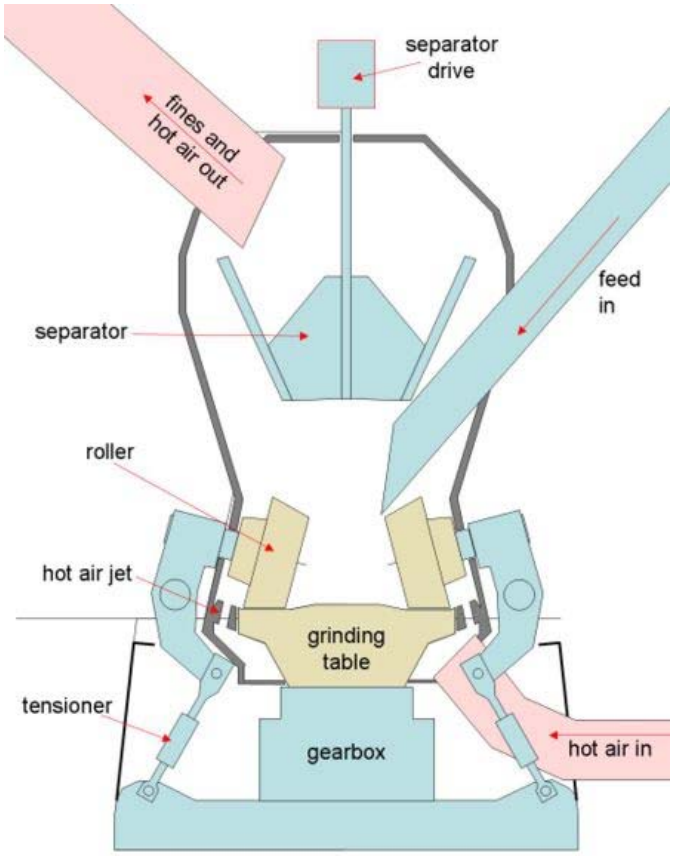
Plant has the state of the art technology and equipment at every stage of production. Surface miners for mining, energy efficient MMD crusher for lime stone, vertical roller mill for raw materials and clinker grinding and electronic packers are installed in the plant. The manufacturing products are OPC (Ordinary Portland Cement) and PPC (Portland Pozzalana Cement). The plant is also ISO 9002, ISO 14001 systems certified.

With excellent efforts towards energy conservation, the plant has reduced its specific electricity consumption from 68.66 kWH/Ton of cement (1999– 00) to 62.4 kWH/Ton of cement (2002- 03).

Vertical Roller Mills

These are the standard form in modern installations, occasionally called vertical spindle mills. In a typical arrangement, the material is fed onto a rotating table, onto which steel rollers press down. A high velocity of hot gas flow is maintain ed close to the dish so that fine particles are swept away as soon as they are produced. The gas flow carries the fines into an integral air separator, which returns larger particles to the grinding path. The fine material is swept out in the exhaust gas and is captured by a cyclone before being pumped to storage. The remaining dusty gas is usually returned to the main kiln dust control equipment for cleaning. Feed size can be up to 100 mm.

Roller mills are efficient, using less than half the energy compara tive to a ball mill. Roller mills with output in excess of 800 ton es per hour have been installed. Unlike ball mills, feed to the mill must be regular and uninterrupted; otherwise damaging resonant vibration sets in.



Lay out of a typical roller mill

Project Details

MCL has one of the biggest clinker grinding mill s in the world supplied by M/s. Loesche, Germany. It is a Vertical Roller Mill with high efficiency separator.

Description – Mill

Make: M/s. Loesche, Germany
Mill size: LM 56.2 + 2C
Fineness for PPC: 3200 Blaine
Mill motor drive: 4000 kW

Classifier

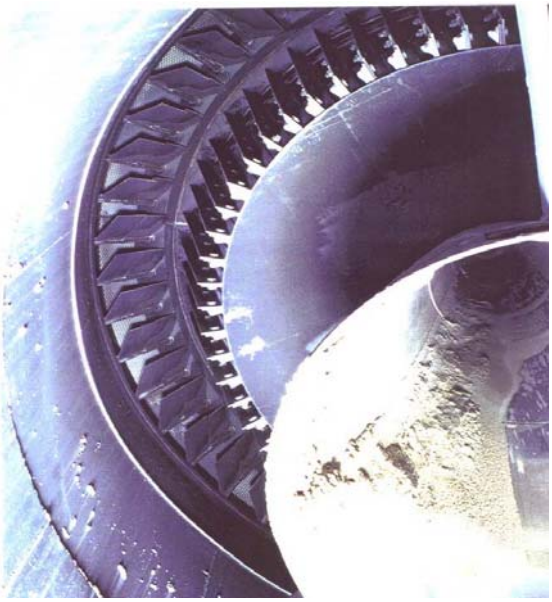
Type: LSKS 85 C
Drive: 160 KW

As a part of the energy conservation activity, the plant team had carried out an extensive study for optimizing the operation of the mill.

Vertical Roller Mills

Vertical Roller Mills (VRM) has found increasing application in the area of grinding. The VRM draws 40 % less electrical energy as compared to the corresponding ball mill system. These mills can accept larger feed size and hence mostly be used with single stage crushing. VRMs are now being used in clinker and slag grinding and also as pre -grinder to existing grinding installations.

One of the major energy consumers in the VRM system is the fan. All the material ground has to be physically lifted to the classifier. This requires large gas volumes and the gas velocity at the mill table is of larger magnitude. The typical velocities in the VRMs are in the range of 55 to 75 m/s. This results in significant pressure drop across the mill table.

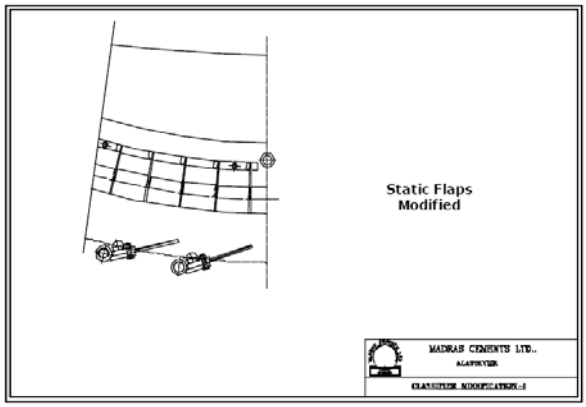


Various cement plants have carried out several in-house modifications to lower the gas flow requirement in the VRM. The overall objective is to achieve the required grinding with lower gas volumes.

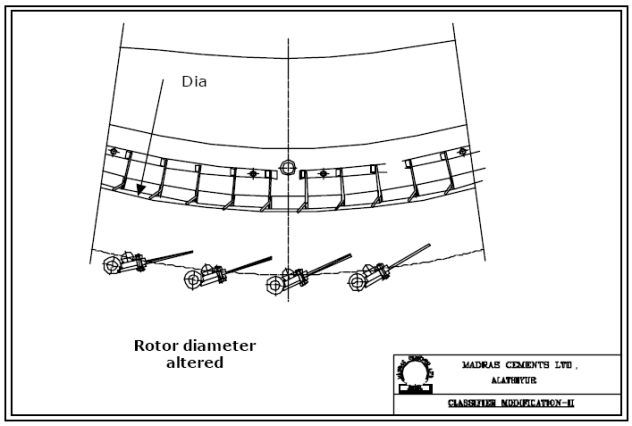
MCL, Alathiyur has also carried out modifications in its clinker VRM to lower the gas flow volume. Some of the modifications carried out are as under:

1. Modification of Width of static flaps
2. Alteration of Rotor diameter of High efficiency dynamic classifier

Before modification



After modification:



Result

These modifications carried out in the clinker VRM has resulted in lower gas volumes and thereby, lower pressure drop across the mill. This, in turn, has reduced the fan power consumption in the VRM. Lower pressure drop across the mill has also facilitated additional m ill feed.

The results of the modifications are documented as per format below:

Product		**Before Modification**	**After Modifications**
Total Feed on dry	Tph	220	235
Mill inlet draft	mbar	-5 to -8	-5 to -8
Mill differential pressure	**mbar**	**44 to 49**	**41 to 46**
Mill inlet temperature	^{o}C	121	125
Mill outlet temperature	^{o}C	100	98
Air flow behind filter	m^3/hr	685000	660000
Power Consumption			
LM Motor	kW	3415	3200
Fan Motor	kW	1725	1520

Classifier Motor	kW	130	110
Auxiliaries			
Fan Speed	rpm	880	850
Sp. LM Power	kWh/t	15.52	13.62
Sp. Fan Motor	kWh/t	7.84	6.47
Sp. Aux. Power (mill & classifier)	kWh/t	0.59	0.46
Sp. Power total	kWh/t	**23.95**	**20.55**

Issues faced during Implementation

There is no major issue faced during the implementation of th e project.

Comments from the Plant team

The project to modify the clinker VRM was taken up by the plant team after extensive studies and consultation with the OEM. This has resulted in enhanced energy efficiency. Similar opportunities regarding fine tuning of equipment are available in various cement plants.

Financing of the Project

The modification of the width of the stator plates and altering the rotor diameter was totally done in-house. The investment was negligible.

Results of the Project

Modification of Width of static flaps of the classifier, Classifier Rotor diameter has resulted in improvement in operating efficiency. As shown in the table, this has resulted in electrical saving of **3.4 Kwh / Ton of cement.**

Financial Benefits:

The annual savings achieved is **Rs 20.0 Million (USD 0.5 Million).**

Annual savings –Rs 20.0 Million (USD 0.5 Million)

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Case Study: 42

UTILISATION OF VENT GASES FROM VACUUM DISTILLATION UNIT (VDU) IN FURNACES

Project Implemented by : Reliance Industries Ltd, Jamnagar

Project Implemented in : 2003

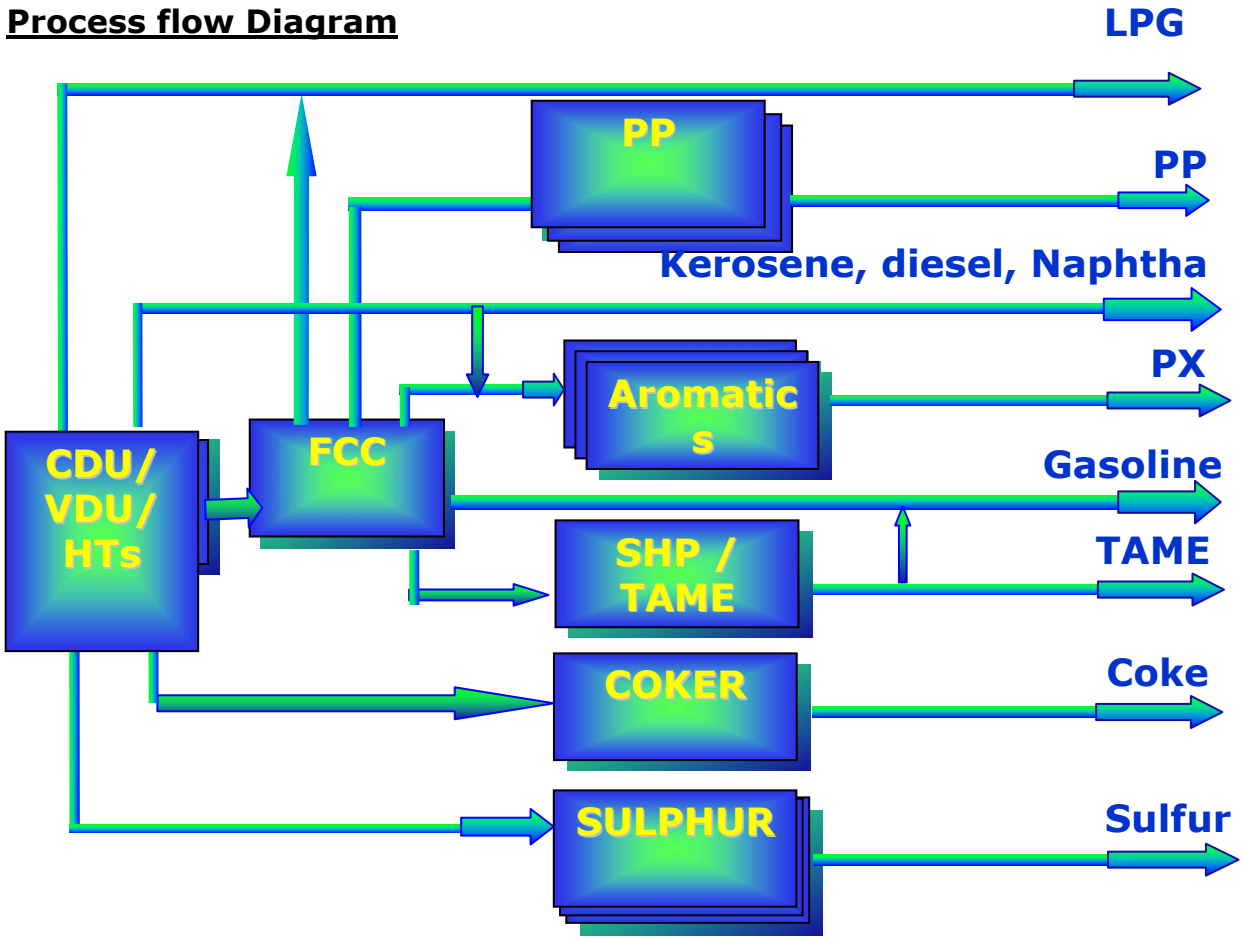
Company Details

The Reliance Group, founded by Dhirubhai H. Ambani, is India's largest private sector enterprise, with businesses in the energy and materials value chain. Group's annual revenues are USD 22 billion. Starting with textiles in the late seventies, Reliance successfully entered into polyester, fibre intermediates, plastics, petrochemicals, and gas exploration and production.

The Group exports products in excess of USD 7 billion to more than 100 countries in the world. Group of companies are Reliance Industries Limited (Reliance Petroleum Limited and Reliance Retail Limited), Indian Petrochemicals Corporation Limited and Reliance Industrial Infrastructure Limited.

Reliance Industries Ltd (RIL) is the fourth largest refinery in the world. The main petroleum products are LPG, Gasoline, Diesel, Naphtha, Coke, Sulpher etc. The current production capacity is around 30 MMTPA.

Process flow Diagram



Waste Heat Utilization:

Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, and then "dumped" into the environment even though it could still be reused for some useful and economic purpose. Waste heat is generally low grade in nature.

Waste heat recovery is one of the best options to reduce the specific energy consumption and to improve the overall system efficiency. In furnaces, the re takes place a lot of heat loss in terms of flue gases vented out.

There exists a good potential to capture this low-grade heat and which can be utilized for various applications like combustion air pre heating, space heating etc. The main criterion for waste heat recovery is that availability of waste heat at the source should match with the utilization, on a real time basis.

Crude Distillation Unit (CDU) Furnace:

In the Crude Distillation unit, crude oil is fractionated into different products like light naphtha, heavy naphtha, Lkero, Hkero, LGO and HGO by distillation process. The unit has major equipment like crude distillation column, fired heater, network of heat exchangers, coolers and air coolers, pumps, compressors and vessels.

Vacuum Distillation Unit (VDU) Column:

This is a basic unit to upgrade the atmospheric residual oil received from CDU through distillation process (carried out under vacuum) to derive products like vacuum distillate, LVGO, HVGO and HHVGO. This unit is equipped with major equipments like vacuum distillation column, ejector system, fired heater, pumps, vessels and the integrated network of heat exchangers, coolers and air coolers with CDU.

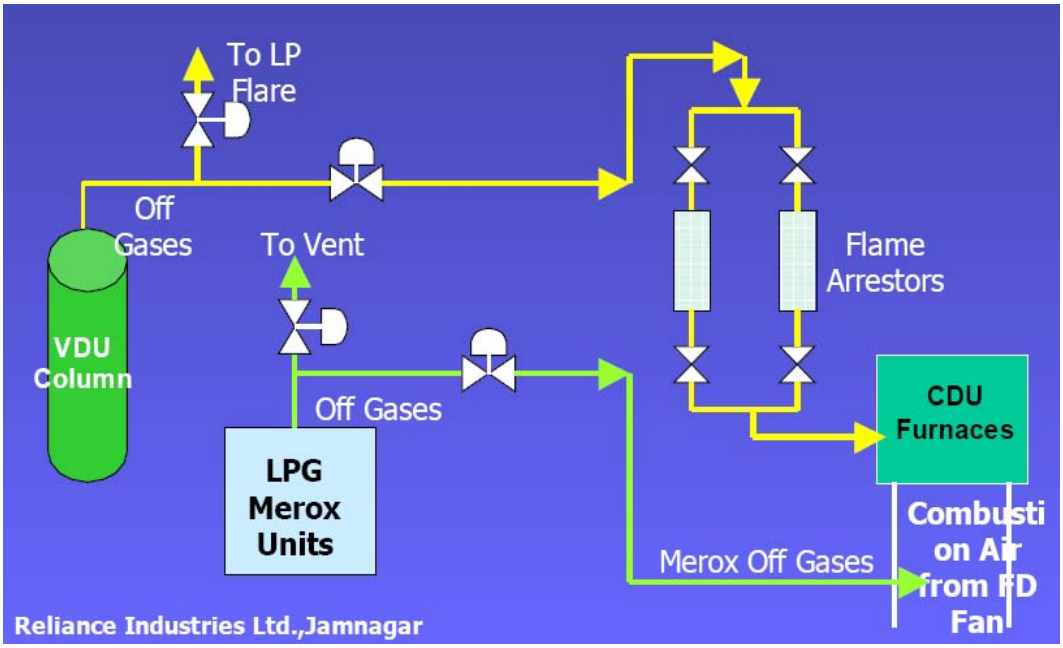
During the process vent gases are generated in the VDU column. The common practice is to vent these gases into the atmosphere as LP Flare.

Project Description:

Initially the off gasses from the VDU column were flared out. Similarly, the merox off gasses from LPG merox units were vented into atmosphere. Due to increased awareness of energy conservation, the plant team decided to put in a scheme where by the waste heat is effectively utilised.

The idea was that instead of venting and flaring, these gasses can be used for firing application, because they contain considerable amount of 'calorific value', thus saving the main fuel.

The modified schematic is shown



Issues Faced during Implementation

No major issues were faced during the implementation of project.

Comments from the Plant Team

Flaring of vent gases is one of the key potential areas where implementation of Waste Heat recovery could lead to both economic and environmental benefits.

Financing of the Project

The plant has invested about **Rs. 0.70 million** for implementation of the project. The investment was taken up fully with internal funds.

Results of the Project

Utilisation of VDU vent gases in CDU furnace has resulted in minimization of vent gasses. The gas quantity reduction in CDU furnace is around 0.7 TPH. The annual savings achieved due to utilization of waste heat is **Rs 560.00 million (USD 14 Million).**

The investment made for this project is **Rs 0.70 millions (USD 0.017 Million)** and the simple payback period for this project is less than **1 Month,** which is very attractive**.**

Replication Potential

This project has excellent replication potential among various industries like ferrous & non-ferrous metals, petrochemicals, etc

Annual savings	**–Rs 560.00 million (USD 14 Million)**
Investment	**–Rs 0.70 millions (USD 0.017 Million)**
Payback Period	**–1 Month**

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Case Study: 43

INSTALLATION OF ELECTRO STATIC AIR FILTER IN LIEU OF CONVENTIONAL AIR FILTERS IN DG SETS

Project Implemented by : Shree Cement Ltd., Beawar

Project Implemented in : 2003

Company Details

Shree Cement Ltd. is an energy conscious & environment friendly business organization. Shree Cement Ltd is currently, the largest single location plant in North India. The company's installed capacity accounted for 15 percent of Rajsthan's total capacity in 2002-03 and 2.5 percent of Indian's production in 2002-03. The company has been taking various efforts to bring down specific energy consumption on a continuous basis. Shree cement Ltd is certified ISO – 9002 & ISO 14001.

Project Details

Diesel engine works on the same principle of compression ignition (CI) engine. Diesel engine is a prime mover, which drives an alternator to produce electrical energy. In the diesel engine, first the air is drawn into the cylinder and is compressed to a high ratio (14:1 to 25:1). During this compression, the air is heated to a temperature of 700–900°C.

A metered quantity of diesel fuel is then injected into the cylinder, which ignites spontaneously because of the high temperature. The piston in the cylinder expands to rotate the alternator and then generates power. The air required for the combustion will be taken from atmosphere.

The combustion air required for DG sets in Shree Cements Ltd was initially taken from conventional/dry type air filters. The main purpose of these air filters is to eliminate the dirt, dust and moisture in the air. This will lead to proper mixing of air to fuel and gives better combustion efficiency.

Conventional Air Filters (CAF):

Most DG sets are fitted with conventional type of air filters, due to lower upfront cost. In conventional air filters the air required for combustion will be cleaned effectively only during initial years of operation. Their effectiveness reduces over a period of time.

The main disadvantage with conventional air filters is they absorb moisture which restricts the airflow. The volume of air supplied comes down. The pressure as well as flow reduces leading to the DG set starving for air.

Air starvation is a common problem due to frequent choking of air filters. This would lead to higher fuel consumption, lower power generation. The specific fuel consumption of the DG set increases. The carbon monoxide (CO) emissions in DG set flue gas will increase.

Air Intake mechanism with Conventional / Dry Type Air Filter

Electrostatic Air Filter (EAF):

EAF use electronically charged filters to attract and hold the dirt, dust and moisture.In EAFs the dust particles stick to the filters due to static electricity of filters. Hence these Electrostatic Air Filters will capture dust particles of size upto 0.01 µm.

Electrostatic air filters are much more effective than a conventional air filters. The life of EAF is also very high compared with conventional type. This Results in reduction of fuel consumption as well as reduction in pollution caused due to Carbon monoxide in flue gas.

Air Intake with Electro-Static Air Filter

Financing of the Project

The plant was installed the project with total cost of internal funds.

Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Comments from the Plant Team

Implementation of the project of replacing dry type filters with electrostatic filters has improved the effectiveness of the filter, resulting in a reduction of specific fuel consumption by the DG as well as improvement in environmental performance. The project has good potential to be replicated in various industries where DGs are running continuously.

Results of the Project

Installation of Electrostatic Air Filters in DG sets has resulted in both environmental and energy saving benefits. The specific fuel consumption has improved from 3.5 kWh/ liter of Furnace oil to 3.64 kWh/ liter, resulting in an annual saving of **Rs 0.569 Million (USD 0.014 Million)**.

The investment made for electrostatic air filter was **Rs.0.30 million (USD 0.007 Million)** which was paid back in **7 months**.

Replication Potential

This project gives good replication potential in all the DG sets which are using conventional filters.

Environmental Benefits

Description	**Unit**	**Value**
Reduction of Pollution Load		
CO_2 Reduction (10 DG sets)	Tones/Year	1370

Economical Benefits

Description		**Unit**	**Value**
Sp. Power generation	before ESF	kWh/lt	3.50
	After ESF	kWh/lt	3.64
	Gain	%	4.00
Fuel oil consumption	before ESF	Lt/hr	180.00
	After ESF	Lt/hr	172.80
	Gain	Lt/hr	7.20
Fuel oil saving per year (10 DG sets)		Rs.	6,220,800

Annual savings	**–Rs 0.569 Million (USD 0.014 Million)**
Investment	**–Rs.0.30 million (USD 0.007 Million)**
Payback Period	**–7 Months**

Contact Information of the Plant

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Case Study: 44

IMPELLER REDUCTION IN MAIN CENTRIGURAL AIR COMPRESSOR TO REDUCE PRESSURE FROM 8 KG/CM^2 TO 6.0 KG/CM^2

Project Implemented by : Sterlite Industries Ltd, Tuticorin

Project Implemented in : 2003

Company Details

Sterlite Industries (India) Ltd (SIIL) is a leading producer of copper in India. Sterlite, a part of Vedanta Resources, a London listed metals and mining major has operations in the Aluminium, Copper and Zinc sectors. The operations are spread across UK, India, Australia and Zambia.

Sterlite Industries has a copper smelter in Tuticorin. The main by-products are Sulphuric acid & Phosphoric acid. Sterlite industries ltd, Tuticorin plant is an ISO – 9001:2000, ISO – 14001 AND OSHAS – 18001 certified plant.

Project Details

Compressors are the major auxiliary electrical energy consumers in Sterlite industries ltd. The connected electrical load of compressors aggregates to 9.5 MW.

For constant compressed air generation requirements of more than 10,000 CFM (Cubic Feet per Minute), dynamic type centrifugal compressors are generally employed.

The latest trend is installing one centralized centrifugal compressor of higher capacity in a closed ring mine system, replacing multiple numbers of individual small reciprocating compressors.

Impeller Selection in Centrifugal Equipment:

An impeller is a rotating component of centrifugal equipment, usually made of iron or steel, which transfers energy from the motor to the fluid being pumped by forcing the fluid outwards from the center of rotation. Impellers are usually short cylinders with protrusions forming paddles to push the fluid and a splinted center to accept a driveshaft.

In any centrifugal equipment, the relation between flow, head and power consumption with respect to speed is governed by the affinity law or 123 rule as given below

- Flow ∞ [Diameter or speed]^1
- Head ∞ [Diameter or speed]^2
- Power ∞ [Diameter or speed]^3

The power consumed by centrifugal equipment is proportional to the cube of the diameter. Hence any reduction in diameter will result in huge saving in power consumption.

The sizing of the impeller is very critical to ensure energy efficient operation. The pressure developed by the compressor can be changed by replacing or trimming the impeller.

Selection of impeller will be the following criteria:

- Required air flow
- Required pressure

Depending on the exact operational requirements, it is possible to reduce the diameter of the impeller either by trimming or by replacing it with one size lower diameter impeller supplied by the OEM. Centrifugal equipments are design in such a way that, the impeller size can be increased or decreased to next two levels.

Impeller reduction will be successful, only when there is a mismatch between design and operational parameters where equipments are operating with controls like a valve, damper, IGV etc.

In addition, when an impeller reduction exercise is undertaken, the equipment operating efficiency will be slightly reduces. This results in the specific energy consumption increases slightly as compared to the ideal scenario. However, energy savings potential through impeller reduction is much higher, compared to reduction in fall efficiency.

Sterlite Tuticorin had two oxygen plants of different vintage. The old oxygen plant of capacity had a Main Air Compressor A (MAC A 2.6 MW, centrifugal type) of capacity 14000 Nm3/hr, operating at 8 kg/cm2.

A new oxygen plant was installed one year after the old one. The capacity of the new plant was similar to the old one but the Main air compressor in this case was operating at a pressure of 6 kg/ cm2. The capacity of the air compressor was 14000 Nm3/hr, similar to that of the Main air compressor in the Old plant.

The plant team compared both the compressors and their operating conditions and concluded that for the operating conditions in old oxygen plant, the compressor was over designed. It was decided to go for impeller reduction for the old plant compressor. The impeller was replaced with the next lower size impeller.

Issues Faced During Implementation

The plant team found out that old oxygen plant compressor (Centrifugal) was over sized. In centrifugal compressor design of the impeller is critical to energy consumption. It was decided to go in for impeller reduction by replacing the same with the next lower size impeller.

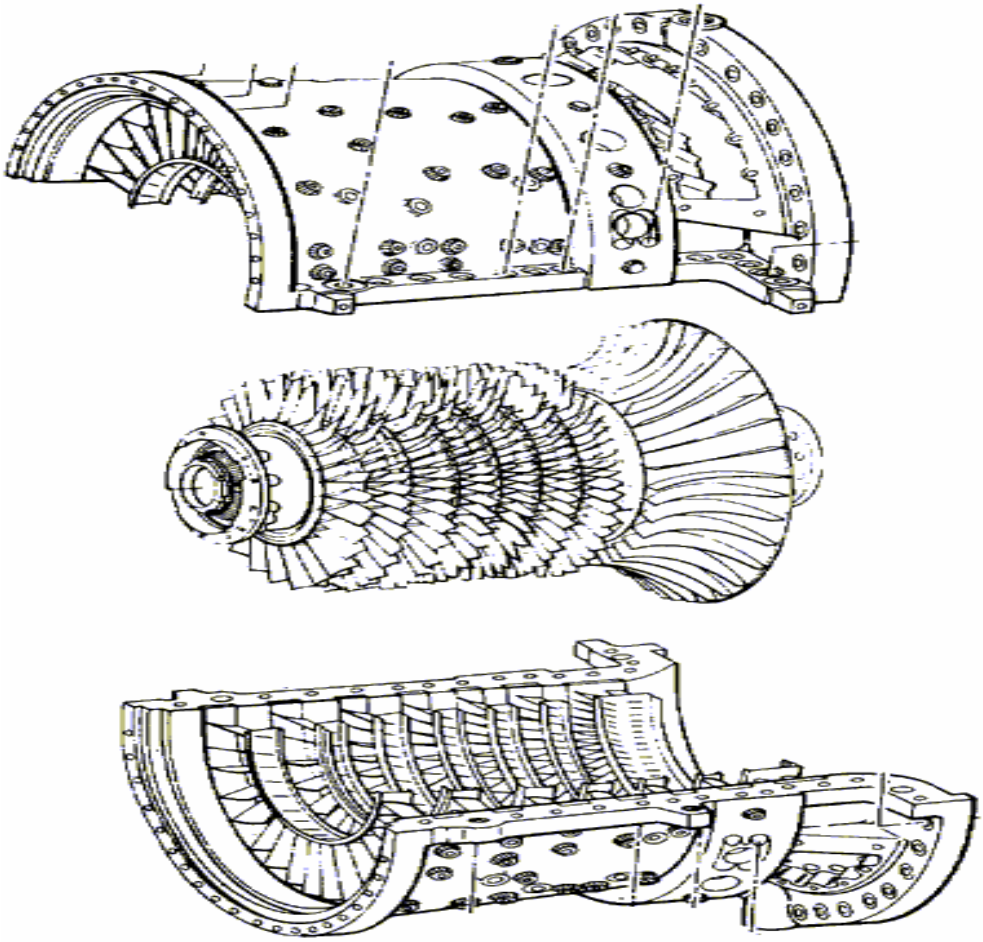
No major issues faced during the implementation of the project. The replacement was undertaken during the annual maintenance shut down period.

Comments from the Plant Team

A comparative study between the Old oxygen plant and new one enabled the plant to understand that the old oxygen plant compressor (Centrifugal) was over sized.

In centrifugal compressor design of the impeller is critical to energy consumption. The only option for reduction in pressure in case of a centrifugal compressor is impeller reduction. Hence It was decided to go in for impeller reduction by replacing the same with the next lower size impeller.

Sizing of centrifugal equipment is critical and correct sizing by design is the best method to ensure optimum energy efficiency.



Financing of the Project

The plant invested about **Rs. 10.00 million** for implementation of the project. The investment has been taken up fully with internal funds.

Results of the Project

Installation of the next correct lower size impeller resulted in reduction of compressed air delivery pressure from 8 kg/cm2 to 6 kg/cm2 this has resulted in reduction the power consumption of the compressor is 250 kW.

The annual savings achieved is **Rs 8.40 million (USD 0.21 Million)**. The investment made for next lower size impeller is **Rs 10.00 million (USD 0.25 Million).** The simple payback period is **14 Months.**

Annual savings	**–Rs 8.40 million (USD 0.21 Million)**
Investment	**–Rs 10.00 million (USD 0.25 Million)**
Payback Period	**–14 Months**

Contact Information of the Plant

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Case Study: 45

COAL TAR INJECTION IN BLAST FURNACES AS ALTERNATIVE FUEL

Project Implemented by : TATA Steel Ltd, Jamshedpur

Project Implemented in : 2003

Company Details

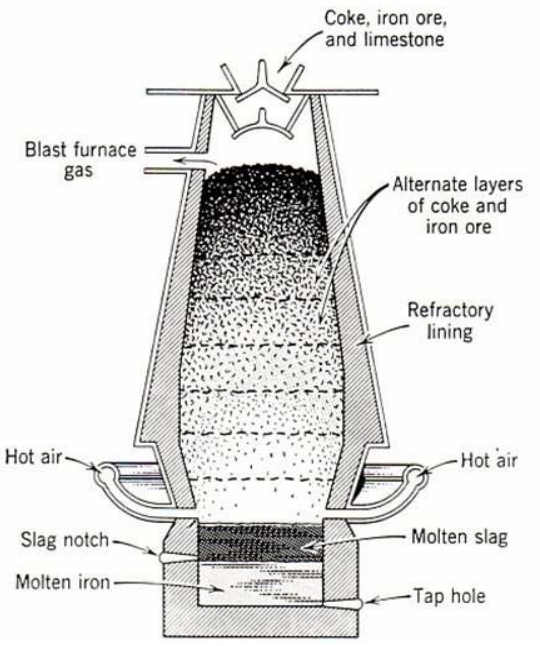
Established in 1907, TATA Steel is Asia's first and India's largest private sector steel company. TATA Steel is among the lowest cost producers of steel. TATA steel ltd is a group of company of TATA group and it is the first integrated steel plant in Asia and largest private plant in India.

Project Details

TATA steel ltd has four blast furnaces to produce the steel. Initially coke is used in the blast furnace to melt the along with iron ore. The calorific value (CV) of Indian coke will be in the range from 2500 to 4000 Kcal/kg. Since the availability and handling is easy, most of the steel plants follow the same pattern to melt the iron ore.

Blast Furnace:

The function of blast furnace is to chemically reduce and physically convert iron oxides into liquid iron called "hot metal". The blast furnace is a huge, steel stack lined with refractory brick, where iron ore, coke and limestone are dumped into the top, and preheated air is blown into the bottom.



The main purpose of fuel is to supply heat for melting the iron ore. The quantity of fuel required is depending upon its calorific value. Right selection of fuel based on the availability, cost economics, CV and chemical properties will gives the better energy savings.

Coal Tar Injection to Blast Furnace:

TATA Steel Ltd has achieved breakthrough in Coal tar Injection technology in Blast Furnaces as a supplement for coke. This technology is first of its kind in the country, as part of their indigenous development initiative. The calorific value of coal tar is 36,000 kJ/kg, which is higher than coke.

System Description:

The system consists of the following equipments:

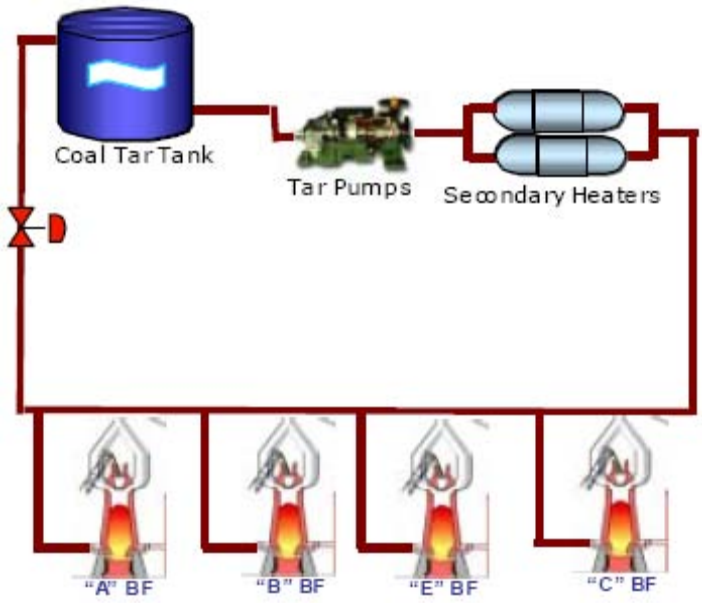
- Coal tar storage tank: Uses to store the coal tar. The capacity of tank is 1000 KL.
- Pumping station: Uses to pump the coal tar. The capacity of pump is 6 m3/hr.
- Heating control: Uses to control the temperature of coal tar. The temperature of coal tar maintained at 75 ºC.
- Transportation lines: Uses to supply / transport the coal tar to blast furnace. The size of supply line is 100 NB and the return line is 80 NB equipped with back pressure control.
- Distribution system at each furnace will control the mass flow rate. The distribution system is shown
- Injection system: Here coal tar will be atomize for proper combustion by using compressed air and is injected through tuyeres by injection lancers. The injection system is shown below.

Distribution System

Injection system

Circuit Diagram:

Coal tar circuit diagram and equipments are shown below



Issues Faced during Implementation

No major issues were faced during the implementation of the project.

Comments from the Plant Team

The project to use "Coal tar Injection technology in Blast Furnaces as a supplement for coke" was taken up as an indigenisation initiative. The success of the project goes on to prove that technology development, especially with regards to using locally available resources in the process can contribute to cost efficiencies.

Financing of the Project

The investment was taken up fully with internal funds.

Results of the Project

Installation of the coal tar injection system has resulted in completely elimination of coke in to the blast furnace. This has resulted in reduction of coke consumption of about 4,500 T per year. The annual savings achieved is **Rs 9.10 million (USD 0.227 Million)**.

Replication Potential

Since blast furnaces are major energy, consumers in all steel industries, Usage of alternate fuels like coal tar gives good energy & Cost savings.

Annual savings –Rs 9.10 million (USD 0.227 Million)
Investment –Rs 5.0 Million (USD 0.125 Million)
Pay back period -7 Months

Contact Information of the Plant

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Case Study: 46

REPLACEMENT OF ELECTRICAL VAPORISER BY AMBIENT WATER VAPORISER IN LPG STORAGE TANKS

Project Implemented by : Tata Motors, CVBU, Pune

Project Implemented in : 2006

Company Details

The Tata Group is one of India's oldest, largest and most respected business conglomerates. The Group's businesses are spread over seven business sectors. It comprises 96 companies and operates in six continents. It employs some 2 , 46,000 people and collectively has a shareholder base of over two million and mar ket capitalisation of $57.6 billion.

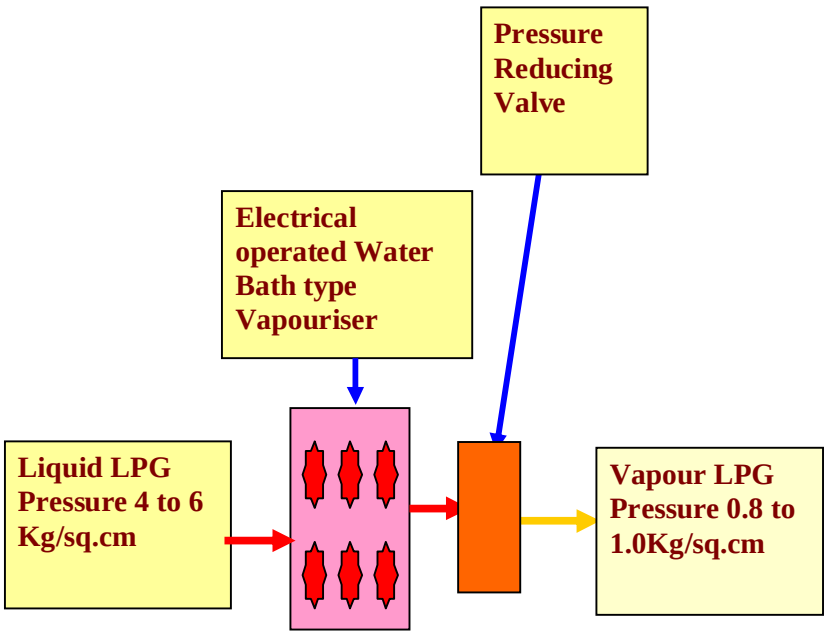
Established in 1945, Tata Motors is India's largest automobile company, with revenues of Rs 24,000 crore (USD 5.5 billion) in 2005 - 06. The company is the world's fifth -largest medium and heavy commercial vehicle manufac turer.

Tata Motors' product range covers passenger cars, multi -utility vehicles as well as light, medium and heavy commercial vehicles for goods and passenger transport

Project Overview

As per the original design, liquid LPG has been converted into vapour by electrical heating and then supplied for plant requirement. Liquid LPG is received at a pressure of 4 to 5 kg/cm2. Electrical heaters are utilized for heating LPG to convert into gas at the same pressure. After vaporization, LPG pressure has been reduc ed to 1 kg/cm2 using a control valve and then supplied to the plant requirement.

The installed capacity of the electrical heater is about 24 kW and the power consumption is about 86400 units/annum. The schematic diagram of the original system is given bel ow.



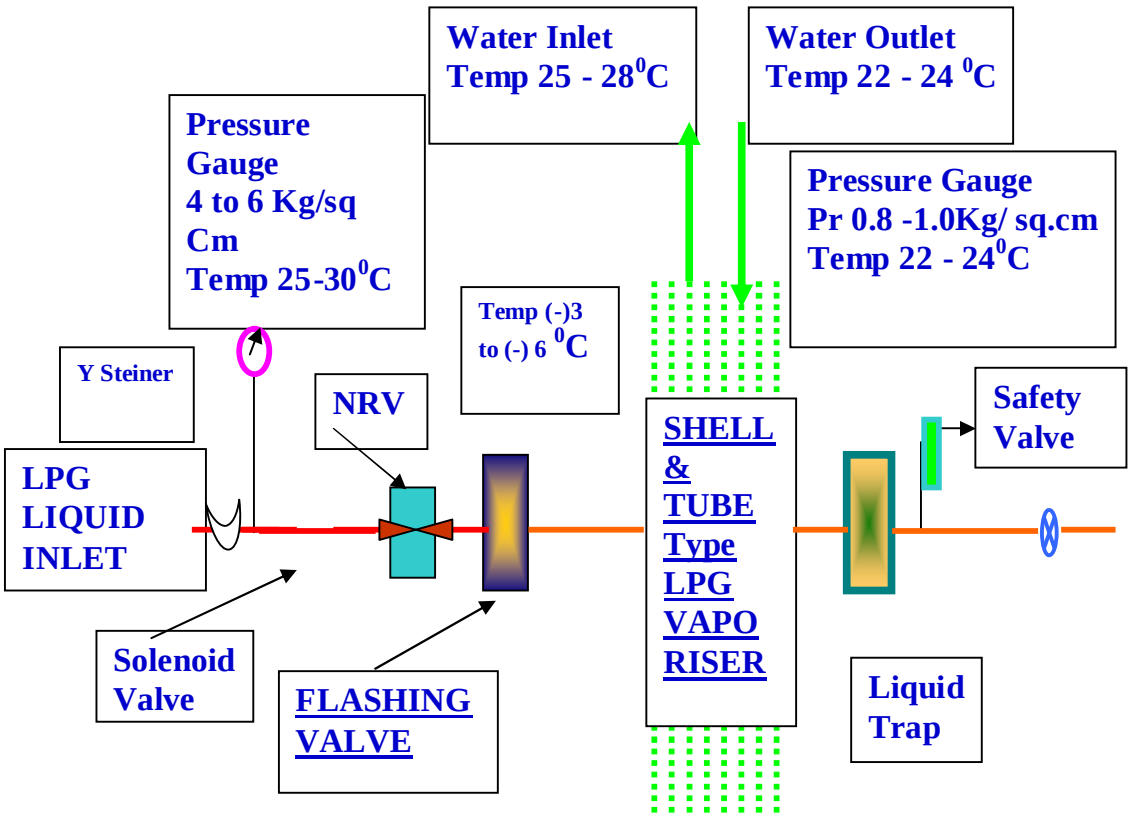
Project Implemented

The boiling point of LPG is 1 ^{o}c at atmospheric pressure. Hence the system has been modified to vaporize LPG at lower temperature and totally eliminate the electrical heaters. This has been taken up in two stages.

In the first stage, LPG at a pressure of 4 -5 kg/cm^{2} and 25-30^{o}C of temperature has been reduced to lower pressure of 1 kg/cm ^{2} by using a flashing valve. This pressure reduction results in partial vaporization of LPG.

Since the boiling point of LPG is only about 1^{o}C at atmospheric pressure, water at a temperature of 25 -28^{o}C has been utilized for vaporizing. This has been done using a shell and tube heat exchanger. The electrical heater has been totally eliminated. The present energy cost for vaporizing LPG is about 10800 units/annum.

The schematic diagram of the modified system is given below.



Issues during Implementation

This project was implemented and no issues were faced during implementation.

Financing of the Project

A marginal investment was made for implementation of the project. The investment has been taken up fully with internal funds.

Comments from the Plant Team

The project of replacement of electrically operated vaporizer to LPG based system was an in house initiative towards cost savings. With increasing costs of electrical energy, thermal energy for various heating applications is a cost effective option. Among the various thermal sources LPG was selected because of the lesser emissions associated with its usage.

Replication Potential

Replication potential in all automobile plants

Results of the Project

The annual savings achieved is Rs 0.32 million (USD 0.008 Million).

Annual savings –Rs 0.32 million (USD 0.008 Million)

Contact Information of the Plant

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Case Study: 47

MODIFICATION OF BLOOM PUSHER OF REHEATING FURNACE

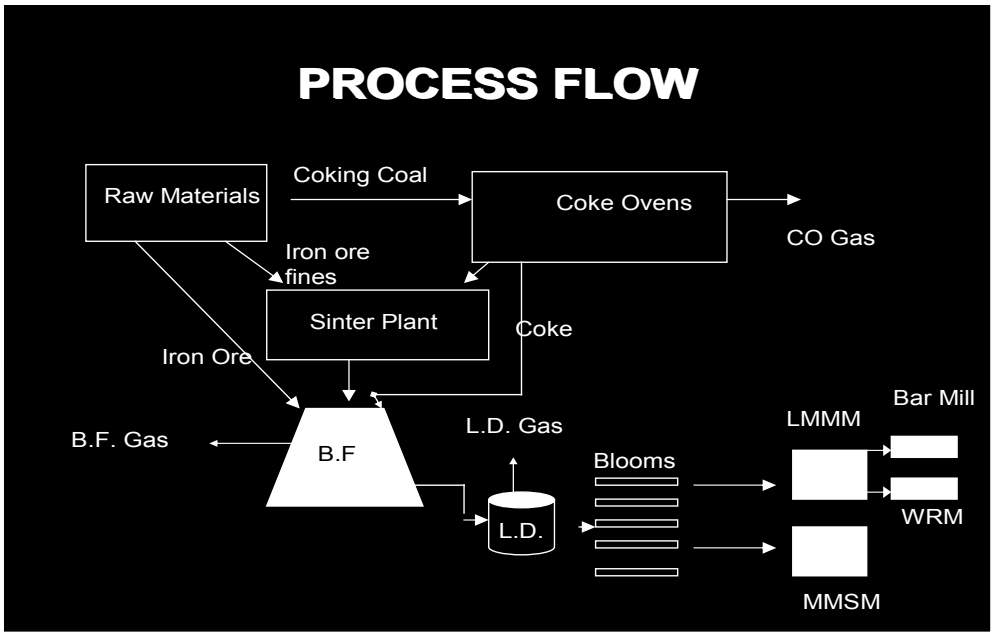
Project Implemented by : Vizag Steel plant, Visakhapatnam

Project Implemented in : 2005

Company Details

Vizag Steel Plant part of the **Rashtriya Ispat Nigam Limited** (RNIL) is one major steel producing public sector companies in India. The steel plant was setup in collaboration with the Government of India & erstwhile Soviet Union offering techno-economic cooperation.

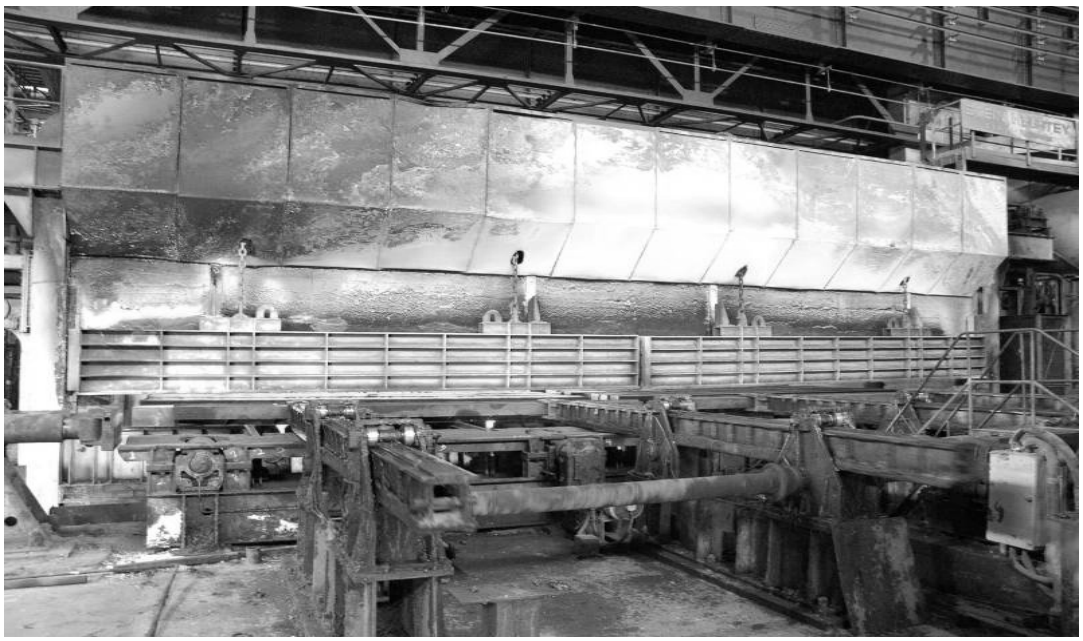
Presently the Plant is operating at higher efficiency levels surpassing the rated capacities thus achieving 4.15 Mt of Hot Metal, 3.6 Mt of Liquid Steel and 3.2 Mt of Saleable Steel i.e 122%, 120% & 122% of the respective rated capacities during 2005-'06. RINL has been forefront in energy efficiency and won many national awards in energy conservation.

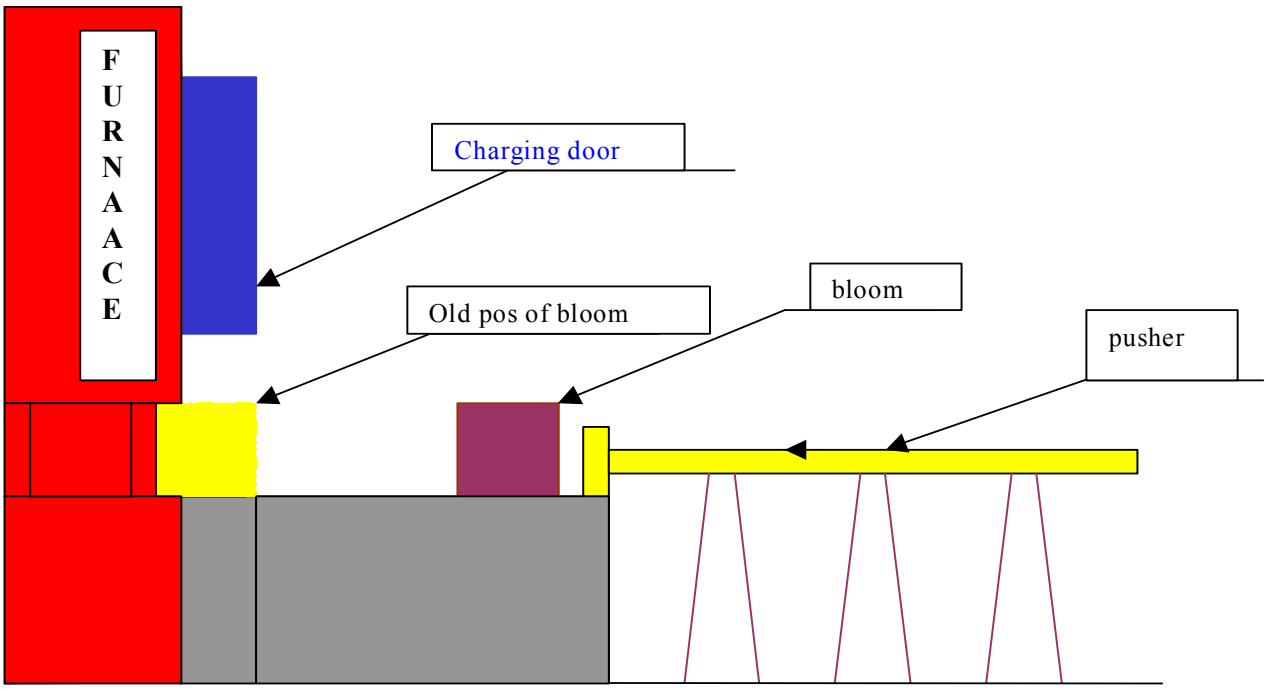


Project Overview

The Plant had 2 bloom reheating furnaces of capacity130 t/hr each. The blooms from the bloom casting machine are reheated in the above two furnaces before they are sent for further shaping into rods, billets of various sizes.

In the earlier system the blooms were pushed into the reheating furnaces beneath the charging door. This resulted in incomplete closure of the furnace inlet door resulting in heat loss through the opening. The corresponding fuel loss was calculated to be about 0.8 Gcal/hr.





The above diagram describes the process of bloom being feed into the furnace.

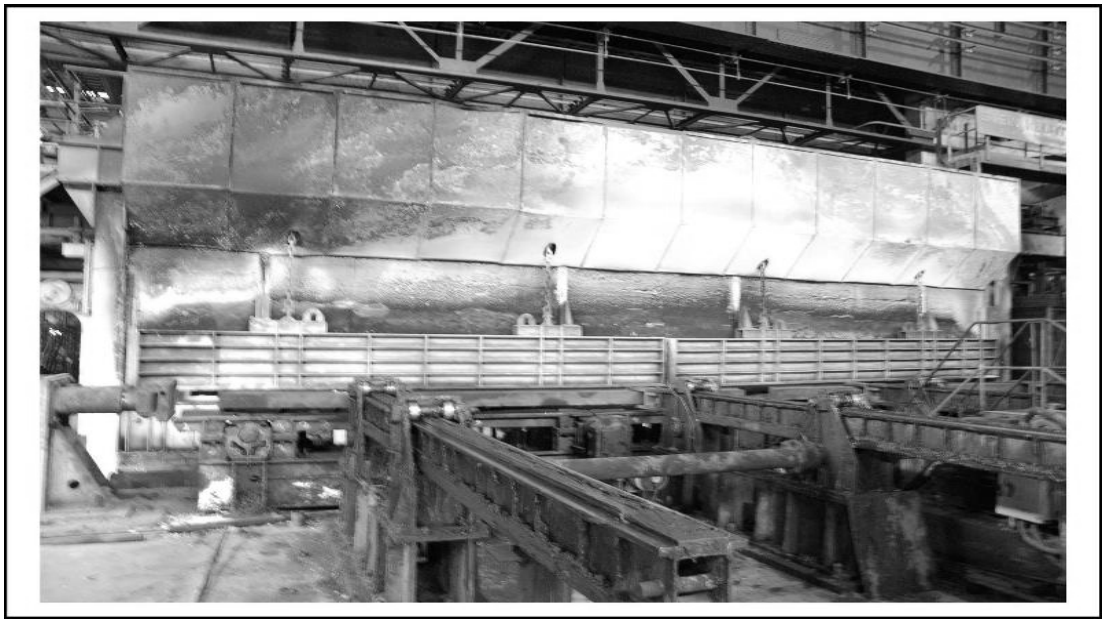
Modified System

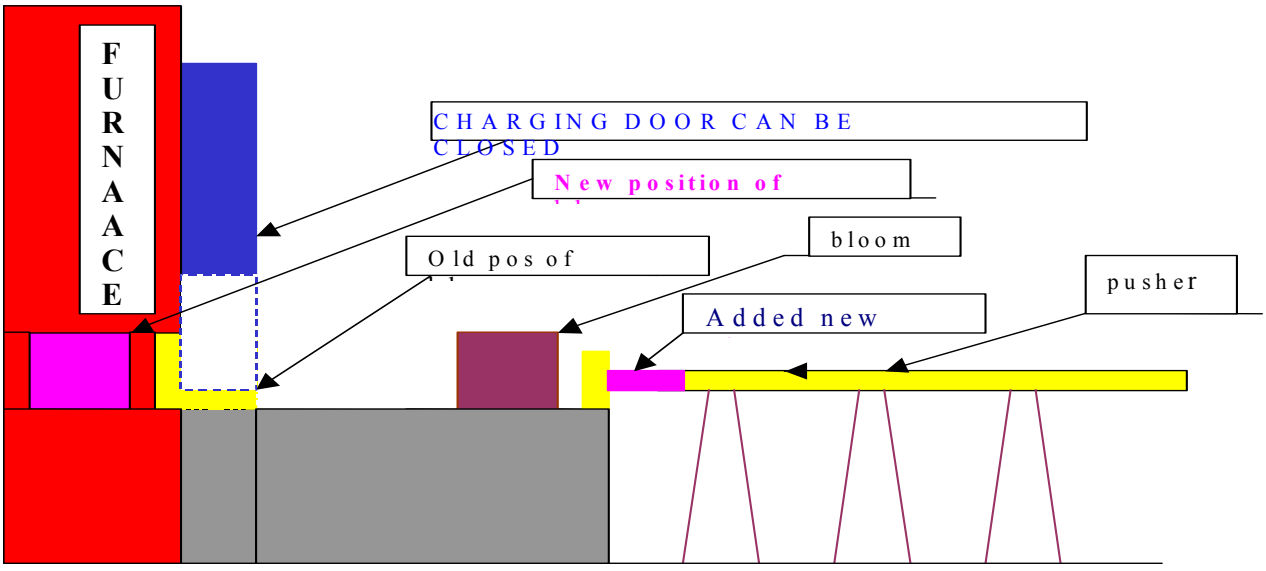
The plant team thought of an ingenious idea to nullify this heat loss. It was observed that the positioning system placed the bloom exactly in the path of the door closure resulting in incomplete closure.

The detailed review revealed that plunger (pusher) has to move forward for about 400 mm so as to ensure that the bloom is completely inside the furnace**.**

The plant team developed a system consisting of addition of a spool piece so as to facilitate the pushing of the bloom further into the furnace and thus ensure complete closure of the charging door. Implementation of this modification has resulted in significant energy saving in terms of reduction in heat loss to the tune of **6967 Gcals per year.**

The modified system is shown as below





Since the plunger was relocated both the protection system for avoiding damage to the furnace as well as end limit switches were modified.

Other Advantages:

The new system not only ensures reduction in heat loss through the furnace opening but also ensures uniform heating of the bloom.

Due to uniform heating of the bloom the electrical energy consumption in the mills for further reducing the bloom into rods and billets, has also come down.

Issues Faced during Implementation

No major issues were faced during the project implementation. The addition of the spool piece was done online.

Comments from the Plant team

The project was identified and implemented by the Plant team. The modifications were carried out internally. The project received immediate approval due to low cost investments. There is a good potential for similar modifications across various industries operating furnaces, especially of higher capacities.

Financing of the Project

The modification in the plunger (pusher) assembly by addition of spool piece was done using internal expertise and the investment incurred was marginal.

Replication Potential

Replication potential is very high in all furnaces where energy escapes as heat due to inadequate closure of doors and can be taken up as in house activity under TPM or TQM.

Results of the Project

The annual savings achieved is **Rs 2.83 Million (USD 0.070 Million)**. The investment made for this project is marginal.

Annual savings –Rs 2.83 Million (USD 0.070 Million)

Contact Information of the Plant

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Case Study: 48

INSTALLATION OF HOT AIR DIRECT DUCTING SYSTEM AT BASE TRANSCEIVER STATION (BTS)

Project Implemented: Tata Tele services Ltd in 2005

Company Details

Tata Tele Services ltd, a part of Tata Group, provides basic and mobile Telecommunication services across 20 states in India. Incorporated in 1996, it was the first company in India to launch CDMA mobile services. Under the brand name 'Tata Indicom' Tata Tele Services has a customer based of 17.1 million customers in over 3,400 towns.

Tata Tele Services' offers mobile services, wireless desktop phones, and public booth telephony and wire line services. It also offers voice portal, roaming, post-paid internet services, 3-way conferencing, group calling, wi-fi internet, USB modems, data cards, and calling card and enterprise services.

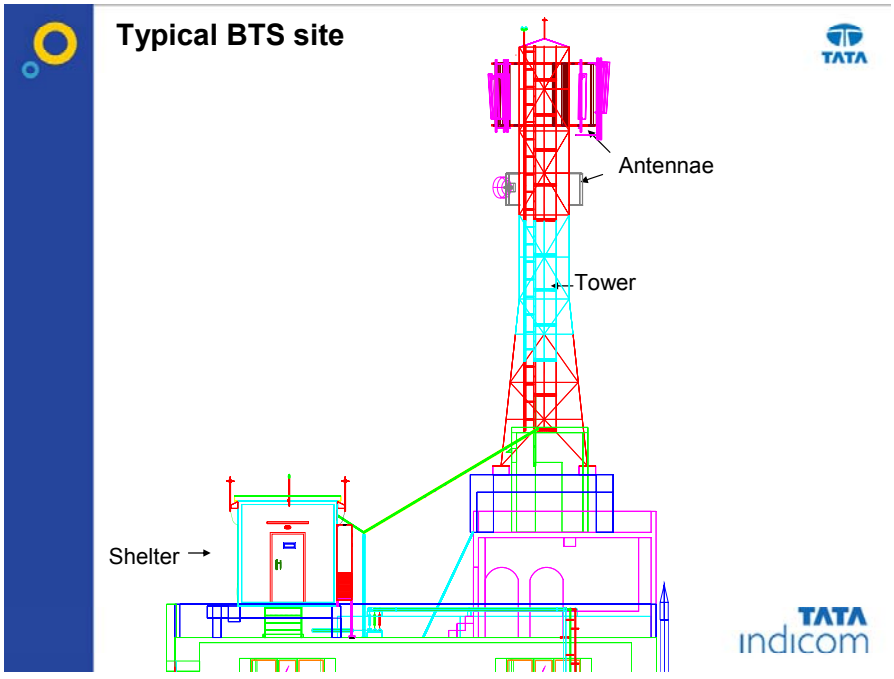
The Telecom Industry in India is characterised by high rate of penetration, High competitiveness, Rapid fall in tariff, Rapid strides in Technology, High Operating Expenditures, High Gestation periods and a Power cost of around 14-16 % of the total operational costs.

About Base Transceiver Station (BTS)

A Base Transceiver Station (BTS) is the equipment which facilitates the wireless communication between user equipments and the network. User equipments are devices like mobile phones (handsets), Wi-Fi gadgets etc. The network can be that of any of the wireless communication technologies like GSM, CDMA, WLL, etc.

BTS forms part of the Base Station Subsystem (BSS) and has the equipments like transceivers, signal processors, signal amplifiers, and equipments for system management. . Antennas may also be considered as components of BTS. Typically a BTS will have several transceivers (TRXs) which allow it to serve several different frequencies. The basic structure and functions of the BTS remains the same regardless of the wireless technologies employed.

Typical BTS Tower

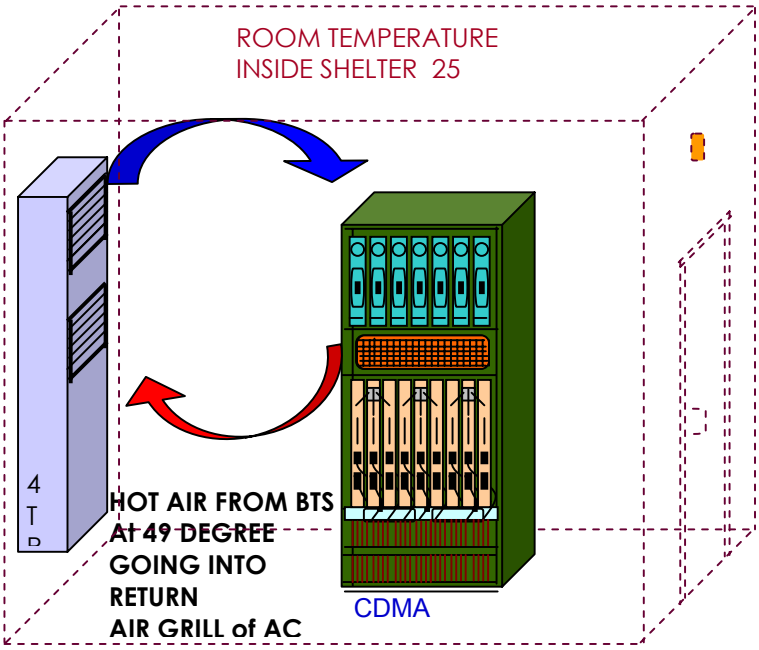


Schematic of Site (Tower & Shelter)

A shelter generally houses all the electronic equipment. At Tata Tele the CDMA Mod cell equipment is installed inside the shelter of dimensions (4MX3MX3M).

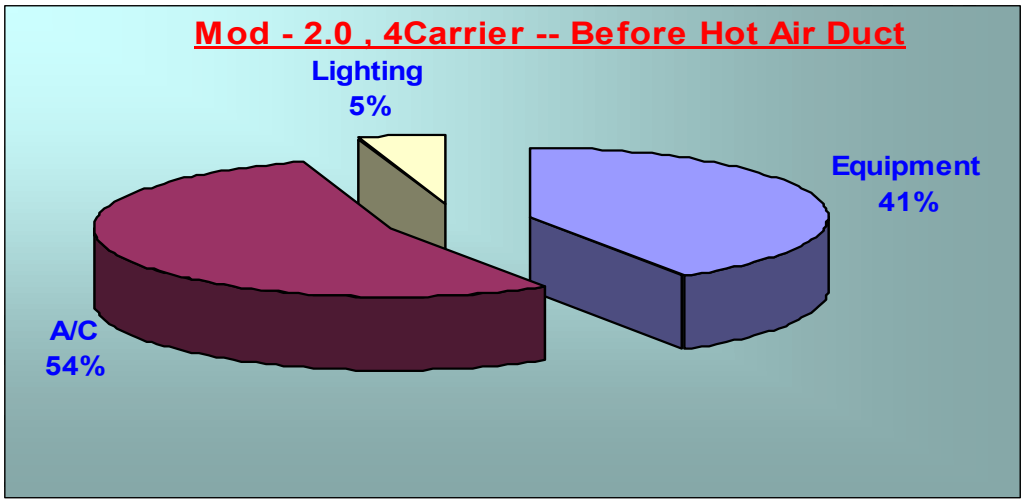
The shelter was fitted with an Air-conditioning system (Split A/C) of capacity 4 TR so as to maintain an operating Temperature of 25 Deg, with a humidity range of 55- 65 % as specified by the OEM.

The CDMA mod Cell equipment emits hot air from the equipment. The hot air from the equipment is at a temperature of 49 degrees. This resulted in room temperate inside the shelter going up. To keep the temperature constant at 25 Degrees, the air conditioning equipment had to over work.



NORMAL RUNNING
CONSUMPTION
UNITS
PER DAY 216 units
PER MONTH 6500 units
AMOUNT RS 40,950

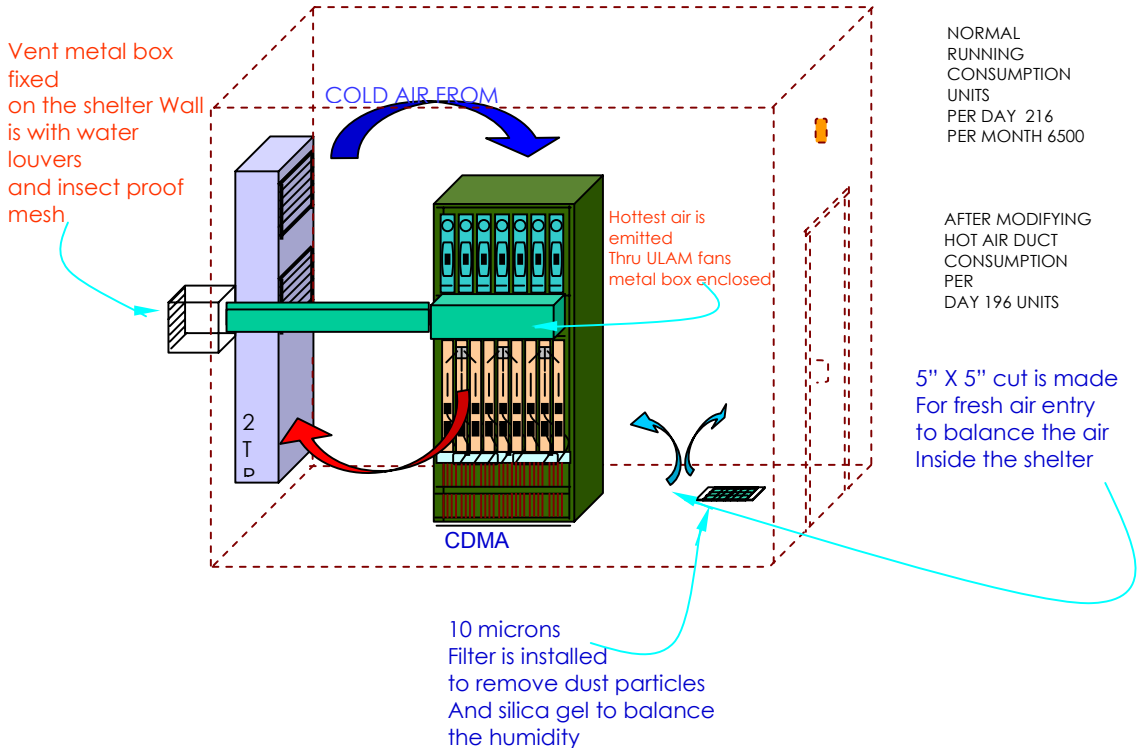
The technical team analysed the situation and found that air conditioning is a major contributor to shelter operational costs, contributing to 54 % of the energy costs. The consumption of the air conditioning unit was 216 kWh per day and this worked out to an annual cost of Rs 0.5 Million.



The plat team analysed that the main contributor to this energy cost is the hot air (49 Degree C) emitted from the CDMA Mod cell equipment which goes into the air conditioning space.

A Project was implemented to route this hot air directly and dump it into the external atmosphere, through a ducting system. The ducting system consists of the following. A metal box at the back of the CDMA mod cell equipment fitted with ULAM fans to blow hot air, PVC duct to route hot air and a vent metal box placed on the outside (exposed to the atmosphere & fitted with water louvers and insect proof mesh. Also a cut is made at the basement of the shelter (dimensions 5" X 5" with 10 micron filter) so that fresh air entry is provided. This is to balance the air outflow and inflow.

The schematic & actual installation is as shown.


Vent metal box
fixed
on the shelter Wall
is with water
louvers
and insect proof
mesh
COLD AIR FROM
Hottest air is
emitted
Thru ULAM fans
metal box enclosed
2
T
D
CDMA
NORMAL
RUNNING
CONSUMPTION
UNITS
PER DAY 216
PER MONTH 6500
AFTER MODIFYING
HOT AIR DUCT
CONSUMPTION
PER
DAY 196 UNITS
5" X 5" cut is made
For fresh air entry
to balance the air
Inside the shelter
10 microns
Filter is installed
to remove dust particles
And silica gel to balance
the humidity

Implementation of the Project

The implementation of the project was taken up in a phased manner after a number of trials, at different geographic locations. Each shelter was observed for air balance and any probable abnormal temperature rise.

Comments from the Technical Services Team

The telecom industry in India is characterised by High competitiveness, Rapid fall in tariff, and a power cost of around 14-16 % of the total operational costs. Hence there is a need for cost cutting through innovative schemes.

The installation of Hot Air Direct Ducting system at Base Transceiver Station (BTS) was an innovative idea put forward by the technical services team.

The project resulted in air conditioning load coming down by 20 %. This has excellent replication potential across various Base Transceiver Stations (BTS) as well as various data centres across the country. However the requirements regarding air balance and parameters like humidity are to be estimated specific to the installation.

Financing of the Project

The investment was around Rs 4600 per site resulting in a total investment of Rs 1.6 Million. The investment was made using internal funds alone.

Results of the Project

The installation of Hot Air Direct Ducting system at Base Transceiver Station (BTS) resulted in the heat load on the air conditioning system coming down by 20 %. The power consumption was reduced by 20 kWh per day for a single shelter. For certain shelters, the team was able to replace the original air conditioner of capacity 4 TR with a new air conditioner of capacity 2 TR, thus reducing the capital costs of new installations.

The installations at 348 shelters, put together has resulted in annual saving of **Rs 19.8 Million (USD 0.495 Million)**. The investment towards the same was around Rs 4600 per shelter, resulting in a total investment of **Rs 1.6 Million (USD 0.04 Million)**, with a pay back period of **1 Month**.

Annual savings	**–Rs 19.8 Million (USD 0.495 Million)**
Investment	**–Rs 1.6 Million (USD 0.04 Million)**
Payback Period	**–1 Month**

Contact Information of the Plant

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A P state operation

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Case Study: 49

HEAT RECOVERY FROM EXO-GAS SYSTEM

Project Implemented by : Kirloskar Copeland Limited, Atit

Project Implemented in : 2003

Company Details

Kirloskar Brothers Limited a leading engineering company in the Refrigeration and Air-conditioning industry in India and Copeland Corporation of U.S.A a subsidiary of Emerson Electric Company, U.S.A, formed a joint venture - Kirloskar Copeland Limited. The new joint venture company took over the compressors manufacturing and sales business of hermetic compressors division (at Karad and Atit) of Kirloskar Brothers Limited from 1st April 1993.

Today, Kirloskar Copeland Ltd is one of the leading manufactures of refrigeration and air conditioning compressors – especially the Reciprocating Type Hermetically Sealed type Compressors of range 1/8th HP to 40 HP, both nationally and internationally. Kirloskar Copeland was the first to make CFC-free compressors.

Kirloskar Copeland Ltd is one of the ISO 14001 certified companies. The company has been recently renamed as Emerson climate technologies.

Project Overview

Decarburizing plant undertakes the Process of Annealing & De-Carbonizing of Electrical Steel Stamping.

In De-Carbonizing process, stamping steel is heated up at 1000 °C & this heat is generated by burning the LPG. The system Exhaust gas temperature is around 1000 °C.

In decarb plant, exo-gas used for the process is produced at 1000 °C. Then the exo gas is cooled to 40 °C with the help of cooling water. Ultimately this heat content is liberated to atmosphere through cooling tower.

The plat team found that there was a good chance of recovering the heat from the exo gas and use the same for pre heating applications.

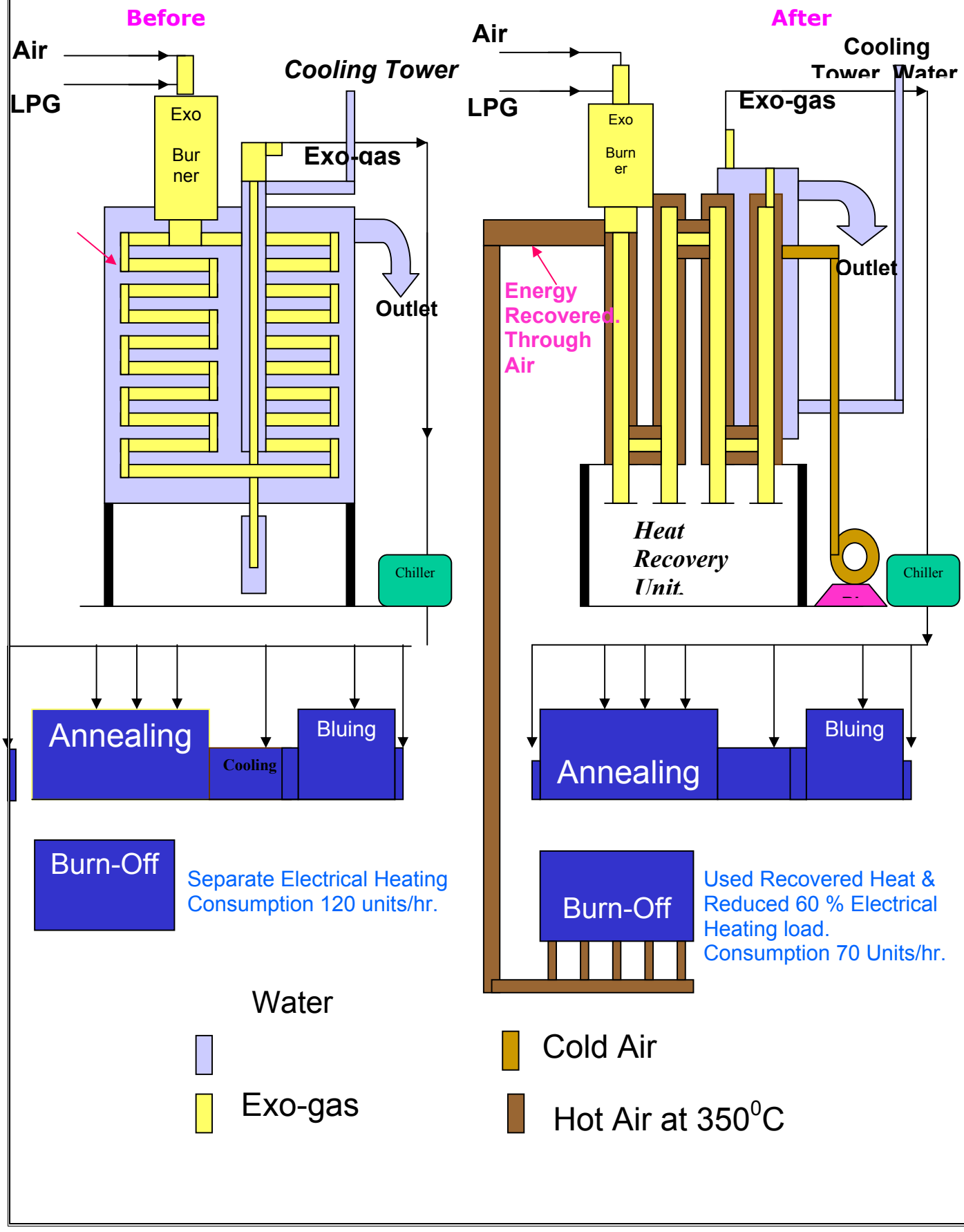
Action Taken

The plat team installed a 'Heat recovery unit' which cools the exo-gas to 450 °C using both air & water. Earlier the heat content was carried away only by water. In the new system, the heat generated is carried away by air & this pre - heated air is used in burn-off zone in the furnace. This has resulted in partial switching off of electrical heating system, which was used in burn off zone.

Parameter	**Old System**	**New System**
Exo-Gas Outlet Temperature	45 °C	25 °C
Water Outlet Temperature	38 °C	38 °C
Generated Heat	Waste in Water	Used to heat to air
Energy Recovered	No	70 Units/hr

The electrical energy consumed in Burn-off Zone without Heat Recovery Unit (HRU) was 120 kW per hour. This was reduced to 50 kW per hour after installation of HRU.

Schematic Diagram of Heat Recovery Unit from Exo- Gas System


Before
Air
LPG
Exo
Bur
ner
Cooling Tower
Exo-gas
Outlet
Chiller
Annealing
Cooling
Bluing
Burn-Off
Separate Electrical Heating
Consumption 120 units/hr.
After
Air
LPG
Exo
Burn
er
Cooling
Tower Water
Exo-gas
Outlet
Energy
Recovered.
Through
Air
Heat
Recovery
Unit
Chiller
Annealing
Bluing
Burn-Off
Used Recovered Heat &
Reduced 60 % Electrical
Heating load.
Consumption 70 Units/hr.
Water
Exo-gas
Cold Air
Hot Air at 350^{0}C

Benefits

There was a reduction of 70 kW in the power consumption of electrical heater.

Issues during Implementation

There were no issues faced during implementation.

Financing of the Project

The plant has invested about **Rs 0.45 million** for a heat recovery unit. The investment was taken up fully with internal funds.

Replication Potential

This project can be implemented in all engineering industries having annealing process involving exo gas.

Results of the Project

Implementation of the project had resulted in reduction in energy consumption by 70 kW per hour. The annual savings achieved was **Rs 1.65 Million (USD 0.041 Million)**. The investment made for this project was **Rs 0.45 Million (USD 0.011 Million)**. The pay back period is **4 Months**.

Annual savings	**–Rs 1.65 Million (USD 0.041 Million)**
Investment	**–Rs 0.45 Million (USD 0.011 Million)**
Payback Period	**–4 Months**

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Energy Efficiency Bulletin

A Newsletter on Energy Efficiency from CII-Sohrabji Godrej Green Business Centre

A Case Study on Installation of Efficiency Control System for Boiler

Company details

Dr Reddys Laboratories, one of the leading pharmaceutical companies in India, has operations all over the world. It has market in more than 60 countries with a large focus in United states of America, Europe, Russia, China and India.

The company has 6 FDA inspected API facilities, 7 formulation plants 3 catering to the US and Europe.

The portfolios of the company include active pharmaceutical ingredients, branded generics, specialty pharmaceuticals, generic pharmaceuticals and new chemical entities.

Project details

Boiler is the major thermal energy consumer in a pharmaceutical industry. Typically oil fired package type boilers are utilized for steam generation.

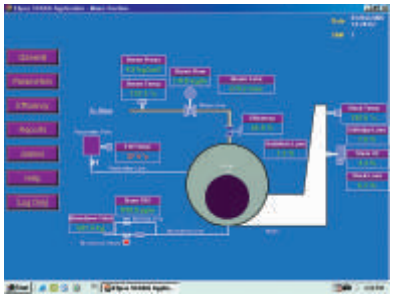
With the present trend of ever increasing fuel price, even a slight reduction in operating efficiency of the boiler results in significant increase in operating cost. There is an immense need for continuous monitoring of the operating efficiency and maintaining the same at optimum level.

The latest trend is installing online efficiency monitoring equipment and control system for the oil fired boilers.

Against this background, the plant team decided to install efficiency monitoring & control system for the boiler.

Benefits of installing efficiency control system for boiler

- Sustained improvement in boiler efficiency
- Monitoring & trending of parameters



Features of efficiency monitoring & control system

For package boilers of capacity 2-3 tons/hr, direct method of estimating the operating efficiency is practiced. Steam flow, oil/gas flow, steam pressure, temperature and feed water temperatures are measured and the following are estimated.

- Steam fuel ratio
- Direct operating efficiency

For boilers of capacity more than 3 tons/hr, the indirect efficiency monitoring system with blow down control is utilized. The monitoring system consists of oxygen analyzer for excess air measurement, stack temperature and steam temperature measurement, feed water temperature measurement, vortex type flow meter, blow down control, computation and display unit, as well as data acquisition and diagnostic software package.

The monitoring system measures steam flow, temperature, stack oxygen (O_2%), flue gas temperature, ambient temperature, drum TDS and feed water temperature.

Based on the measurements, the indirect operating efficiency, steam fuel ratio and quantity of blow down requirement are estimated.

The main advantage of the system is the visual Human Interface and self explanatory mimic of the boiler on the front display. It also allows for real time / historical trending on the display. The system is connected to the personal computer and has features enabling internet connectivity.

ICICI Bank
UNEP

Cost benefit analysis

- Annual Savings - Rs 0.78 Million (0.0195 Million USD)
- Investment - Rs 0.90 Million (0.0225 Million USD)
- Simple payback period - 14 Months.

Issues faced during implementation

No major issues were faced during the implementation of the project. The project was implemented online.

Financing of the project

The plant invested about Rs 0.90 Million (0.0225 Million USD) for implementation of the project. Only internal funds were utilized for investment.

Comments from the Plant Team

The project was implemented by Dr Reddy's Laboratories Generic Division, Hyderabad, in the year 2003.

Implementation of the project “Installation of efficiency control system for Boiler” resulted in improvement of Boiler efficiency and consequent fuel savings. The system enabled the plant team to monitor data and various parameters on a real time basis. Trending of data is also possible. It is possible to operate the boiler continuously at higher efficiency.

Results of the Project

Installation of the efficiency monitoring system resulted in improvement in operating efficiency of about 1-1.5%. This resulted in reduction in fuel consumption of about 5-6 lit/hr.

The annual savings achieved is **Rs 0.78 Million (0.0195 Million USD)** The investment made for installation of efficiency monitoring system is **Rs 0.90 Million (0.0225 Million USD).** The simple payback period is **14 Months.**

About CII & CII-Godrej GBC

CII is a non-government, not-for-profit, industry led and industry managed organisation, playing a proactive role in India's development process. Founded over 112 years ago, it is India's premier business association, with a direct membership of over 6500 organisations from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 90,000 companies from around 350 national and regional sectoral associations.

CII-Godrej GBC is a Centre of Excellence in Energy Efficiency, Green Buildings, Renewable Energy, Water, Environment & Recycling and Climate Change activities in India.

About 3 Country Energy Efficiency

The Project "Developing Financial Intermediation Mechanisms for Energy Efficiency Projects in Brazil, China and India" (in short "3 Country EE") aimed to substantially increase investments in energy efficiency by the domestic financial sectors in Brazil, China and India.

The 3 Country EE was a partnership between the World Bank, the United Nations Environment Programme (UNEP) through the UNEP Risoe Centre on Energy, Climate and Sustainable Development (URC), and institutions in Brazil, China and India.

The “Energy Efficiency Bulletin” comprises of a series of newsletters on energy efficiency projects implemented by the Indian industry and is supported under the "3 Country EE" initiative as well as by USAID.

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