

Barauni Refinery, Indian Oil Corporation, Barauni (Bihar)

(i) Unit Profile

Barauni Refinery, the second public sector oil refinery of the country, was built in collaboration with the erstwhile USSR and limited Rumanian participation. It went on stream in the year 1964 and was formally inaugurated and dedicated to the nation by Prof. Humayun Kabir, the then Union Minister for Petroleum & Chemicals, Govt. Of India on 15th January 1965. This was the first major industry to be set up in the predominantly agrarian North Bihar region.

The installed capacity of crude oil processing has been enhanced from 3.3 MMTPA to 6.0 MMTPA since Jan'2003 after commissioning of process units like RFCCU, DHDT, HGU, SRU, ARU & SWS.



Atmospheric & Vacuum Unit-I



Delayed Coker Units

During the year 2004-05, Barauni Refinery processed 5.08 MMTPA crude oil. The different petroleum products produced by Barauni Refinery are LPG, Naphtha, Motor spirit, Motor spirit (Superior Kerosene Oil, High Speed Diesel, Light Diesel Oil, Raw Petroleum Coke & Sulphur. Barauni Refinery caters to the Oil requirement of large number of customers of Northern West Bengal, Bihar, Nepal and part of U .P.

(ii) Energy Consumption :

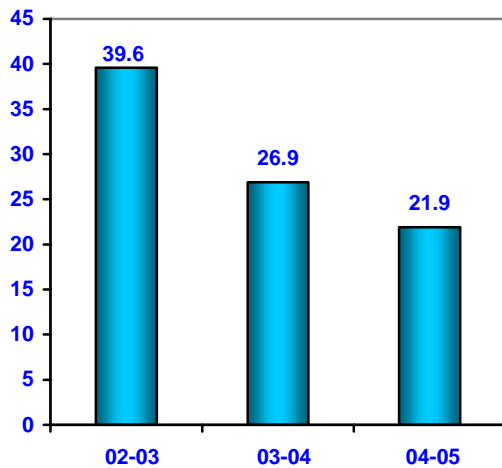
Refining of crude oil being an energy intensive activity, the major chunk of expense in the process is the energy cost. Therefore, the need of energy conservation is of utmost importance. This leads to not only increase in profitability in the form of lower energy cost and adding on to the bottom line but also protection of environment and quality of life. Due efforts were made by the refinery and various energy conservation measures like yield and energy optimisation of distillation units (AVU-I, II & III) & Coker-A & installation of high efficiency Gas Turbine. Old conventional pneumatic systems used for operational controls have also been replaced with Distributed Control System in all process units and OM&S. These measures along with day to day monitoring of fuel & loss helped to bring down the energy consumption level from 171 MBTU/BBL/NRGF in 1990-91 to 124 in the year 2004-05.

	UNIT	2002-03	2003-04	2004-05
CRUDE	MMT	2.99	4.30	5.08
COKER T'PUT	MMT	0.65	0.45	0.74
RFCCU	MMT	0.50	1.02	1.15
DHDT	MMT	0.71	2.17	2.23
HGU	MMT	0.04	0.092	0.092

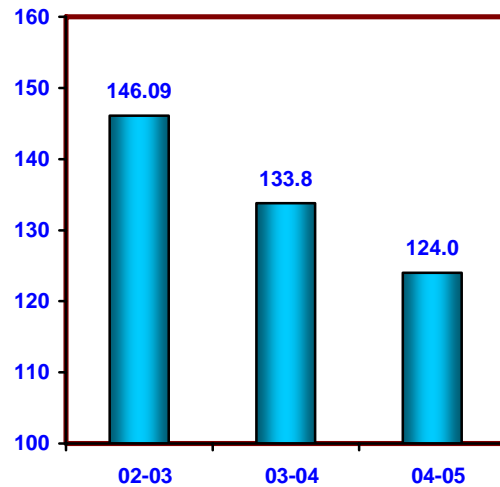
Energy Performance				
FUEL	%	10.92	9.91	9.89
NRGF		3.8312	3.8636	3.8714
MBTU/BBL/NRGF		146.09	133.8	124.0
SP. ENERGY CONSUMPTION	Kwh /MT of Crude processing	37.65	47.07*	42.20
	MKcal/MT of Crude Processing	0.56	0.74*	0.60

* During the year 2002-03 new secondary units like RFCCU, DHDT, HGU, SRU commissioned. Stabilised operation of these units started in 2003-03. Hence, Sp. Energy consumption increased in 2003-04.

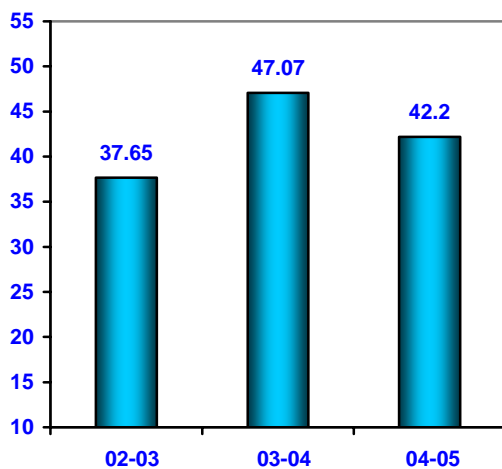
**ENERGY COST
(% OF MANUFACTURING COST)**



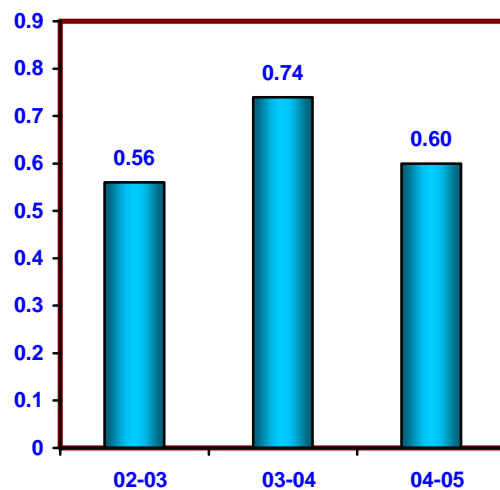
**ENERGY + LOSS PERFORMANCE
(MBTU / BBL / NRGF)**



**SPECIFIC ENERGY CONSUMPTION
(Kwh/MT OF CRUDE T'PUT)**



**SPECIFIC ENERGY CONSUMPTION
(MKcal/MT OF CRUDE T'PUT)**



- * During the year 2002-03 new secondary units like RFCCU, DHDT, HGU, SRU commissioned. Stabilised operation of these units started in 2003-03. Hence, Sp. Energy consumption increased in 2003-04.

(iii) Energy Conservation Commitment, Policy and Set Up :

To conserve energy, optimisation of the operation of the process heaters and boilers and maximum possible heat recovery from out going streams have been given utmost emphasis in day-to-day refinery operations. The efficient usage of utilities, optimisation of steam-power balance, and optimization of heat exchanger train have been the prime concern in the Energy Conservation area.

As a broad classification the energy conservation activities have been grouped under long term and short term ones. The long-term activities are the high investment projects spread over a long period. The short-term measures consist of continuous efforts for energy optimisation.

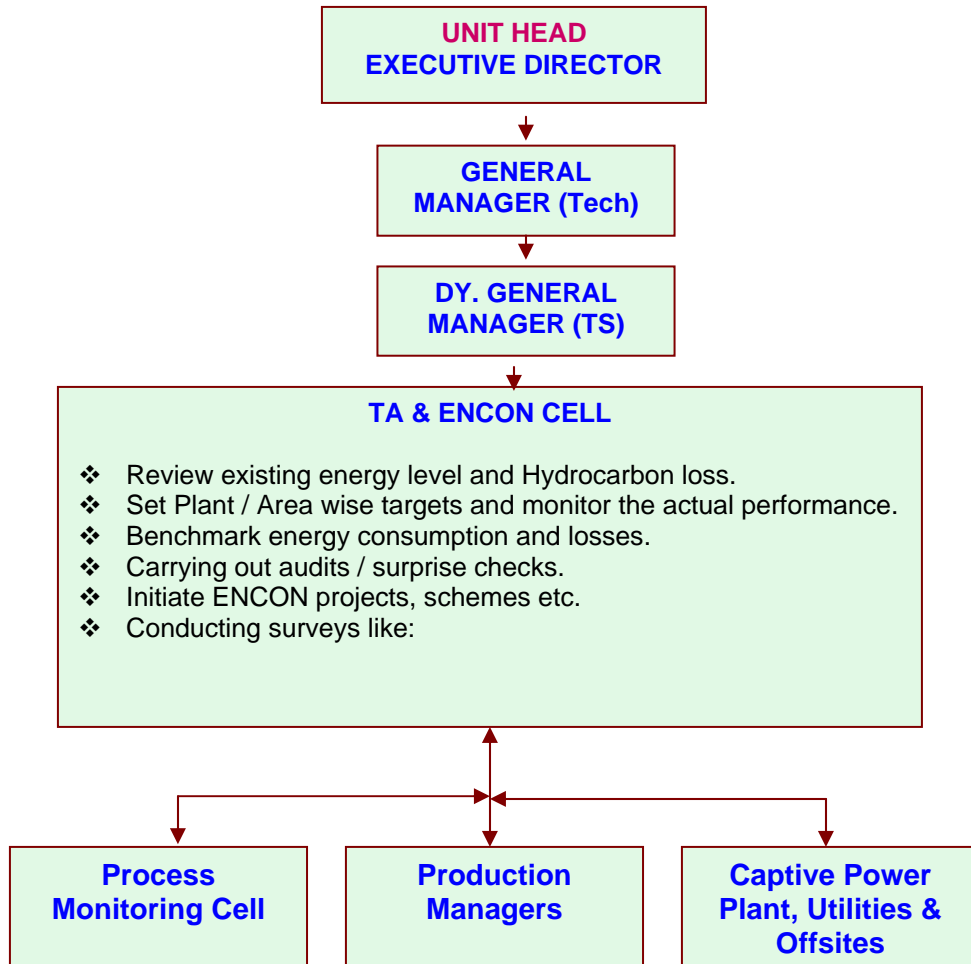
The specific energy consumption is monitored daily/weekly/monthly for effective control. The optimisation of process conditions and implementation of energy conservation scheme is given the highest priority.

Energy Conservation fortnight is celebrated every year from 15th Jan to 31st January. Various completion like essay, slogan, poster on energy saving and cycle rally & in-house seminar is conducted.

The importance of energy conservation is emphasized through TPM (Total Productive Maintenance) by achieving zero breakdown, zero defect culture. Barauni Refinery has started TPM implementation in October'2002 and Coker-A unit has been selected for implementation of Pilot model by April'2004. TPM was formally Kicked off on 30th Aug'2004 after successful implementation of Pilot Model at process unit. Refinery wide implementation of TPM is planned to be completed by 2007 end.

Right from the beginning Barauni Refinery has an exclusive Energy Conservation Cell for monitoring energy consumption and implementation of ENCON measures.

Energy Conservation Team Structure



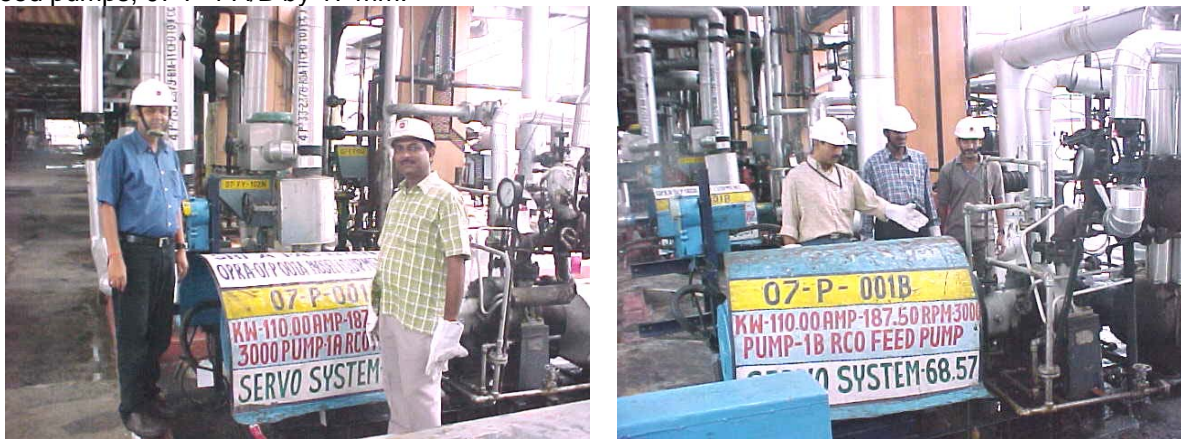
(iv) Energy Conservation Achievements:

The major projects implemented during 2004-05 are as under:

1. TRIMMING OF IMPELLERS OF FEED PUMPS IN COKER-B

Coking units are subjected to slugs of high density & viscosity feed material of non-uniform quality especially during HS crude processing in AVU-3. At times, the Coker Feed viscosity ranged to as high as 243 cst @ 100 °C with feed CCR & density of 10.4 %wt & 1.003 gm/cc respectively. Such situations resulted in tripping of operating feed pump of Coker-B under high amperage (Tripping value of 187 amp). It was also observed that the pump develops more head than required at fractionator operating conditions. This extra pressure developed by the pump was dropped across the control valve which was an energy inefficient operation. Under these circumstances, both the feed pumps, 07-P-1 A & B of Coker-B need to be operated for maintaining desired T'put level of Coker-B leaving no standby pump making the unit prone to emergency situations in case of tripping of any of these pumps.

In order to overcome the above problem, it was decided to trim the impellers of two nos. of Coker feed pumps, 07-P-1 A/B by 17 mm.



Pumps 07- P -1 A/B

Impact of implementation :

- Pump amperage reduced by 25 amps saving 82.66 Kg/Day of SRFT equivalent to benefit of 870/- Rs./Day.
- Single pump is able to cater to the desired T'put level of Coker-B keeping the other pump as stand by saving 605 Kg/Day of SRFT (6300/- Rs/Day) .
- Saving of power equivalent to 136.4 KW (one pump operation 120 KW + 16.4 KW due to amperage reduction) with saving of 21900/- Rs/Day @ 6.7/- Rs./KW.

2. ON LINE INSULATION OF TANKS

Energy conservation is one of the major thrust areas for reduction of overall fuel & loss, improving energy performance with respect to MBN and profitability of Barauni Refinery. Steam is used in these tanks for maintaining tank temperature to avoid congealing of viscous fluid like LSHS, Coker feed and preparation of slop tanks before feeding to units for reprocessing.

On line insulation of four nos. of tanks have been completed at a cost of Rs. 60 Lakhs.



Tanks after Insulation

Impact of implementation :

On line insulation of four nos. saves Rs. 107 Lakhs /yr.

3. RE-VISIONING OF MAIN STACK DAMPER OF AVU-1 FURNACES TO REDUCE FLUE GAS TEMPERATURE EXHAUSTED TO ATMOSPHERE.

On closure of main stack damper, the tripping of FD fans used to occur under high arch pressure of main crude heater. Hence, it was suspected that the cold flue gas duct (from

APH outlet to ID fan suction) was restricting.

The immediate cause of tripping FD fans was high arch pressure of process heaters on closure of main stack damper. The restriction of cold flue gas duct used to act as the main cause of the furnace pressurisation on closure of main stack damper. This has been the perennial problem which prevented closure of main stack damper.

During the shut down (from 27 June 04 to 17 July '04) of AVU-1, the cold flue gas duct Ex-APH to ID fan suction was opened & cleaned. A lot of deposits were found in the duct.



AVU-I Furnace Stack

After the cleaning of the cold flue gas duct, the unit was started on 18/7/04. The main stack damper was successfully closed to 100% and the APH parameters are compared below before & after cleaning of the duct.

Impact of implementation :

The operation of APH of AVU-1 has significantly improved after cleaning operation leading to a reduction of % SRF by 0.06% wt. The flue gas temperature after the stack damper came down to 190 °C (on full closure of stack dampers) from earlier level of 284 °C (without closing of stack dampers) which resulted in above saving of SRF.

4. INSTALLATION OF 3 NOS. OF HERO OIL GUNS IN AVU-I

All the burners of AVU- ½ furnaces were HPR-18 types supplied by M/s John Zink. The hole size of the existing burners of all the three furnaces is very small and the oil guns are of Y-jet type. This results in frequently choking of some of the burners' tip consequently diminishing the heat release capacity of the burners. In order to serve the desired heat load, remaining burners have to cater to the requirement causing local flame impingement on the furnace coils resulting in high skin temperatures.



In addition to this, existing atomising steam pressure control valves are of fixed pressure type. Due to the existing Y-jet type oil gun (which are very sensitive to oil viscosity and steam conditions), it is very difficult to control the flame pattern of the burners manually, which in turn was resulting in smoky flame (incomplete combustion) or extinguishing of the burners on increasing atomising steam. To overcome the problems, 3 nos. of Y-jet type oil gun of furnace F-01 & F-02 of AVU-1 were replaced by HERO oil guns supplied by M/s John Jink.

Impact of implementation :

- Radiant & compact flame pattern indicating relatively better atomization
- Frequency of Burners cleaning is reduced.
- Better combustion
- Relatively less time for burner adjustment

5. INSTALLATION & COMMISSIONING OF KEROSENE COALESCER IN AVU-1/2 & AVU-3

Since Kerosene is withdrawn from strippers, it contains traces of water. To minimise the requirement of water draining from storage tanks of Kerosene with the objective to reduce slop generation in the refinery, coalescer in Kero stream of AVU-1/2 (common for both) & in Kero stream of AVU-3 has been provided in the Kero run down line to remove the water from Kerosene.



KEROSENE COALESCER IN AVUs

Impact of implementation :

This facility has reduced the water content of kerosene stream from 300-500 ppm to 100-150 ppm level and also reduced the slop generation and hence loss of Kerosene along with slop.

(v) Energy Conservation Plan & Targets:

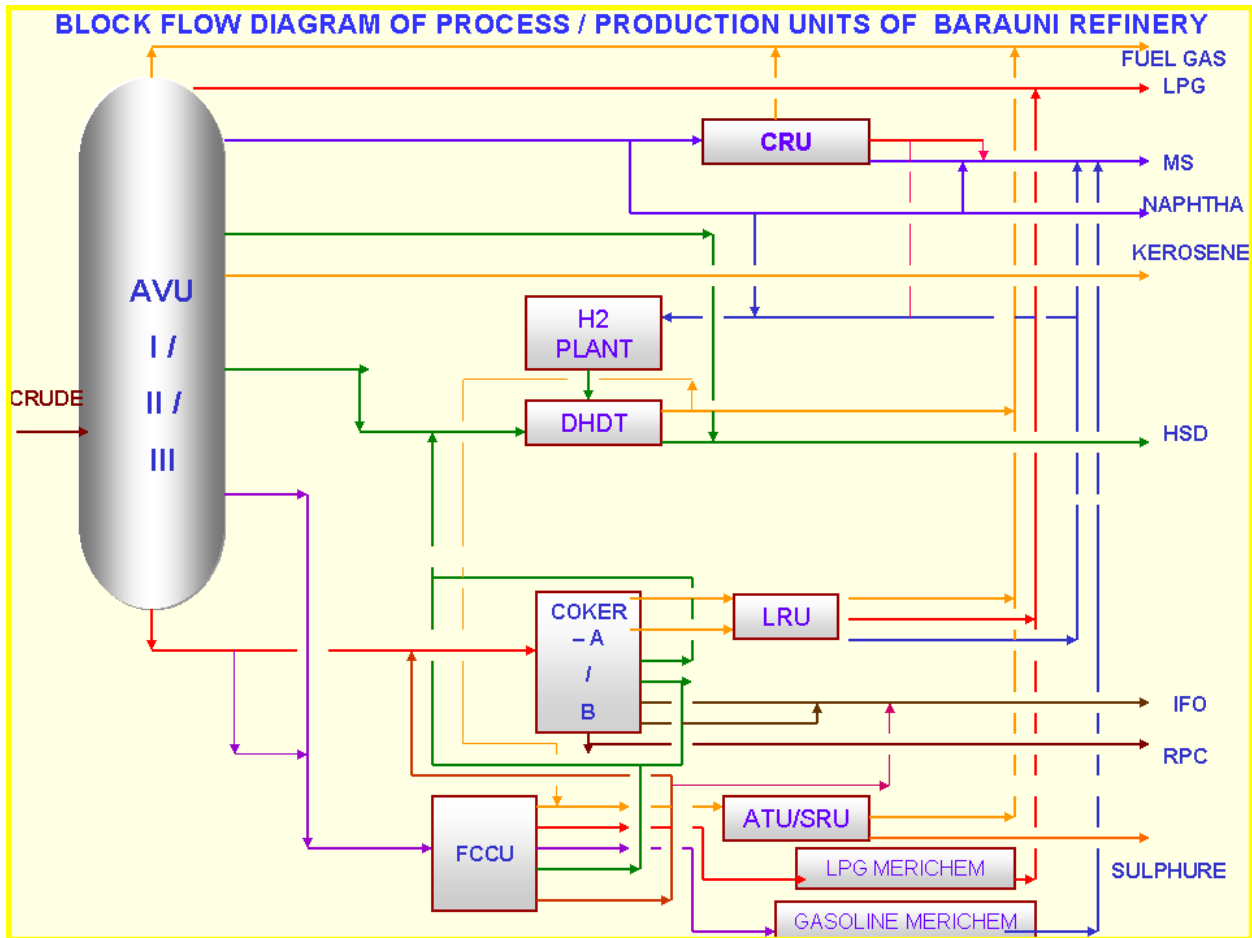
To improve the energy performance further, the following major projects are under implementation / active consideration :

SL. NO	PROJECTS / MODIFICATIONS	TARGET (YEAR)	ANNUAL SAVINGS (SRFT)	ANNUAL SAVINGS (Rs. Lakhs)
1.	Installation of BMS in TPS Boilers.	2005	180	18
2.	Insulation of 9 nos. of RCO / LSHS tanks	2005	1800	180
3.	Recovery of reactor blow down in Coker-A	2005	1200	120

SL. NO	PROJECTS / MODIFICATIONS	TARGET (YEAR)	ANNUAL SAVINGS (SRFT)	ANNUAL SAVINGS (Rs. Lakhs)
4.	Heating of desalter wash water by desalter brine in AVU-I/II	2005	600	60
5.	Installation of TPI in ETP	2005	150	15
6.	Heat recovery from RFO stream in Coker-A by steam generation @ 3 MT/Hr	2005	1700	170
7.	Hydrogen recovery from CRU off gas	2005	1200	1360
8.	Flare management with provision of	2005	1200	120

SL. NO	PROJECTS / MODIFICATIONS	TARGET (YEAR)	ANNUAL SAVINGS (SRFT)	ANNUAL SAVINGS (Rs. Lakhs)
	LPG vaporizer			
9.	Stoppage of operation of CRU cooling tower and connecting the CW system with PCT.	2006	390	39
10.	Revamping of heat exchanger network and fractionation improvement in AVU-I&II	2006	6400	500
11.	Installation of LP Burners in AVU-III	2006	920	95
12.	Routing of CBD Flash steam of Boilers to De-aerators	2006	200	21
13.	Routing of CRU condensate for use in steam generation from CRU OBSG	2006	100	10
14.	Efficiency Improvement of Air Fin Coolers	2006	250	26
15.	Revamp of steam condensate recovery facility from old Process units / OM&S area.	2007	480	50
16.	Installation of flare gas recovery facility	2008	1500	155
17.	Replacement of Two old steam turbines with a new TG & Boiler.	2008	1200	124
	Total		19470	3063

With the implementation of above energy conservation projects, specific energy consumption of the refinery will about 115 MBTU/BBL/NRGF.



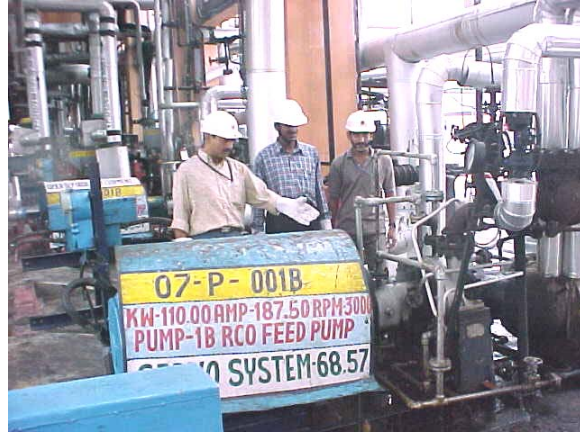
6. TRIMMING OF IMPELLERS OF FEED PUMPS IN COKER-B

Background :

Coking units are subjected to slugs of high density & viscosity feed material of non-uniform quality especially during HS crude processing in AVU-3. At times, the Coker Feed viscosity ranged to as high as 243 cst @ 100 °C with feed CCR & density of 10.4 %wt & 1.003 gm/cc respectively. Such situations resulted in tripping of operating feed pump of Coker-B under high amperage (Tripping value of 187 amp). It was also observed that the pump develops more head than required at fractionator operating conditions. This extra pressure developed by the pump was dropped across the control



valve which was an energy inefficient operation.



Pumps 07- P -1 A/B

Under these circumstances, both the feed pumps, 07-P-1 A & B of Coker-B need to be operated for maintaining desired T'put level of Coker-B leaving no standby pump making the unit prone to emergency situations in case of tripping of any of these pumps.

In order to overcome the above problem, it was decided to trim the impellers of two nos. of Coker feed pumps, 07-P-1 A/B by 17 mm.

Objectives of Impeller Trimming

- Energy efficient operation by reduction of the motor amperage arising out of lower pump discharge pressure
- Operation of the unit with single pump on sustained basis enabling the other to remain as stand by.

Observation Made :

The trial run of the pump was taken at various flow rates and its amperage was measured. The observations of the trial run is given below:

Attributes	Unit	Actual field reading before trimming	Actual field reading after trimming	Actual Delta
Pump capacity	M3/Hr	80.5	80.5	Nil
Impeller Diameter	MM	368.3	351.3	17
Discharge Pressure	Kg/Cm2(g)	19.9	17.4	2.5
Amperage	Amps	165	140	25
Power (BHP)	Kw	124	107.6	16.4

Technical & Financial Analysis Made :

Savings due to Impeller Trimming	16.4	Kw
Power Cost	6.7	Rs./Kw
Savings (a)	2637	Rs./Day
SRFT	0.21	MT/MW
Savings in SRFT	82.66	Kg/Day
Savings in terms of FO	87.01	Kg/Day
Benefit	870.1	Rs./ Day

Saving Due to operation of One pump in place of Two Nos.

Savings	120	Kw
Power Cost	6.7	Rs./Kw
Savings (b)	19296	Rs./Day
SRFT	0.21	MT/MW

Savings in SRFT	604.80	Kg/Day
Savings in terms of FO	636.63	Kg/Day
Benefit	6366.3	Rs./ Day
Total savings (a + b)	21933	Rs./Day

Impact of implementation :

- Pump amperage reduced by 25 amps saving 82.66 Kg/Day of SRFT equivalent to benefit of 870/- Rs./Day.
- Single pump is able to cater to the desired T'put level of Coker-B keeping the other pump as stand by saving 605 Kg/Day of SRFT (6300/- Rs/Day) .
- Saving of power equivalent to 136.4 KW (one pump operation 120 KW + 16.4 KW due to amperage reduction) with saving of 21900/- Rs/Day @ 6.7/- Rs./KW.

7. ON LINE INSULATION OF TANKS

Background :

Energy conservation is one of the major thrust areas for reduction of overall fuel & loss, improving energy performance with respect to MBN and profitability of Barauni Refinery. Steam is used in these tanks for maintaining tank temperature to avoid congealing of viscous fluid like LSHS, Coker feed and preparation of slop tanks before feeding to units for reprocessing.

On line insulation of four nos. of tanks have been completed at a cost of Rs. 60 Lakhs.



Tanks after Insulation

Technical & Financial Analysis Made :

Attributes	Savings for one 5000 KL tank
Diameter / Height , M	22.8 / 11.86
Surface Area of shell / , M ²	849.1
Surface Area of roof, M ²	408.1
Total Surface Area, M ²	1257.2
Area considered for heat loss, M ²	637
Tank wall temperature, °C	70
Ambient Temp (Avg), °C	25
Temp Difference, °C	45
Heat transfer coefficient for heat loss from tank wall, Kcal/hour/M ² /C	8
Heat loss per tank, Kcal/Hr	229252

Heat loss per tank, SRFT /Hr	0.0229
Estimated fuel saving per Year	200
Number of tanks	4
Savings SRFT / Year	800
Savings, Rs lakhs/Yr	107

Impact of implementation :

On line insulation of four nos. saves Rs. 107 Lakhs /yr.

8. RE-VISIONING OF MAIN STACK DAMPER OF AVU-1 FURNACES TO REDUCE FLUE GAS TEMPERATURE EXHAUSTED TO ATMOSPHERE.

Background :

On closure of main stack damper, the tripping of FD fans used to occur under high arch pressure of main crude heater. Hence, it was suspected that the cold flue gas duct (from APH outlet to ID fan suction) was restricting. The immediate cause of tripping FD fans was high arch pressure of process heaters on closure of main stack damper. The restriction of cold flue gas duct used to act as the main cause of the furnace pressurisation on closure of main stack damper. This has been the perennial problem which prevented closure of main stack damper.



AVU-I Furnace Stack

Observation Made :

During the shut down (from 27 June 04 to 17 July '04) of AVU-1, the cold flue gas duct Ex-APH to ID fan suction was opened & cleaned. A lot of deposits were found in the duct. After the cleaning of the cold flue gas duct, the unit was started on 18/7/04. The main stack damper was successfully closed to 100% and the APH parameters are compared below before & after cleaning of the duct.

Technical & Financial Analysis Made :

	(Before Cleaning)	(After Cleaning)
Hot Flue Gas APH I/L temp., Deg C	340	337
Hot Air Ex-APH temp., Deg C	200	220
Main Stack Damper opening (%)	100	0
Temperature Below damper, Deg C	359	352
Temperature after damper, Deg C	284	190
Furnace Efficiency , %	85	90
SRF Savings, %	0.06	
SRF Savings, Kg/Day	41	
Eqv. Fuel Oil Savings, Kg/Day	43	
Savings, Rs./Day	426	

Impact of implementation :

The operation of APH of AVU-1 has significantly improved after cleaning operation leading to a reduction of % SRF by 0.06% wt. The flue gas temperature after the stack damper came down to 190 °C (on full closure of stack dampers) from earlier level of 284°C (without closing of stack dampers) which resulted in above saving of SRF.

9. INSTALLATION OF 3 NOS. OF HERO OIL GUNS IN AVU-I**Background :**

All the burners of AVU- ½ furnaces were HPR-18 types supplied by M/s John Zink. The hole size of the existing burners of all the three furnaces is very small and the oil guns are of Y-jet type. This results in frequently choking of some of the burners' tip consequently diminishing the heat release capacity of the burners. In order to serve the desired heat load, remaining burners have to cater to the requirement causing local flame impingement on the furnace coils resulting in high skin temperatures. In addition to this, existing atomising steam pressure control valves are of fixed pressure type. Due to the existing Y-jet type oil gun (which are very sensitive to oil viscosity and steam conditions), it is very difficult to control the flame pattern of the burners manually, which in turn was resulting in smoky flame (incomplete combustion) or extinguishing of the burners on increasing atomising steam. To overcome the problems, 3 nos. of Y-jet type oil gun of furnace F-01 & F-02 of AVU-1 were replaced by HERO oil guns supplied by M/s John Zink.

Observation Made :

- Radiant & compact flame pattern indicating relatively better atomization.
- Arch temperature observed to be lower by about 2 °C than earlier & simultaneous comparing with F-02 of AVU-2 implying better combustion.
- Burner adjustment time reduced.

**Technical & Financial Analysis Made :**

	HPR-18 Type Burner	Hero Oil Gun
Steam Fuel Ratio	0.27	0.15
Fuel Oil / Burner (Kg/Hr)	140	140
Atomising Steam, (Kg/Hr)	38	21
Steam Saving, (Kg /Hr)	17	
Eqv. FO savings, (Kg/Hr/Burner)	1.3	
Savings / Burner, (Rs/Yr)	131975	
Savings for 3 burners, (Rs Lakhs /Yr)	4.0	

Impact of implementation :

- Radiant & compact flame pattern indicating relatively better atomization
- Frequency of Burners cleaning is reduced.
- Better combustion
- Relatively less time for burner adjustment

10. INSTALLATION & COMMISSIONING OF KEROSENE COALESCER IN AVU-1/2 & AVU-3

Background :

Since Kerosene is withdrawn from strippers, it contains traces of water. To minimise the requirement of water draining from storage tanks of Kerosene with the objective to reduce slop generation in the refinery, coalescer in Kero stream of AVU-1/2 (common for both) & in Kero stream of AVU-3 has been provided in the Kero run down line to remove the water from Kerosene.



KEROSENE COALESCER IN AVUs

Technical & Financial Analysis Made :

Crude processed in AVU-I & II, MT/Day	18500
Kerosene production, MT/Day	3145
Reduction Of Slop Generation, KG/Day	1258
Reduction Of Slop Generation, MT/Year	415.14
Savings in SRFT, MT/Year	7.5
Savings , Rs lakhs/Year	1.0

Impact of implementation :

This facility has reduced the water content of kerosene stream from 300-500 ppm to 100-150 ppm level and also reduced the slop generation and hence loss of Kerosene along with slop.