

## Reliance Jamnagar

### Unit Profile

Reliance, Jamnagar is the largest grass root refinery in the world set up with annual capacity of 27 million tons. It is the first and the only Refinery to be set up in the private sector in India after oil sector reforms were initiated. It is the 3rd largest refinery in the world at any single location and accounts for 24% of India's refining capacity.

The Refinery and Petrochemical Complex comprises of Crude Unit (2 parallel trains), Diesel Hydrotreater (2 trains), VGO Hydrotreater (2 trains), Sulfur (3 trains), Hydrogen(2 trains), Coker, Fluid Catalytic Cracker, Propylene Recovery Unit, Amine treating Unit, Desalination Units, Naphtha Hydrotreating, Catalytic Reforming, Paraxylene Extractions trains (3 nos), Tatoray Unit, Xylene extraction, Polypropylene Unit(3 trains), Captive Power Plant and an Effluent treatment plant.

### Highlights :

- **Commissioned in 2000.**
- **Original Capacity- 450 KBPSD (22.5 MMTPA). Current Capacity 27 MMTPA**
- **Largest Grass Root Refinery.**
- **World's Largest FCCU – 9.5 MMTPA (180 KBPSD).**
- **World's Largest Coker – 8.12 MMTPA (155 KBPSD).**
- **World's Largest Aromatics Complex – 1.6 MMTPA (PX + OX) capacity in one site.**
- **World's largest PP in one site – 750,000 MTPA**
- **India's largest Sulfur Recovery Complex – 1350 TPD**
- **Large size Captive Power Plant 360 MW Capacity (Power) and 1500 MT/Hr (HHP Steam)**
- **India's largest Petroleum Terminal, Oil movement and Storage area.**

### Achievements:

\* RIL has been ranked as amongst the top 25 climbers in the Fortune Global 500 list in terms of growth.

\* It was conferred the '2004 International Refiner' award by Hart Energy Publishing LP and became the first Asian company to attain this recognition in the award's 20-year-long history.

### Energy Consumption

Include information on total energy consumption (i.e. coal, oil, gas, electricity and money value). Information on energy consumption in terms of percentage of manufacturing cost should also be presented. Also, it should highlight the specific energy consumption for the period 2002-2003, 2003-2004 & 2004-2005 Good Computer Graphic Presentation related to Specific Energy Consumption may also be incorporated.

Year	Sp Power Cons Kwhr/MT of intake	Thermal Energy Consumption Mkcal/MT of Intake
2002-03	73.87	0.668
2003-04	73.49	0.661
2004-05	73.1	0.662

In the Refinery Energy monitoring, the practice of evaluation of Energy Index is prevailing. In Energy Indices evaluation, the feedstock of all the processing units are considered and the Energy Index arrived at by International Systems such as either SHELL or Solomon Benchmarking normalizes all the specific energy consumption and the reduction in the Index indicates true reduction in the energy consumption.

An Energy Index is the ratio of actual energy consumed and the standard or theoretical energy consumed. Lower the Energy Index better is the Energy Efficiency.

**Following are the Energy Indices for Reliance ,Jamnagar Shell Benchmarking:**

Year	CEL*
2002	88.7
2003	87.6
2004	86.9

**Solomon Benchmarking:**

Year	EII*
2002	64.2
2004	62.5

Reliance Jamnagar is topping the list of Shell Benchmarked Refineries in the world and also topping the list of Large Complex Refineries in Solomon Benchmarking in the Asia Pacific Region for last three years.

### **Energy Conservation Commitment, Policy and Organizational Set up**

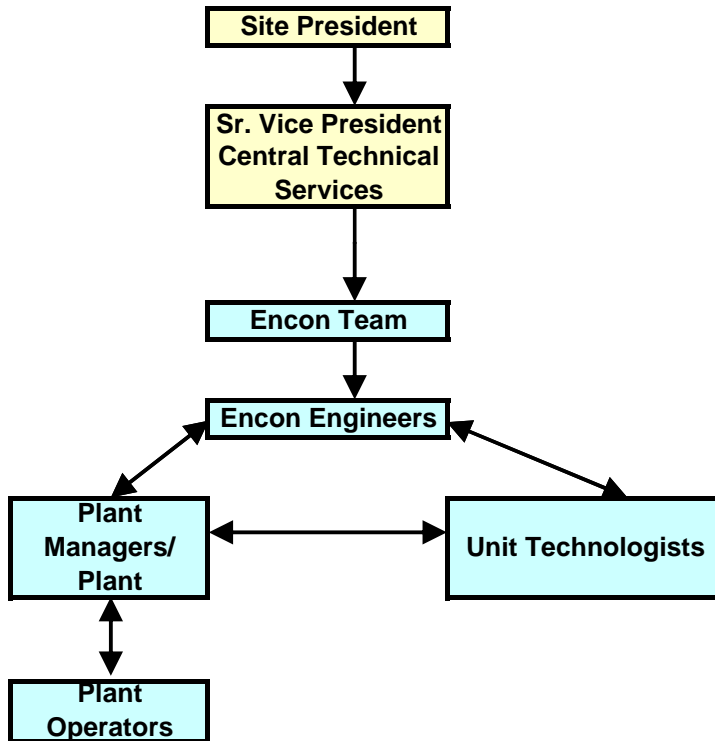
(Please include a photo copy of unit's Energy Conservation Policy, if decided)

Reliance has a comprehensive policy on energy conservation. Innovative energy conservation practices are adopted throughout the site. Better operating practices, improved operating efficiencies, optimum utilization of resources, increased automation, introduction of advanced control systems, new techniques and technologies, higher capacity utilization are the various methods used which aim at the corporate goal or commitment to conserve / optimise energy consumption .The company's Energy Management policy is as under.

### **Energy Management Set-up**

At Reliance Jamnagar on a continuous basis, a detailed review is made at sector chief level weekly with complete focus on Energy Consumption. A rigorous plan is generated by Central Technical Services for implementation of the various projects which are being implemented or are planned in future. Top, middle, junior management and workmen of all level are committed and involved to meet the same corporate goal. The Energy conservation team structure is shown in figure below:

## Energy Conservation Organogram:



Typically an Encon idea is captured through various discussions, brain storming sessions and suggestion schemes from Operators / Technicians / Junior engineers and other connected personnel and taken through various stages of review / evaluation till implementation. The ideas are generated in daily plant review meetings and monthly performance meetings. An idea generated from a plant location (either from workmen, supervisor or engineer) is first discussed at plant head level (Middle and Top management) and the idea, if found attractive, is taken up for evaluation. Evaluation criteria is mainly guided by economics. Typically the payback expected is around one year.

Similarly any Encon idea generated either from technical services department or through a consultant is first discussed with the operating personnel. Subsequently the idea is converted into a proposal for implementation (PFI) by working out cost / benefit analysis, feasibility of implementation and known barriers for successful implementation. This PFI is reviewed in great detail in a "challenge session". After acceptance of the PFI, an approval note is made which is known as Plant Change Order (PCO), incorporating accurate available cost benefit figures. PCO is put up for approval of management.

After obtaining approvals, each PCO will have an owner and project manager for ensuring speedy and successful implementation. After implementation, the project is closed out after carrying out a post implementation, evaluation and review highlighting the envisaged / actual benefits. The closeout report also identifies major deviations in the benefit projected and realized.

## Energy Conservation Achievements

Include one paragraph write-up on each major energy conservation project implemented during the year 2004-2005 only.

A brief writeup of energy conservation measures implemented in 2004-05 is enclosed alongwith

Reliance, Jamnagar's energy conservation efforts not only brought best ranking in SHELL Benchmarking in the year 2004 but also got many National awards for its performance in Energy as detailed below.

**Reliance, Jamnagar has bagged the "National Energy Conservation Award 2004" from Bureau of Energy Efficiency (Ministry of Power, Government of India) for Excellence in Energy Conservation and Energy Management.**

**It received the award for "Excellence in Energy Management - 2004" by CII (Confederation of Indian Industries).**

**It also bagged the "Energy Conservation Award" in 2004 for exemplary work in Energy Conservation from PCRA (Petroleum Conservation Research Association).**

## Energy Conservation Plans and Targets

Reliance Jamnagar aims/plans to become the pace setter and world leader in respect of Energy Conservation and Management in the refining sector. Reliance objectives are also indicated in Energy Management Policy mentioned in Sheet-8 item 13 (e). The List of Planned projects is shown in item No 18.

### Ultimate target :

The ultimate target for Reliance, Jamnagar is to

- Sustain lowest energy consumption per barrel of Crude oil feed stock processed.
- Achieve Solomon International Energy Intensity Index of 55 or lower.
- Achieve Shell Corrected Energy and Loss Index of 80 or lower.

## Environment and Safety

At Reliance Jamnagar, clean environment for sustainable development is of prime concern and is an important business objective achieved by every employee's contribution and responsibility towards environmental performance.

Reliance Jamnagar is fully committed to the protection of environment. The design of state of the art Effluent Treatment Plant, low NOX burners in Furnaces, flare gas recovery systems and zero liquid effluent discharge ensure the protection of environment. Treated sewage, industrial effluent and stack emissions are extensively monitored and controlled to ensure no harm is done to the environment. Reliance is committed to transform the arid land in and around the complex into a lush green belt. Following are the major efforts in this direction:

- Reduction in Emission of CO<sub>2</sub> (Tons/Kilotons of Crude processed) to 4.59 (10.25 in 2003-04).
- Planting of 4.0 million trees in and around the complex has already been done till March 2005 which includes planting of 51,000 Nos of additional Trees during last year.
- Construction of landfill facility for the disposal of hazardous waste.

A 'Reverse Osmosis' (RO) plant is scheduled to be commissioned in 2005 to recycle 135m<sup>3</sup> of water. The treated water will be used as make up water in the cooling towers/horticulture.

The Jamnagar refinery complex is certified as ISO-14001 company conforming to the Environmental Management System. As a recognition to our efforts, State pollution control board has given rebate in the water Cess consecutively for the past three years.

Commitment to Safety is of paramount importance at Reliance. New work permit procedures developed with the help of M/S Shell experts are being consistently followed in Jamnagar. The new procedure provide for more checks and responsibility according to the hazard potential of each activity.

The British Safety Council conducted a Safety and Health Management audit at Jamnagar and awarded the highest Five Star rating to the site in 2003.

#### **Environment/Safety Awards for 2004-05:**

**Reliance, Jamnagar bagged the FICCI Award for "Environmental Conservation & Pollution Control" for Environment Management Systems in Nov,2004.**

**Reliance received the "Greentech Platinum Environment Management Award" for Environment Management Systems in April,2005.**

**Reliance received the "International Safety Award - 2004" for Safety Management Systems in May,2005.**

## **Project Details S.No.1**

### ***In-house Optimiser in CPP to reduce fuel***

#### **Background**

The Captive Power Plant (CPP) configuration at RIL, Jamnagar has 8 Gas Turbine Generators (GTs), 8 Heat Recovery Steam Generators (HRSGs), 4 Steam Turbines Generators (STGs) and 4 Auxiliary Boilers to meet the refinery steam & power demands. Deterioration in power generation capabilities and heat rates of GTs was observed during the regularly conducted base load trials. Low capabilities and high heat rates would have negative impact on the plant operating expenses against reliable steam & power supply and continual change in demands.

The CPP is being operated in islanded mode i.e., CPP is neither imports nor exports power to state electricity grid to ensure power supply at consistent frequency of 50 Hz. Since the ramp-up rates of GTs are much higher than STGs, a power margin of 40 MW is kept in GTs to ensure reliable power supply to refinery.

#### **Observations**

While calculating power margin, slabs on maximum capability of each GT are fixed as 29 MW at or below 30°C, 28 MW at 30 - 40°C and 27 MW above 40°C. GT capability decreases as ambient temperatures increase and the average temperature difference between day and night is about 10-15°C. Refer to Figure-1, there exists an opportunity to improve the gap between actual Available Margin and Present Margin with slab system.

Instead of fixing slabs on GT capability with respect to ambient temperature ranges, the actual GT capability & heat rates at current ambient temperature can be used to optimally distribute power load amongst GTs as well as GTs & STGs.

#### **Technical & Financial Analysis**

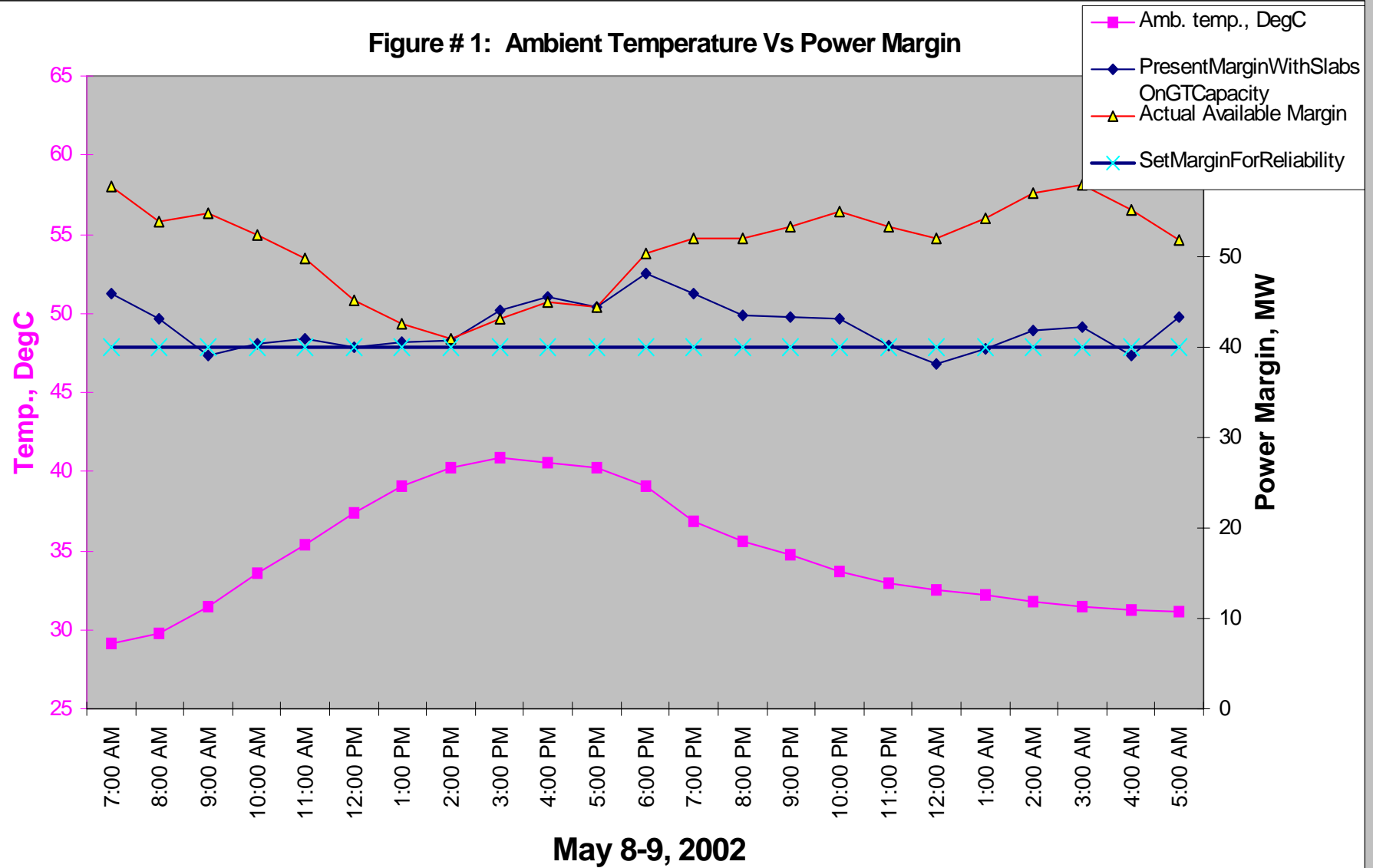
Fine-tuning results in fuel savings by reducing condensation in STGs and improved cogeneration efficiency of GT-HRSG systems. An on-line open-loop optimizer for steam & power system was developed in-house (Refer to Optimization Flow Sheet) and implemented to adjust controllable parameters continually based on performance of boilers & generators and fuel costs.

Savings were monitored under controlled conditions for the above said configuration at 273 MW of power generation, 910 TPH of steam generation with 40 MW of power margin in GTs. Before project implementation, heat input with fuel to CPP was 948.6 MM kCal/hr. After implementing optimizer results for load adjustment amongst GTs, heat input was reduced to 947.5 MMkcal/hr, resulting in net savings of 1.09 MM kCal/hr equivalent to **Rs. 45 lakhs/yr.**

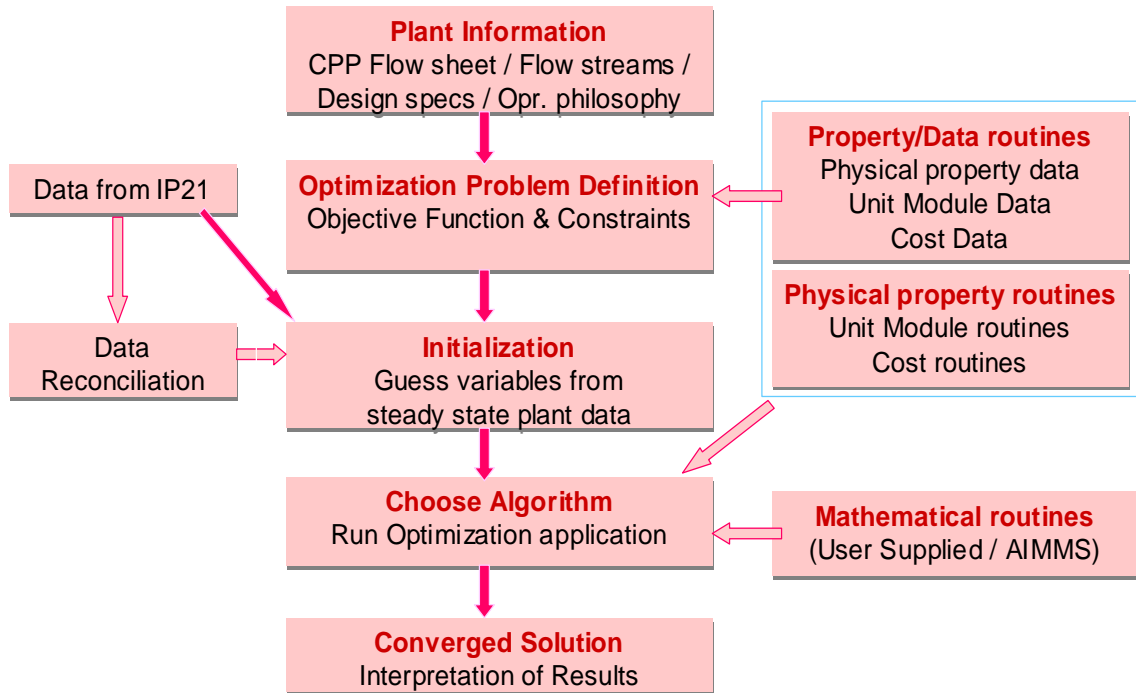
#### **Implementation**

The project was implemented in December 2004.

Figure # 1: Ambient Temperature Vs Power Margin



## Optimization Flow Sheet



## **Project Details S.No.2**

### ***Insulation of HRSG drum manhole cover and duct burner:***

**Background:** The Captive Power Plant (CPP) of RIL, Jamnagar has 8 Gas Turbine Generators (GTs), 4 Steam Turbines Generators (STGs), 8 Heat Recovery Steam Generators (HRSGs) and 4 Aux Boilers to meet the refinery steam and power demands. The HRSG manhole cover and duct burner casing was insulated to reduce the heat loss and hence saving energy.

**Observations:** The HRSG manhole cover was insulated which reduced the manhole surface temperature from 312°C to 45°C. The insulation of duct burner casing reduced the surface temperature from 165 °C to 50 °C.

**Technical & Financial Analysis:** The heat loss per HRSG was reduced due to insulation of manhole cover by

$$\text{Heat loss reduction} = 30 * 0.6359 * (312 - 45) = 5093 \text{ W} = 4380 \text{ kcal/hr } \{Q = hAdT\}$$

where  $h = 30 \text{ W/m}^2\text{K}$  and manhole area =  $0.6359 \text{ m}^2$ .

The heat loss per HRSG was reduced due to insulation of duct burner casing by

$$\text{Heat loss reduction} = 30 * 8 * (165 - 50) = 27600 \text{ W} = 23736 \text{ kcal/hr } \{Q = hAdT\}$$

where  $h = 30 \text{ W/m}^2\text{K}$  and manhole area =  $8 \text{ m}^2$ .

Total savings realized from insulating manhole covers of 8 HRSGs and duct burner casing of 6 HRSGs = **Rs.16 lakhs/annum.**

**Implementation :** The above changes were implemented in December 2004.

### **Project Details S.No.3**

#### ***Steam reduction in Auxiliary boilers to minimum turndown & loading HRSGs which is more energy efficient:***

**Background:** The Captive Power Plant (CPP) of RIL, Jamnagar has 8 HRSGs and 4 auxiliary boilers to meet the steam demand of the refinery (Refer attached Figure). In HRSG steam is generated by firing hot exhaust gases from Gas turbines (GTs) and the remaining steam required is by firing supplementary fuel. By virtue of design the steam generation through supplementary firing is more than the steam generated from the Auxiliary boilers for a given tonne of fuel fired. Hence for efficient operation, it is required to operate the Auxiliary boilers at minimum possible load.

Though in the earlier instance we had reduced the combustion air lock and thereby the steam generation from Auxiliary boiler. It was further reduced to the minimum possible turndown in consultation with vendor and actual trial run. This steam load reduced in Auxiliary boilers was shifted to be generated from HRSGs, thus saving fuel. With increase in HRSG load, flaring of fuel gas and condensation in Steam Generator could also be avoided.

**Observations:** The Auxiliary boiler load was reduced from 60T/h per boiler. The equivalent steam was generated from HRSGs.

**Technical & Financial Analysis:** Average load per Auxiliary boiler = 50.75 TPH.

The steam load was shifted by (60-50.75) TPH per boiler.

For 243 days of reduced Auxiliary boiler load operation, the savings are

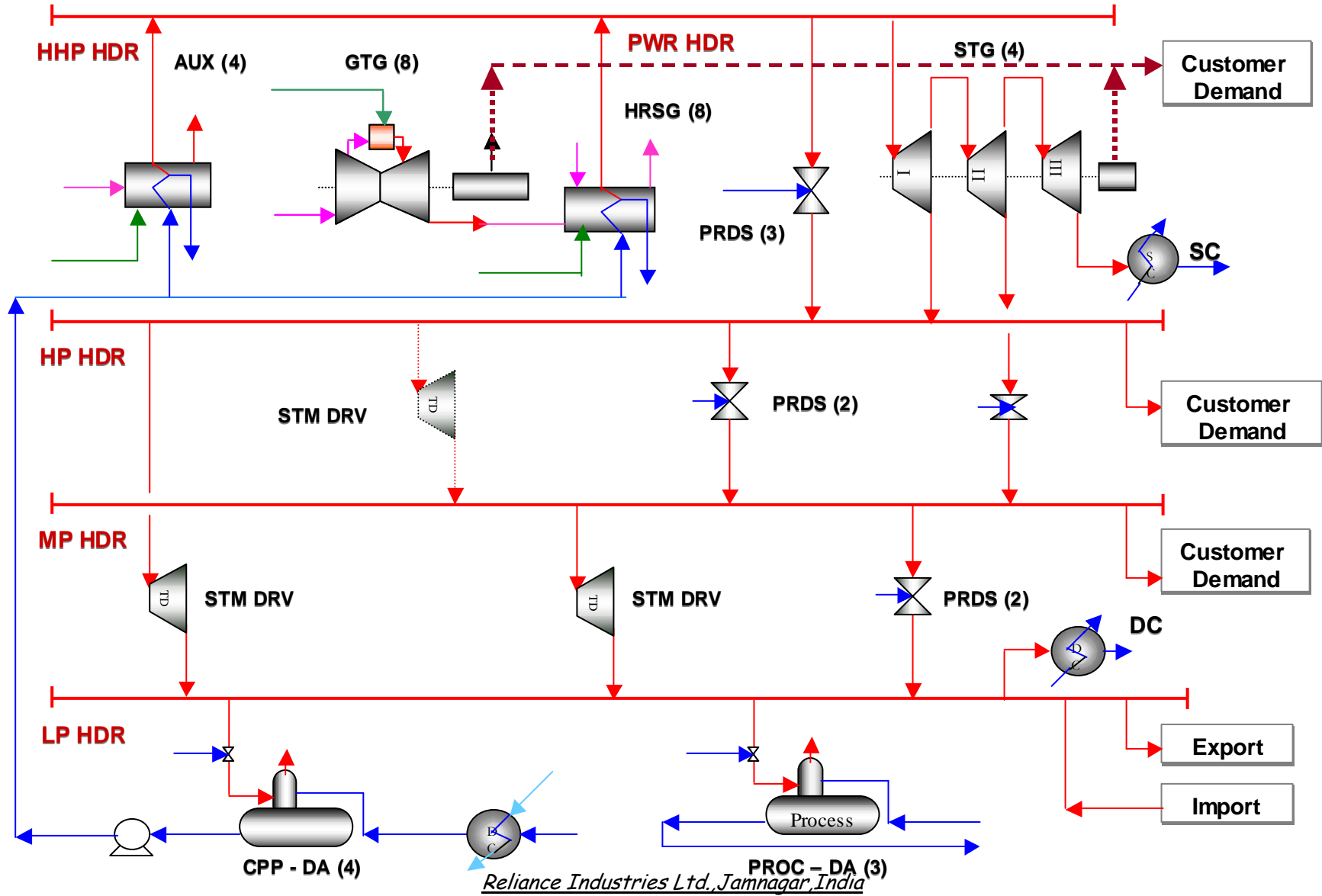
Steam load shifted from Auxiliary boilers to HRSGs =  $(60-50.75)*4*24*243 = 215784$  T/yr.

Taking steam to fuel ratio as 13 for Auxiliary boiler and 18 for HRSG,

Net savings = **Rs.455 lakhs/annum.**

**Implementation :** The above changes were implemented in April 2004.

**Figure:**



## **Project Details S.No.4**

### ***New parallel Fractionator overhead condenser in Coker plant:***

**Background:** A new parallel Fractionator overhead condenser was commissioned in Coker plant as a part of the 'Quality Yield Improvement' plan during the shutdown (Refer attached sketch).

Coker product Yield improvement is a major function of the following parameters:

1. Furnace COT.
2. Drum Pressure.
3. Throughput Ratio (TPR).
4. Feed Quality (CCR Content of the Feed).

With the commissioning of new parallel main fractionator overhead condenser, fractionator top pressure reduced. Since the Coke drum operation floats with the fractionator, lower pressure in the fractionator means lower Coke drum pressure and better cracking of hot residue leading to more yield of Gas oil & naphtha .

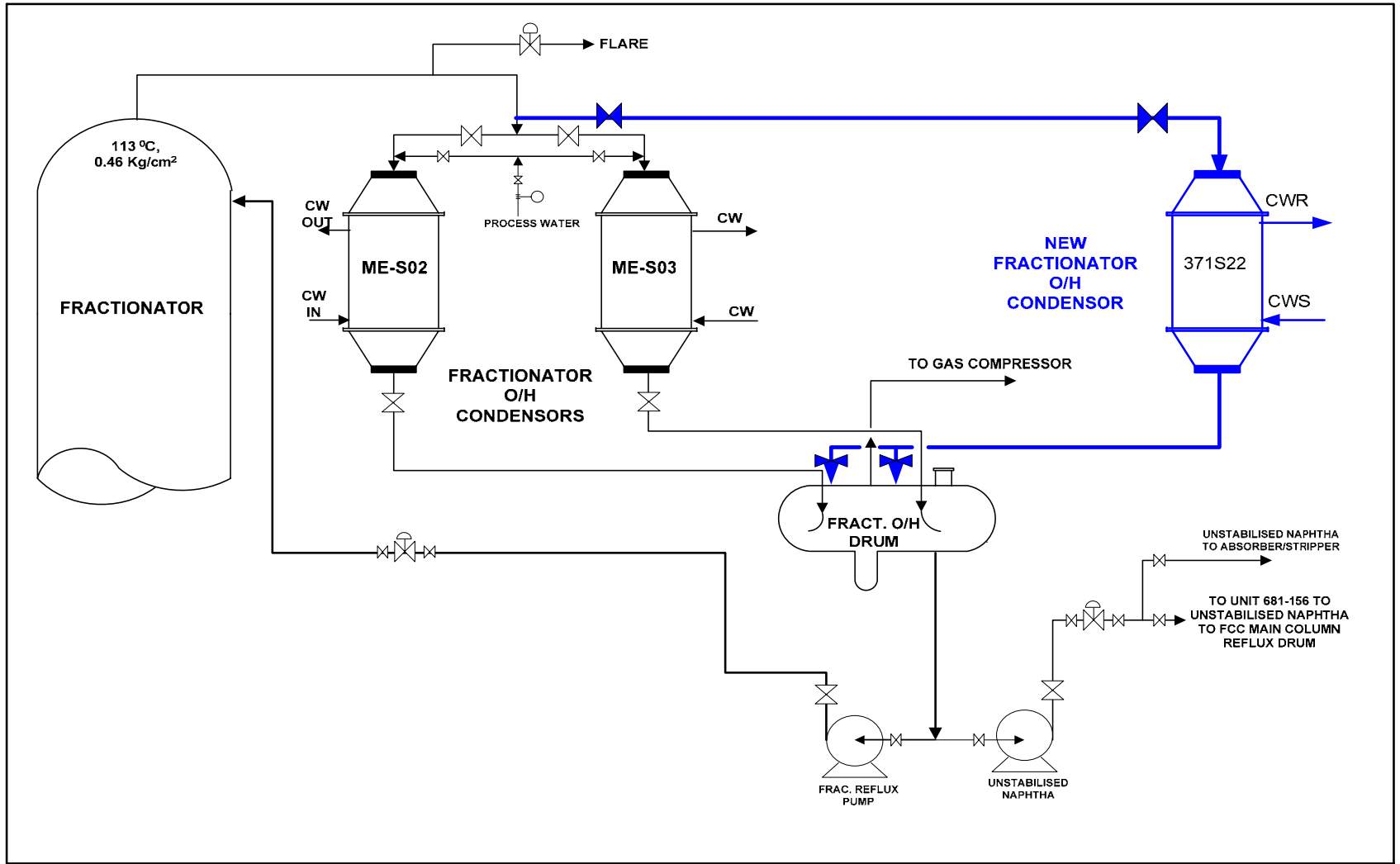
Earlier flaring was taking place from fractionator overhead due to high fractionator overhead pressure and limitation in Coker Gas Compressor. The flaring could only be stopped by reducing the throughput of the plant.

**Observations:** With the commissioning of the new parallel fractionator overhead condenser the flaring from fractionator overhead was reduced without any consequences on the throughput. The reduced fractionator pressure also improved Coker yields (coke yield was reduced while Gas oil yield was improved).

### **Technical & Financial Analysis:**

Total benefit realized from reduced flaring and increased throughput = **Rs.25.4 lakhs/yr.**

**Implementation :** The Coker fractionator new overhead condenser was commissioned in May,2004.



## **Project Details S.No.5**

### ***Routing of Stripper off gases routed to Primary Absorber bypassing HP Receiver in CDU2:***

**Background:** In the Crude unit, Saturated Gas Concentration section separates refinery gas, LPG and stabilized naphtha. HP receiver, Primary Absorber, Sponge Absorber, Stripper and Debutaniser are the principal equipments in this section. Normally gases from Stripper top section which contain mainly Methane, Ethane & H<sub>2</sub>S and a little C<sub>3</sub>s & C<sub>4</sub>s are recycled to HP receiver. These gases are absorbed in HP receiver liquid (Naphtha from Crude Distillation Units, Hydrotreaters) and again are fed to stripper. The reabsorption/recycling of these lighter gases in stripper feed increases the stripper reboiler load.

In the newly provided scheme in a new condenser, these off gases are cooled & partly condensed. The gas from the new condenser is directly routed to Primary Absorber feed while the liquid is routed to HP receiver. This has reduced undue recycling and reabsorption of gases in HP receiver. This has led to good energy savings in the stripper reboiler.

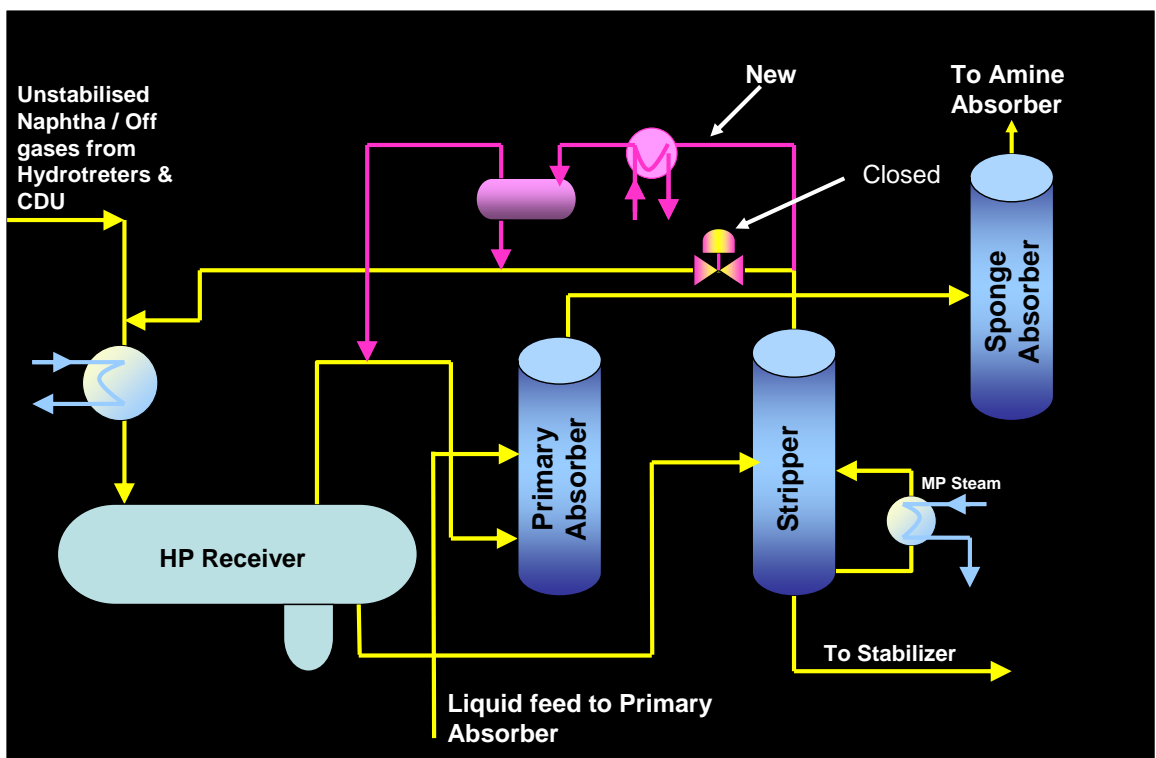
**Observations:** It was observed that there was reduction in MP steam consumption in Stripper reboiler by making the stripper adequate for 325 kBPSD. There was better stripping in the stripper resulting in lower H<sub>2</sub>S in LPG.

**Technical & Financial Analysis:** The benefits from this project based on reduced MP steam consumption in Stripper reboiler is **Rs. 211.5 lakhs/annum**.

**Implementation :** This scheme was implemented in March,2005.

**Sketch:** Stripper off gases routed to Primary Absorber bypassing HP receiver

(The new scheme is shown in pink coloured lines)



## **Project Details S.No.6**

### ***LLP Flare Gas Recovery:***

**Background:** Flaring from refineries has been under constant pressure due to environmental regulations and the need to recover valuable hydrocarbons which are otherwise burnt. Delayed Coker is one of the major sources of flaring in a refinery.

Coking operation is a semi batch process which involves various sequential activities between coking and coke cutting cycle. Each pair of Coke drums are switched online and offline after filling cycle of 16hrs. Filled Coke Drum is first cooled by steaming. During the steaming step, hydrocarbon from the filled coke drum is routed to the Blowdown Recovery tower. Heavier hydrocarbons are recovered in this Blowdown tower but the lighter fraction (non condensable) from the blowdown system is routed to Flare (Low Pressure Flare system).

Reliance has recently commissioned an in house designed flare gas recovery system (FGRS) that helps recovering these hydrocarbons from the blowdown system (Refer attached Figure). The flare gas from the blowdown system is collected at the common flare knock out drum from where the gases are recovered with the help of ejectors. The ejector system is a combination of four steam ejectors of equal capacity in parallel. Medium pressure steam is used as a motive fluid and the flare gas is routed to the main fractionator overhead condenser receiver vessel after cooling. Since this is an intermittent operation, 3 steam ejectors are switched in services during the flare gas recovery operation only (to conserve energy).

This Flare gas recovery system is one of its kind in the world. This system was audited by Foster Wheeler Corporation (Process licensor for the Coker unit).

**Observations:** Around 44 T/day of hydrocarbon flare gases are recovered by the recovery system (Refer attached Graph). Apart from the reduction of flaring from Coker, the following minor changes were observed in the plant:

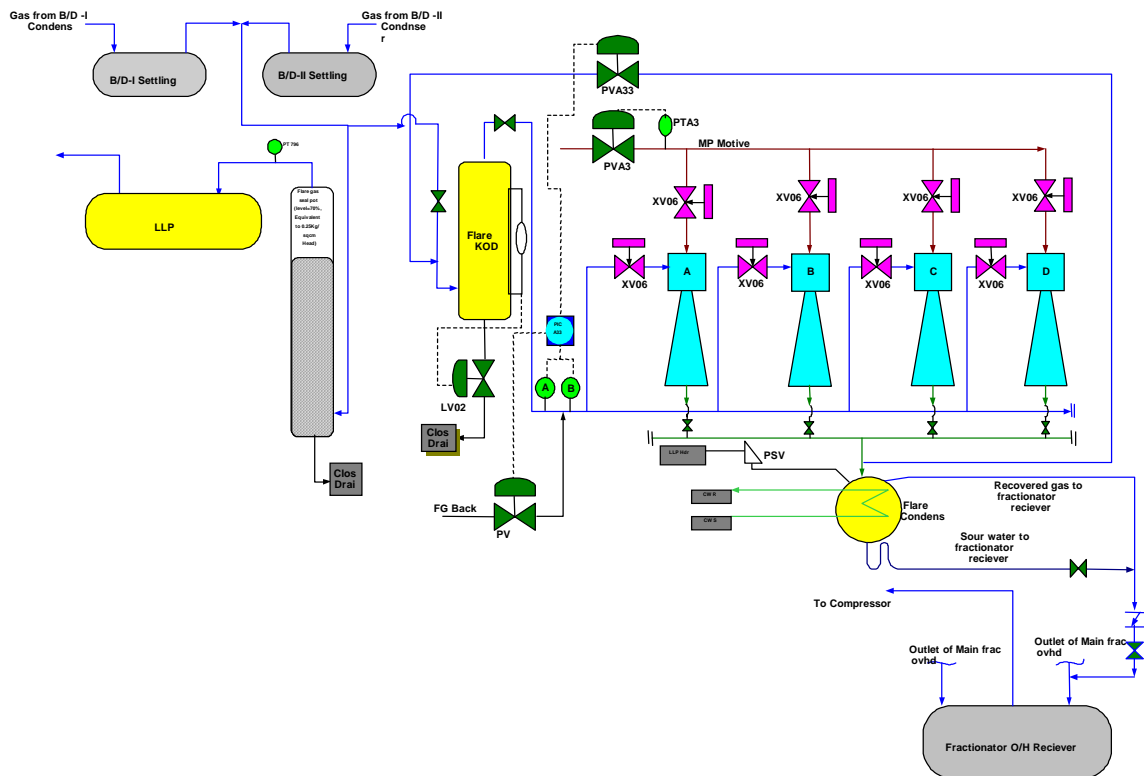
- Marginal increase in Gas plant compressor power to accommodate additional flare gas.
- Increase in fuel gas yield.
- Increase in H<sub>2</sub>S in Rich amine.
- Increase in sour water generation from fractionator overhead condenser.

**Technical & Financial Analysis:** Due to this system, flaring of hydrocarbons from Coker plant has reduced by 95.4%. There was also a reduction of SO<sub>x</sub> levels in the flared gas by 95%.

Economic benefit = **Rs. 15.75 crores/yr.**

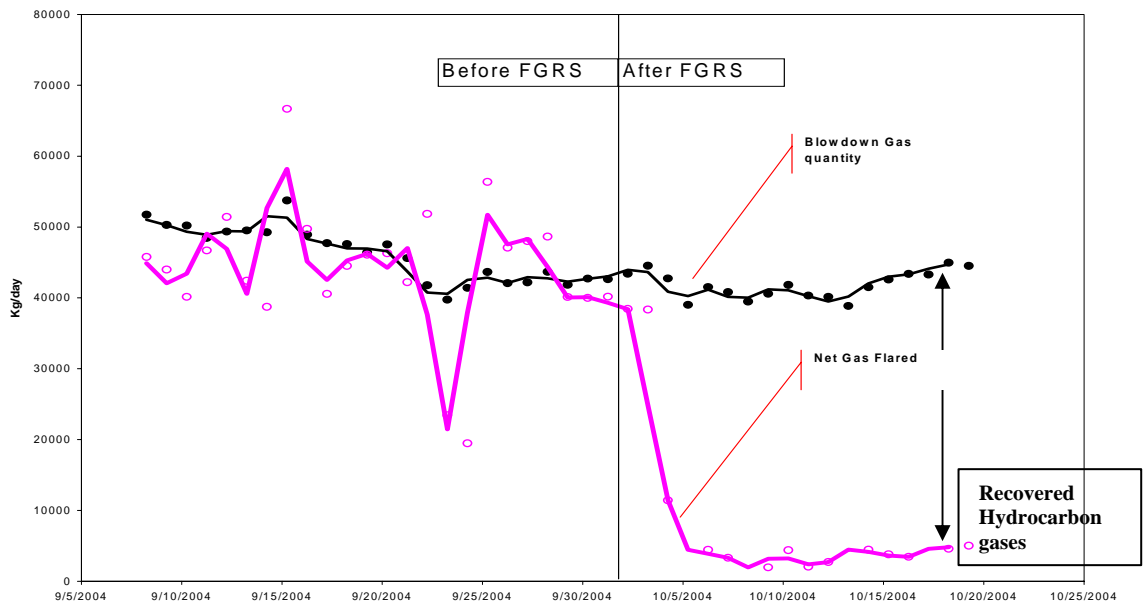
**Implementation:** The above changes were implemented in October 2004.

**Figure:**



**Figure: LLP Flare Gas Recovery System Schematic.**

**Graph:**



**Graph: Indicates the trend of gas rates (Kg/day) from the Blowdown and the net hydrocarbon being flared before and after commissioning of FGRS.**

**Photographs of LLP Flare Gas Recovery System in Coker Plant:**



## **Project Details S.No.7**

### ***Power Saving by Trimming of impeller size for Naphtha Feed Pump and Recycle Liquid Naphtha Pump in LNUU (Light Naphtha Unionfining Unit):***

**Background:** Light Naphtha Unionfining Unit (LNUU) is normally operating at an average load of 45 -50 %. The Naphtha Feed to the unit is pumped by Charge pump driven by motor (400 kW) and Recycle liquid Naphtha required to maintain the temperature rise at or below the design limits across reactor is pumped by a separate motor driven pump (350 kW). Both pumps were running at less required flow rate compared to its rated capacity & were under utilized. Feasibility study was carried out to reduce the impeller dia so as to derate the pump & there by reduce the power consumption.

The net Differential head calculated after changing the impeller size in P04 A (Naphtha Feed Pump) / P06 A (Recycle Liquid Pump) was sufficient enough to operate the unit up to @ 60 % load. There was a potential power saving by reducing the Impeller size of both pumps. The max flow & developed head through the pump for the corresponding load (up to 60%) for the trimmed impeller operation was sufficient to cater unit's normal requirement.

Out of the two Naphtha charge pumps, the impeller of one pump was trimmed to the minimum possible diameter (239.8 mm from 280 mm) and among two Recycle liquid pumps, the impeller of one pump was trimmed to the minimum possible diameter (400 mm from 466 mm).

The PCO was implemented under revenue at "Zero Cost" the power consumption of both pumps reduced while operating at @ 50 % through.

**Observations:** This led to power savings of 72.5 kW (at 60% unit load) in case of Naphtha charge pump and power savings of 63.4 kW (at 60% unit load) in case of Recycle liquid pump.

**Technical & Financial Analysis:** The actual benefit due to the above power savings is **Rs.23.8 lakhs**. The benefit was worked out considering the unit operating for 7000 Hrs in a year.

**Implementation:** The above changes were implemented in August 2004.

## **Project Details S.No.8**

### ***Replacement of fin fan cooler blades with hollow FRP blades in Aromatics and PRU/SHP/Tame:***

**Background:** The existing fin fan blades were replaced by hollow FRP blades in

- Cooling tower of Aromatics – 10 fans
- PRU/SHP/Tame – 5 fans
- Aromatics Complex – 105 fans.

The objective was to increase air flow, hence decrease power consumption.

**Observations:** The normalized power savings achieved are as follows

- Cooling tower of Aromatics – 18%
- PRU/SHP/Tame – 16%
- Aromatics Complex – 19.3%.

**Technical & Financial Analysis:** The total benefit due to the above power savings is **Rs.164.2 Lakhs/annum.**

**Implementation :** The above changes were implemented in Jan,2005.