

Mangalore Refinery & Petrochemicals Limited, Mangalore

(A subsidiary of Oil and Natural Gas Corporation Limited)

Company Profile

Mangalore Refinery and Petrochemicals Limited (MRPL), a subsidiary of Oil and Natural Gas Corporation Limited, is a Grass root Crude oil Refinery located at Mangalore, a coastal city of Karnataka. The refinery is certified with ISO-9001: 2000 & ISO-14001 certifications for its Quality management and Environment management systems. MRPL contributes approximately 8% of India's total Refining capacity. MRPL's refinery complex consists of state-of-the-art facilities for crude distillation and secondary processing units. The refinery, with its predominant middle-distillates product focus, is a trendsetter among Indian Refineries with two Hydrocracker, two Catalytic Reforming & Light Naphtha Isomerization units.

MRPL's Phase-1 Refinery was commissioned during March 1996 with a crude processing capacity of 3.69 MMTPA. Subsequently the Refining capacity was increased to 9.69 MMTPA with the commissioning 2nd phase of 6 MMTPA capacity during November 1999.



The major Secondary processing units consist of two Hydro-cracker units (total conversion), two Continuous Catalyst regenerator (CCR) type Reforming units (produces high octane unleaded Motor spirit), a Gas Oil Hydro-desulphurisation unit to produce Ultra-low sulphur Diesel, three numbers of Sulphur Recovery units with Claus and Selectox process for recovering 99 % of the Sulfur in crude thus minimizing emission of SO₂ to the atmosphere. New units like LN Isomerisation to produce ultra quality (Euro-III/IV) grade motor spirit, Mixed Xylene for value addition and CRMB (Crumb Rubber modified Bitumen) units were commissioned in 2006-07.

The Refinery has achieved the highest ever crude throughput of 12.53 MMTPA which is ~129% of the installed capacity during the year 2006-07 and has also achieved the lowest Energy Index of 63.13 **MBTU/Bbl/NRGF (CHT)** among the Indian PSU Refineries. MRPL has won the prestigious 'Jawaharlal

Centenary Award for Energy Performance among Indian PSU refineries for four consecutive years for 2003-04, 2004-05, 2005-06 and 2006-07. Apart from several Environmental Safety awards, the Refinery has also been awarded with “Five Star Health and Safety Management Audit System” rating by British Safety council, U.K. during the year 2003.

MRPL is currently implementing an ambitious Refinery expansion and Up-gradation project. Major units will be CDU-III, FCC, Delayed Coker, DHT. MRPL is also setting up an Aromatic complex in the ‘Mangalore SEZ’.

Energy Consumption

Energy conservation is accorded the highest priority in MRPL by operating the refinery units at their optimum energy efficiency levels on a continuous basis & also by implementing several energy conservation measures. These have resulted in substantial reduction in Electrical and Thermal energy consumption.

In MRPL, the primary energy source is fuel. Fuel sources are Low sulfur Fuel oil (produced from bottoms of Vacuum Column of CDU & used in power plant & in process heaters), Fuel Gas (consisting of Hydrogen, CH₄, C₂H₆ etc produced in the refinery & used in refinery process heaters), Off gases (mainly consisting of CH₄ & C₂H₆, generated in crude, Vacuum & VBU units & consumed directly in the same units’ process heaters) & Hydrogen PSA purge Gas (Consisting of Hydrogen, CH₄, CO & CO₂, directly consumed in the Hydrogen reformer).

Secondary sources of energy are Steam & power. They are generated in house in cogeneration power plant. Steam is also produced at process plant area by waste heat recovery. Three levels of steam being used (HP-40kg/cm², MP- 16kg/cm², LP - 4kg/cm²). Power consumption at 2 levels (MV -6600V, LV-430).

The Primary fuel energy consumption pattern for the year 2006-07 is as follows:

	MT	%ge on crude	% of Fuel & Loss
Gross Crude processed	12535637	----	---
Total Fuel & Loss	810322	6.46	---
Fuel Oil	418020	3.33	51.59
Fuel Gas	140973	1.12	17.40
Off gas	20258	0.16	02.50
Purge gas	144994	1.16	17.89
Loss	86077	0.69	10.62

Cogeneration Energy pattern is as follows:

Fuel oil consumed in CPP	267663	MT/year	% on Crude	
SHP Steam generated	4270683	MT at 100kg/cm ²	34.07	MT/MT
Power generated	582082	MWH/year	04.65	MWH/MT
HP Steam export to process	1344311	MT/ year at 40kg/cm ²	10.72	MT /MT
LP Steam export to process	118187	MT/ year at 4kg/cm ²	00.94	MT/MT
Steam to Fuel ratio	15.96	MT of SHP/Mt of FO		
Fuel to Power Ratio	12.22	MMBTU/MWH		

Energy Index reflects the refinery Fuel & Loss & the energy performance. Even though specific electrical consumption is separately shown below, it is a part of Energy Index.

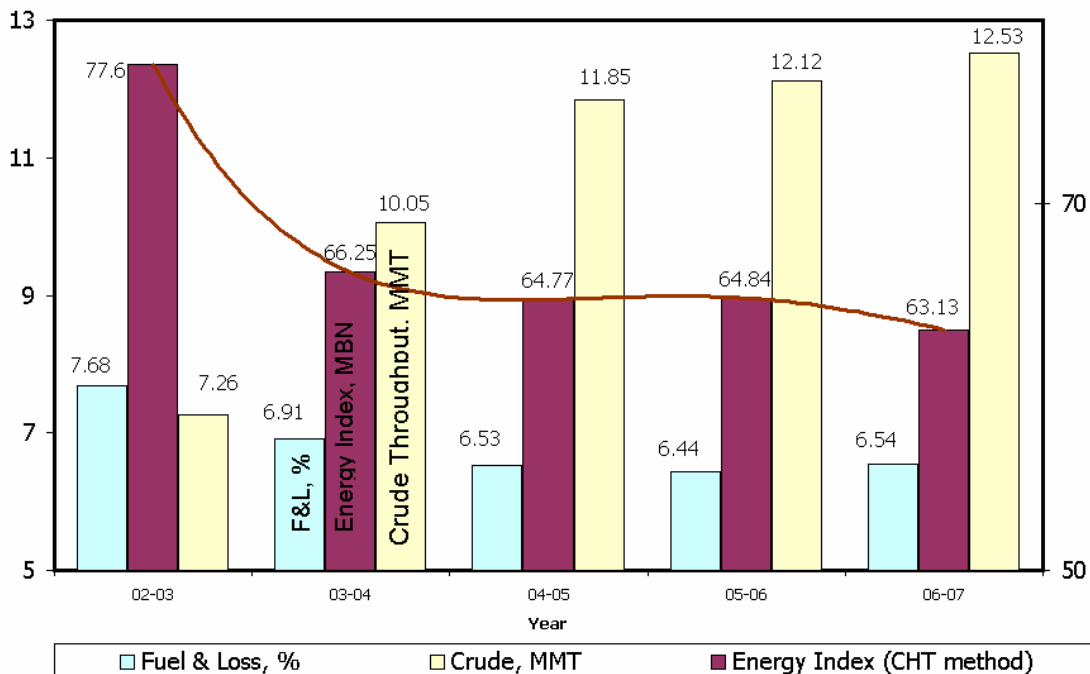
Year	Sp. Energy Consumption				% Reduction over 2003-04			
	Energy Index, MBN	% Energy cost over Manufacturing cost	Electrical Energy KWH/MT	Fuel & Loss/ MT of Crude	Energy Index, MBN	% Energy cost over Manufact cost	Electrical Energy KWH/MT	Fuel & Loss/ MT of Crude
2003-04	66.25	3.49	54.12	0.0691	---	---	---	---
2004-05	64.77	2.68	49.60	0.0653	2.2	23.2	8.4	5.5
2005-06	64.84*	2.43	46.80	0.0644	2.1	30.4	13.5	6.8
2006-07	63.13	2.26	46.50	0.0653**	4.7	35.2	14.1	5.5

* Marginally Higher due to lower energy factor. Actually MBTU/BBL has reduced.

** Higher due to Energy consumed for ISOM & Mixed Xylene pre-commissioning/ commissioning activities.

Energy Index of 63.13 MBN is the lowest among Indian PSU refineries, as well as best among MRPL's previous performances. MRPL Bagged the First prize in Jawaharlal Nehru Energy Award by CHT, under MoP&NG for the fourth consecutive year for the lowest energy specific consumption.

MRPL Energy Performance



Energy index for the year 2006-07 is lesser by 1.71MBN with respect to 2005-06 (64.84 to 63.13).

The major contribution for this reduction is from the Energy conservation schemes implemented in 2006-07.

Total investment		1.1 Crores
Total energy reduced	131488 MM KCal	522 MMBTU
Gross Crude processed	12.54 MM TPA	93.15 MBBL
Complexity factor		4.962
Reduction in Energy index		1.13 MBN
Total Cost savings/year		19.5 Crores

Energy Conservation Commitment, Policy and Organisational setup

MRPL is committed towards Energy conservation & optimization in its operations. Design features like Balanced draft furnaces, Flue gas analyzers, Draft Gauges, flue gas heat recovery systems, Heat exchanger trains for maximum heat recovery from hot streams, adequate heat insulations etc have been incorporated from the design/project stage itself. Energy consumption is given a two-pronged approach in MRPL. The first is to minimize losses by reducing flaring, capacity utilization and process optimization. The second is by implementing Energy conservation projects identified in-house across various process units.



Energy Conservation is a part of the 'Vision- Mission' statement & 'Environmental Policy'.

MRPL's commitment to Energy conservation is reflected in the management's setting-up of an ENCON cell for this purpose. It is established to monitor, control and minimize Energy consumption. Energy consumption report of entire refinery as well as individual unit is done daily & being reviewed in daily & monthly meetings at the level of Associate Vice President.

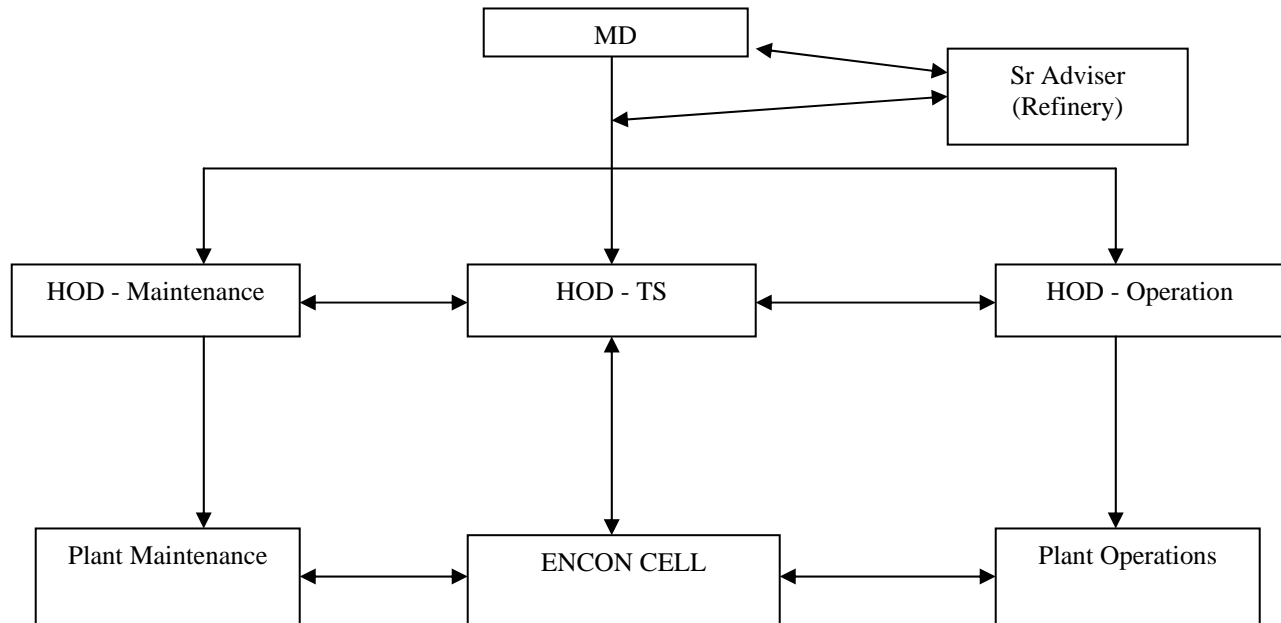
Monitoring of the plant performances in daily/monthly/quarterly/half yearly/yearly wise is the main responsibility of the dedicated personnel at ENCON cell.

The process data from DCS & relevant production figures & lab results will be collected everyday by ENCON Cell personnel & a brief report will be prepared about entire refinery as well as individual units. This report along with major observations/ suggestions will be sent daily to the respective operations departments. ENCON cell will follow up the implementation of suggestions.

In addition to the above activities, ENCON cell identifies opportunities for Energy optimization, both short & long-term projects, follows-up for implementation.

ENCON Cell or any other department personnel can suggest an opportunity. Respective unit process Engineer will prepare the scheme after studying the viabilities and will route it to design & Engineering after necessary clearances from operation department & Hazop study. Design & Engineering Department will prepare the entire drawing & will release for execution. Maintenance department will execute the project. Operations department will commission the project. Individual process personnel will monitor the savings.

The core activities of Energy Management system can be summarized as follows:



- Monitoring of Fuel consumption, furnace performance, utility consumption, flaring and other losses of individual units/ refinery.
- Setting target energy consumption figures (in terms of SRFT) for major units based on the unit's best operating data/ bench marks and monitoring the same on a daily/ monthly basis. The best performing units with respect to Energy conservation are selected for Annual Awards.
- Suggesting measures to bring down the unit energy consumption to the set target levels. Discussing in detail during daily & monthly Performance review meetings attended by plant operating personnel.
- Optimizing the operation like RPM, stripping steam, reflux ratio etc.
- Implementation of various Energy conservation schemes and monitoring their performances.
- Identifying cost-effective opportunities for increasing Energy efficiency either in new or existing plants.
- Creating and maintaining Energy consciousness throughout the Organization.

Energy conservation Achievements

In recognition of its energy conservation performance and schemes, MRPL has won the following awards:

- Bagging the First prize in Jawaharlal Nehru Centenary Award for Energy performance in the year 2006-07 among Indian PSU Refineries. This is the fourth time in the row, as MRPL bagged the first prize for the years 2003-04, 04-05 & 2005-06
- “Energy efficient Unit” award, by ‘Confederation of Indian Industry’ for the year 2006-07.
- “Energy Conservation Award” by Karnataka Renewable Energy development Limited.
- Second prize in the 16th Oil and Gas Conservation Fortnight awards 2006 in Furnace/Boiler efficiency category -2 (total heat duty more than 400 MMKCal/Hr).
- Second prize in the 14th Oil and Gas Conservation Fortnight awards 2004 in Furnace/Boiler efficiency category -2 (total heat duty more than 400 MMKCal/Hr).
- Oil conservation award, 2001-2002 - Medium projects category
- National Energy conservation award, 2001 – Certificate of Merit

Major Energy conservation schemes implemented in the year 2006-07

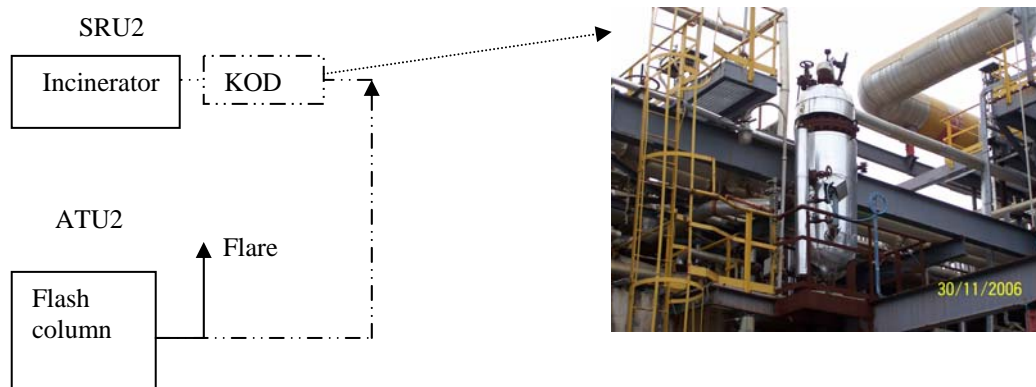
1. Amine flash column Off gas to SRU2 incinerator

An in house modification was done to recover heat from flash column off gases, which was earlier directly sent to flare, as this gas consists of mainly lighter Hydrocarbons.

With this modification the amine flash column off gases are now routed to SRU2 incinerator. In incinerator it was burnt off & the heat was recovered by the production of steam or by reducing the fuel gas consumption in the incinerator to maintain the minimum temperature.

An off gas KOD was put in the line at SRU2 to knock off any traces of liquid, for the process safety.

Another line to SRU3 incinerator along with a KOD is being planned to utilize the flash gas heat even during shutdown of SRU2 unit.



Economics:

Thermal Energy savings ~ 969 SRFT/year ~ Rs 144 Lakh/year

Investment ~ Rs.10.24 Lakh

Pay back ~ 27 days

2. Optimization of SWS operation

A study was carried out to check the feasibility of optimizing Refinery SWS operation. Earlier both Refinery SWS1 & Refinery SWS2 units were run for handling the sour water generated in the respective units. An in house study revealed that SWS2 unit could handle the entire refinery load.

M3/h	Ph1		Ph2	
	Design	Actual	Design	Actual
Earlier, Average	51	27	103	55
Max		33		68
Present		0		~90

overview is shown in the attached table.

Economics:

Thermal Energy savings ~ 1965 SRFT/year ~ Rs 292 Lakh/year
 Electrical power savings ~ 469 MWH/year ~ Rs.21.1 Lakhs/year
 Total Energy Savings ~ 2107 SRFT/Year ~ 313.1 Lakh Rs/year
 Investment Zero

Accordingly SWS1 load was shifted to SWS2 & SWS1 unit was stopped. This mainly results in saving of reboiler steam & power savings. The

3. Antifoulant injection in CDU1 feed

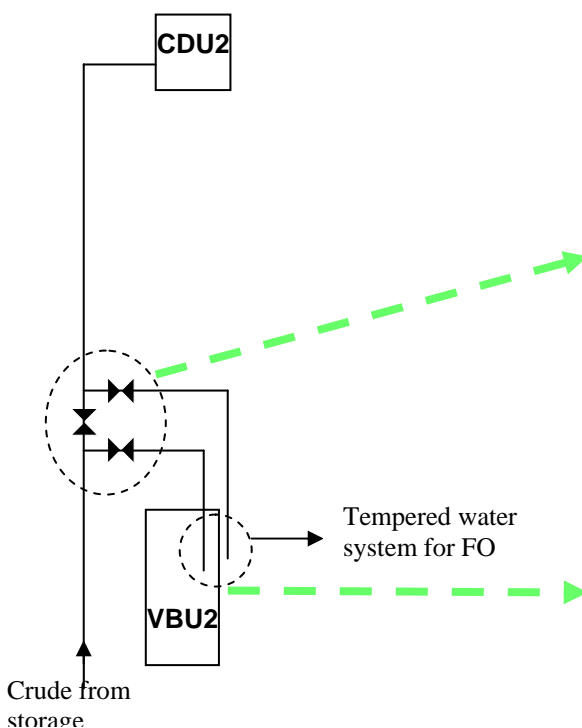
In CDU1, preheat exchangers' Fouling rate was high due to more of Mumbai High crude processing. To minimize this exchangers' fouling rate, Antifoulant injection was started on a trial basis on 23/07/2006. This experiment has been found successful.

Economics:

Thermal Energy savings (accrued) : ~ 1277 SRFT/year ~ Rs 190 Lakh/year
 Chemical cost (accrued) : Rs. 62 Lakh/year
 Investment : Negligible
 Net savings in 2006-07 : Rs ~ 128 Lakh/ year

4. VBU2 Fuel Oil Heat recovery by CDU2 Crude preheating

In VBU2, Fuel Oil product was being cooled by tempered water system. That system consists of



tempered water circulation pump & fin fans. Cold crude feed from OM&S to CDU2 pipeline was through the near by interconnecting pipe rack. This crude was initially preheated with LP Steam & finally with fired heater before entering the atmospheric column.

The system was studied for utilizing waste heat from VBU2 FO to preheat

CDU2 crude. Since the Crude pipeline is nearby, additional length of crude pipeline was smaller.

The modification was carried out. Crude line was cut at the Northwest corner of VBU2 & routed to VBU2 via manifold. Near the tempered water cooler (2 nos), crude line was connected to tempered water line.

After commissioning of the system, Tempered water system in VBU2 has been stopped & LPsteam consumption in CDU2 has come down.

Economics:

Thermal Energy savings at CDU2	:	~10.7MT/h LPSteam ~5006 SRFT/year ~Rs.743.9 Lakh/year
Electrical Energy savings at VBU2	:	~208 KW power ~1667 MWH/year ~Rs.75.1 Lakh/year
Total savings	:	~16.5 SRFT/day ~5511SRFT/Year ~ Rs. 819 Lakh/year
Investment	:	31 Lakhs
Payback	:	~ 15 days

5. Provision of Secondary Seals to 11 storage tanks to reduce fugitive emission

Five existing & six new storage tanks (all floating roof) were provided with secondary seals to minimize fugitive emissions

Existing: 2 crude (1E & 1G), 1 ATF (33B), 1 MS(3B), 1 Naphtha (3F)

New: 2 MS, 1 Mixed Xylene, 2 HSD & 1 SKO

6. Heater Decoking by Hydrokinetics

Earlier Decoking was being carried out in traditional method of burning with air. This was consuming



energy as well as time & during decoking time maintenance & inspection of heater was not possible.

By the Hydrokinetics technology, Decoking was carried out without burning of the coke, instead it was removed by pigging using Hydrokinetics. This eliminated the

usage of utilities and reduced shutdown period.

Decoking was carried out by this technology at VDU1 & 2 heaters in the year 2006-07.

Economics:

Thermal Energy consumption in normal decoking	:	~ Rs 46 Lakh/decoking
Thermal Energy consumption in decoking by Hydrokinetics	:	~ Rs 0 Lakh/decoking
Project cost	:	~ Rs. 27.50 Lakh/decoking
Net savings	:	~Rs. 18.50 Lakh/ decoking
Net savings in 2006-07 (Two units)	:	~ Rs. 37 Lakh/ year

7. Optimization of over flash at HCU 1 & 2:

In Hydrocracker unit 1 & 2, over flash flow was higher than the design. This leads to higher heat duty of Fractionator heater & higher pumping energy requirement.

The over flash was also utilized as reboiling media in Kerosene stripper. But approximately 30 m3/h was sufficient for the reboiler heat duty & the remaining through bypass. The saving potential was in minimizing this bypass flow.

Accordingly the flows were reduced from 75/70 m3/h to 65/65 m3/h.

Economics:

Thermal Energy savings at HCU1/2 : ~ 0.18/0.05 MMKCal/h ~ 184 SRFT/year ~Rs.27.3 Lakh/year

Investment : Nil

Energy conservation schemes/optimization carried out in last three years:

Title of Energy Saving project implemented	Year of Implementation	Annual Electrical Savings achieved		Annual thermal savings		Total Annual Savings	Invest. Made ~	Payback months
		Units Million	Rs Million	SRFT	Rs Million	Rs Million	Rs Million	
1. Routing of excess HCU - LPS gas to H ₂ feed	2004-05			1777.9	17.4	17.4	0	Instant
2. Replacing the cooling tower fan blades with FRP	2004-05	4.1	10.6			10.6	2.3	2.5
3. Insulation of CDU2 preheat train exchangers	2004-05			194.6	1.8	1.8	0.7	4.5
4. Installation of 90 nos. of TD62 energy efficient steam traps in 40ata lines	2004-05			810.0	7.7	7.7	1.5	2.3
5. Installation of 200nos. of MST traps in instrument tracers	2004-05			915.2	8.7	8.7	0.7	0.9
6. Installing 3MV and 119LV variable speed drives	2005-06	21.6	88.3			88.3	200	27.2
7. Changing of PSA adsorbents in H ₂ -2 and CCR-2 units	2005-06			7826.6	105.3	105.3	110	12.7
8. Feed preheat by Fx bottoms Heat recovery at HCU1	2005-06			127.2	1.7	1.7	0.2	1.4
9. Diesel product Heat recovery for feed preheating at HCU2	2005-06			293.4	3.9	3.9	0.15	0.4
10. Interconnection of HCU1&2 stabilizers to reduce flaring and throughput reduction	2005-06			391.3	5.3	5.3	0.5	1.1
11. Routing of excess hydro cracker LPS gas to GOHDS	2005-06			293.4	39.5	39.5	0	Instant
12. Steam traps replacement and repair	2005-06			636.9	8.6	8.6	1.08	1.5
13. Solar heaters for canteen/MD bungalow	2005-06	0.02	0.07			0.07	0.2	33
14. Installation of energy saving lighting transformer	2005-06	0.2	0.8			0.8	0.6	9
15. Replacement of 1957nos. of 40W lamps with 36W tri-phosphor fluorescent lamps, 1250nos. of 200W GLS lamp to 20W CFL lamps, 300nos of 50W lamps to 10W CFL lamps	2005-06	1.0	4.0			4.0	0.35	1.1

16. Crude preheating by the recovery of Fuel Oil product heat in phase-2 crude distillation unit.	2006-07	1.7	7.5	5006	74.4	81.9	3.1	0.5
17. Antifoulant injection at CDU1 to minimize the heat exchanger fouling rate	2006-07			1277.4	19	12.8	0	Instant
18. Steam lines insulation improvement	2006-07							
19. Optimization of HCU1&2 over flash flow	2006-07			184	2.7	2.7	0	Instant
20. Heater decoking by hydro kinetics	2006-07	0.1	0.5	584.6	8.6	3.7	0	Instant
21. Refinery sour water optimization	2006-07	0.5	2.1	1964.6	29.2	31.3	0	Instant
22. Routing ATU2 flash column off gas to SRU2 incinerator to recover waste heat	2006-07			969.4	14.4	14.4	1.24	0.9
23. Steam trap survey & Repair & Maintenance	2006-07			2792	41.5	41.5	2.2	0.6
24. Providing of Double seals for five existing floating roof and six new floating roof tanks to reduce fugitive emissions	2006-07							

Energy Conservation Plans and Targets

Continuing its focus on Energy conservation, MRPL has very clear vision towards the future. MRPL's future plans & Strategies are as follows -

- 1 Developing energy Auditors/Energy managers. One Encon Dy Manger is already a certified Energy Auditor. Another Engineer in Encon cell will be nominated for Energy Auditor course.
- 2 MRPL has participated in the Benchmarking exercises to compare its performance both on regional and global platforms. Implementation of action plans towards gap closure activities identified by Shell benchmarking Exercise will be followed up.
- 3 Hydrocarbon loss survey was carried out by M/s Petroleum Conservation Research Association (PCRA)-Chennai. Action plan based on audit recommendations drawn up for implementation.
- 4 Actively participating in 'Oil & Gas Conservation Fortnight' scheduled in January 2008. Accordingly participating in joint survey organised by Center for High Technology, under Ministry of Petroleum & Natural Gas. Conducting Energy conservation awareness campaign within refinery & township.
- 5 Participating & contributing to PCRA Energy activities.
- 6 Heaters' survey in-house in a scheduled manner. Complete Energy Audit of one Process unit in the current year.
- 7 Proposal, initiation, follow-up for implementation & monitoring the performance of new Energy conservation schemes.
- 8 Regular efficiency improvement programmes such as insulation survey, motor & pump maintenance.

- 9 Regular optimization such as heater operation (excess O₂, Stack temp - APH efficiency), column operation (optimization of reflux, vacuum, Temp, Stripping steam, Product distillation gap etc.), Steam balance, Hydrogen balance, minimization of flaring & sloping on a continuous basis.

Some of MRPL's forthcoming schemes towards Energy conservation are:

	Energy Conservation Measures (Planned)	Net Anticipated savings		~investment (Rs.lakhs)	year
		MMKcal/Year	Rs. Lakhs		
1	Online cleaning of furnaces by GTC Technology	20800	305.46	101.1	2007-08
2	Vapor absorption machines for Air conditioning	424	6.23	25	2007-08
3	Implementation of Advanced process control at CDU2	-	-		2007-08
4	Implementation of Advanced process control for Hydrogen management	-	-		2008-09
5	Product Blending & Optimization	-	-		2008-10
6	NSU feed heat recovery with Kero rundown at CDU1	12000	168		2009-10
7	Use of Hydrogen rich CCR Net gas for GOHDS/ ISOM -makeup, in place of fresh Hydrogen.	48248	1079		2006-07, long term
8	Hydrocracker Fan External foam cleaning			3.3	2007-08
9	Introducing circulating refluxes in fractionator HCU-1 & 2 unit	142857	2000		2009-10
10	Installing Power recovery turbine in HCU1	10714	150		Long term
11	Installation of GT with HRSG	142857	2000		Long term
	Total	81472	5709	129	

Environment and Safety

MRPL is committed to Environment protection and has implemented an effective Environment management system in its functioning. MRPL has installed a comprehensive wastewater treatment facility for treating refinery wastewater so as to get treated water quality much better than the limits set by Karnataka State Pollution Control Board (KSPCB) and MINAS standards. Refinery also successfully recycles about 70% of the treated effluent as makeup water to cooling tower consistently.

MRPL continuously operates three sulfur recovery units of 99% recovery efficiency & also controls the internal fuel oil quality for restricting the overall SO_x emission.

MRPL's commitment to the protection of the ecological system evolves from the Design and Operation Stage and continues in its normal operation. The refinery constantly monitors the quality of treated wastewater and air quality surrounding the refinery. A well-equipped Mobile air quality monitoring van has been adopted for routine monitoring of air quality in and around the refinery for this purpose, in addition to five permanent Ambient Air Quality monitoring stations.

List of major environmental improvements made during 2004–05, 2005-06, 2006-07

2004-05:

- Additional submarine pipeline for disposing the treated effluent into sea.
- Fully automatic weather monitoring station.
- Oil absorbent booms for tackling oil spills, if any in the refinery.

2005-06:

- Fuel quality improvement projects for the manufacture of EURO III /IV compliant automobile fuels.
- Rapid Environmental Impact assessments study for refinery capacity enhancement and fuel quality improvement projects.
- Modifications carried out in WWTP for maximization of treated effluent recycle.
- Risk assessment study for fuel quality improvement projects.
- Up gradation of Environment Management System (EMS) as Per ISO 14001 to latest version of standard i.e. ISO14001:2004.

2006-07:

- Biogas plant for treating the food waste generated in the refinery canteen and township.
- Bioremediation of oily sludge using M/S The Energy and Resources Institute, New Delhi developed biotechnological method.
- Installation of high rate oil skimmers in WWTP for recovering oil.
- Comprehensive VOC monitoring and LDAR Program for reducing the fugitive emissions.
- Comprehensive Environmental Impact assessment study by M/S National Environmental Engineering Research Institute, Nagpur for the increased crude processing capacity of the refinery.
- Additional impervious sludge lagoons as per Central Pollution Control Board design for storing the sludge.
- Secondary seals are provided for 11 Nos crude tanks & middle distillates.

“Safety First” – has been MRPL’s motto. Lectures, seminars and training sessions on plant safety for MRPL staff & contractors are regularly conducted. MRPL is the convener of the Mangalore Chapter of National Safety Council. A well-equipped live fire-fighting ground is used for the training. Safety and housekeeping committees review the plant safety every month. Mock-drills are conducted regularly in the process units and Refinery to regularly evaluate and improve the emergency preparedness of the Refinery.