Shriram Alkali & Chemicals, Jhagadia

Unit Profile

SHRIRAM ALKALI & CHEMICALS (SAC) is a 62,500 tonnes per annum Chlor Alkali Plant situated at Jhagadia (Distt Bharuch , Gujarat) based on state of the art membrane cell technology and integrated with energy efficient captive co-generation plants with 5 nos. DG sets of 3 X 6 + 2 X 3MW .

The unit is manufacturing caustic soda lye, caustic soda flakes, chlorine , hydrochloric acid & hydrogen since March'1996

The major raw materials are common salt and pow

(An overview of plant)

The installed capacities of various products being manufactured at the unit are as follows:

	Product	**Capacity (TPA)**
1.	Caustic soda lye	62500
2.	Caustic soda flakes	33000
3.	Chlorine	54000
4.	Hydro chloric acid	12000
5.	Hydrogen	1560

Our unit has been certified by internationally renowned accreditation agency M/s KPMG for:

Certifications	Certified in	Valid up to
• Quality Management System		
- ISO-9002 : 1994	Feb. '99	upgraded to ISO 9001:2000
- ISO-9001 : 2000	Feb. '01	Feb. '08
• Environment Management		
- ISO-14001: 1996	Oct. '00	Oct.'06

- Occupational Health & Safety
  Management System
  - OHSAS 18001: 1999 Jan. '02 Jan. '08

The unit is also certified by renowned accreditation agency M/s Registro Italiano Navale India Pvt Ltd for

- Social Accountability System
  - SA 8000 : 2001 Dec. '02 Dec. '05

- One of the first chemical plants in India to get SA 8000 certification

- Periodical surveillance and re-certification audits are carried out by the certification agencies as per schedule.

Within nine years of its operation at Jhagadia, SAC has been awarded the following awards:

→ 2005
- **Platinum award** (4th Annual Greentech Safety Award) in chemical sector for outstanding achievement in **Safety Management.**

→ 2004
- **2nd prize** in **National Energy Conservation Award** in Chlor Alkali Sector by **Ministry of Power,Government of India**
- Award for **unique & innovative efforts** in Energy conservation by PCRA**, Ministry of Petroleum & Natural Gas, Government of India**
- Certificate of appreciation for **achieving accident free** million man hours in the year **2003 by Gujarat Safety Council**
- **Platinum award** (Greentech Environment Excellence Award) in chemical sector for outstanding achievement in **Environment Management**

→ 2003
- **National award** for prevention of pollution and Rajiv Gandhi Environmental award for clean Technology for 2002-03 from **Ministry of Environment and Forest.**

→ 2002
- **2nd rank** out of 34 Chlor-Alkali plants in overall **environmental rating** of the Indian caustic-Chlorine sector by Center for Science & Environment (CSE),NewDelhi under their green rating project.
- **1st prize** in **National Energy Conservation** Award in Chlor Alkali Sector by **Ministry of Power**,Government of India.
- Award for **unique & innovative efforts in Energy conservation** by PCRA, Ministry of Petroleum & Natural Gas, Government of India for consecutive second year.

→ 2001
- **National Energy Conservation Award** in Chlor-Alkali Sector by Ministry of Power, Govt. of India for **consecutive third year**
- Award for **unique & innovative efforts in Energy conservation** by PCRA, Ministry of Petroleum & Natural Gas, Government of India for consecutive second year.
- Corporate **Environment Award 2000-01** by Tata Energy Research Institute in recognition of corporate leadership efforts towards **environment management and sustainable initiatives** in the category of "company with turnover below Rs 100 Cr."

→ 2000
- **National Energy Conservation Award** in Chlor-Alkali Sector by Ministry of Power, Govt. of India for **consecutive second year**

- Two awards for **unique & innovative efforts in Energy conservation** by PCRA, Ministry of Petroleum & Natural Gas, Government of India

- ICMA **certificate of merit** for excellence in **energy conservation and management**

→ 1999-2000 First prize for **House keeping** from Disaster Prevention & Management Centre

→ 1999 **National Energy Conservation Award** in Chlor-Alkali Sector by Ministry of Power, Govt. of India

→ 1998 **Rotary safety shield** award for best safety performance.

Energy Management Policy

Our mission is to be the lowest specific energy consumer in the industry we operate.

This is achieved through:

- Maximising the capacity utilisation.
- Optimising our operation and maintenance continually to achieve the above goal.
- Utilising energy efficient processes, equipments and upgrading available technology.
- Promote energy awareness culture in the organisation to achieve a target of reduction in specific power consumption by 1% every year for next 5 years.
- Maintain habits of improved house keeping and waste elimination.
- Benchmark continuously our performance against the best in the industry.
- Setting up a system to continuously monitor the progress.

Energy consumption

The Caustic Soda plant is having state-of-the-art membrane cell energy efficient technology supplied by M/s Asahi Chemicals Industries, Japan.

The electrical energy consumed for the year 2004-05 is 1891 Lac Kwh

There has been a continuous decease in the specific energy consumption due to implementation of various energy conservation measures.

1. Reduction in specific power consumption for caustic soda production

* Normally the specific power consumption to produce caustic soda in membrane cell plant increases with ageing of membrane and cell units due to reasons given as follows:

⇒ Increase in cell voltage due to ageing of membrane

- With deposition of calcium and magnesium on membrane, which enters the membrane cell (though in ppb level i.e. milligrams/MT) with feed brine, the resistance of membrane increases, resulting increase in cell voltage and hence power consumption.
- Reduction in active area due to patch welding on membranes for stopping the pin hole leakage, increases the voltage drop and the power consumption.

⇒ Over potential (voltage drop) of anode and cathode also increases due to gradual de-activation of anodic and cathodic coating with ageing of cell units.

As per industry norms, the normal increase in power consumption to produce caustic soda on account of above two reasons, is 40 Kwh/MT every year.

Due to continuous efforts to conserve energy in all possible areas:

Actual power consumption has in fact reduced by **30 Kwh/MT** (from 2702 Kwh/MT in 1997-98 to 2672 Kwh/MT in 2004-05**)**

instead of

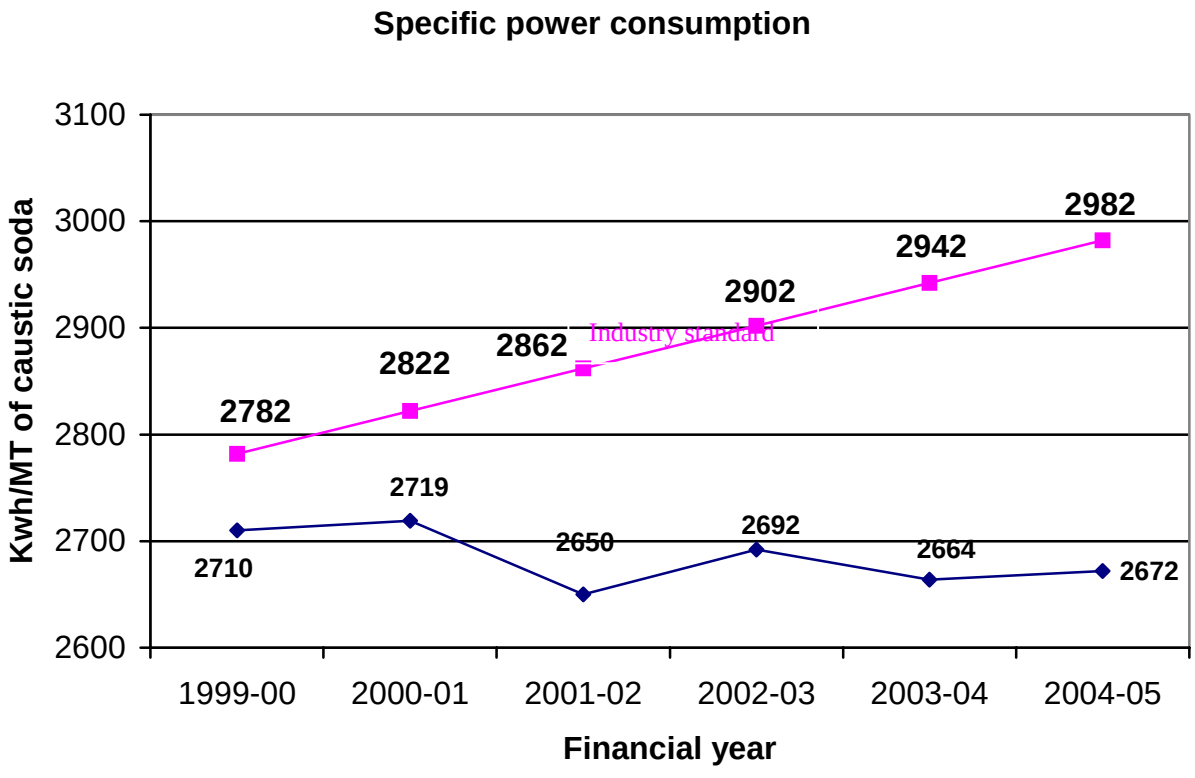
increasing (as per industry norms) **by 280 Kwh/MT** (from 2702 Kwh/MT in 1997-98 to 2982 Kwh/MT in 2004-05) over a **period of seven years.**

The effective **reduction** in **power consumption** is **310 KWH/T of caustic soda** over a base figure of 2702 KWH/T in 1997-98.

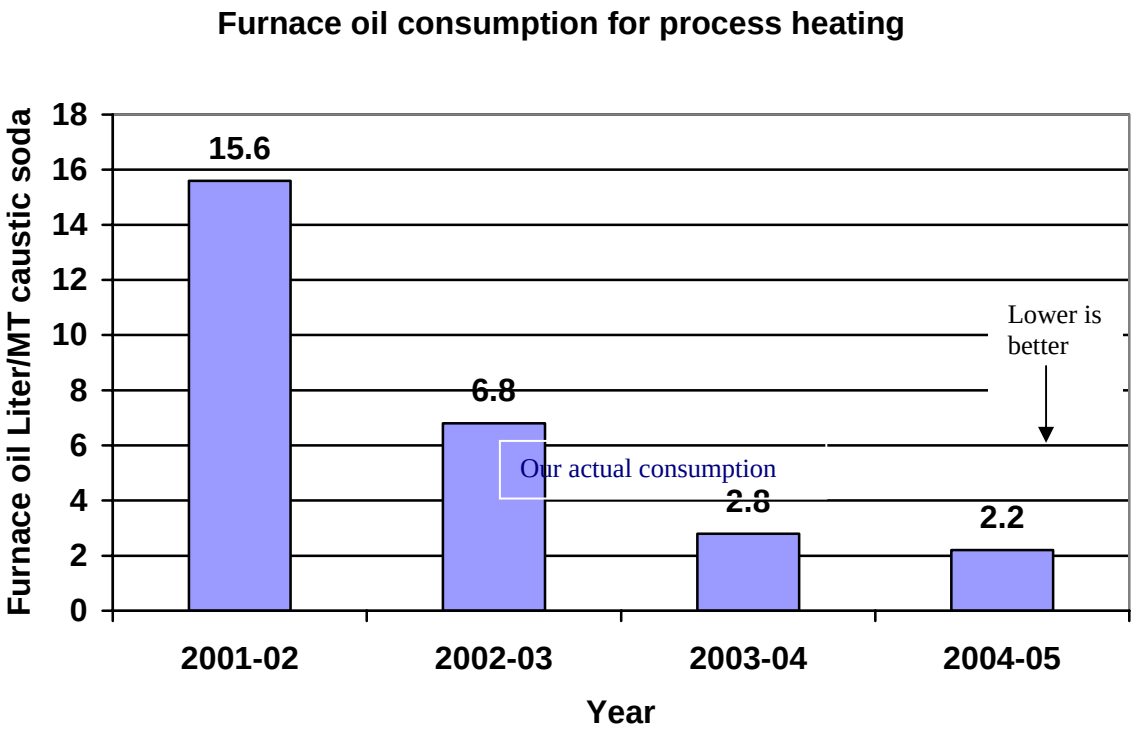
Specific power consumption (cell power + aux power) for caustic soda production

Unit : KWH/T of caustic soda

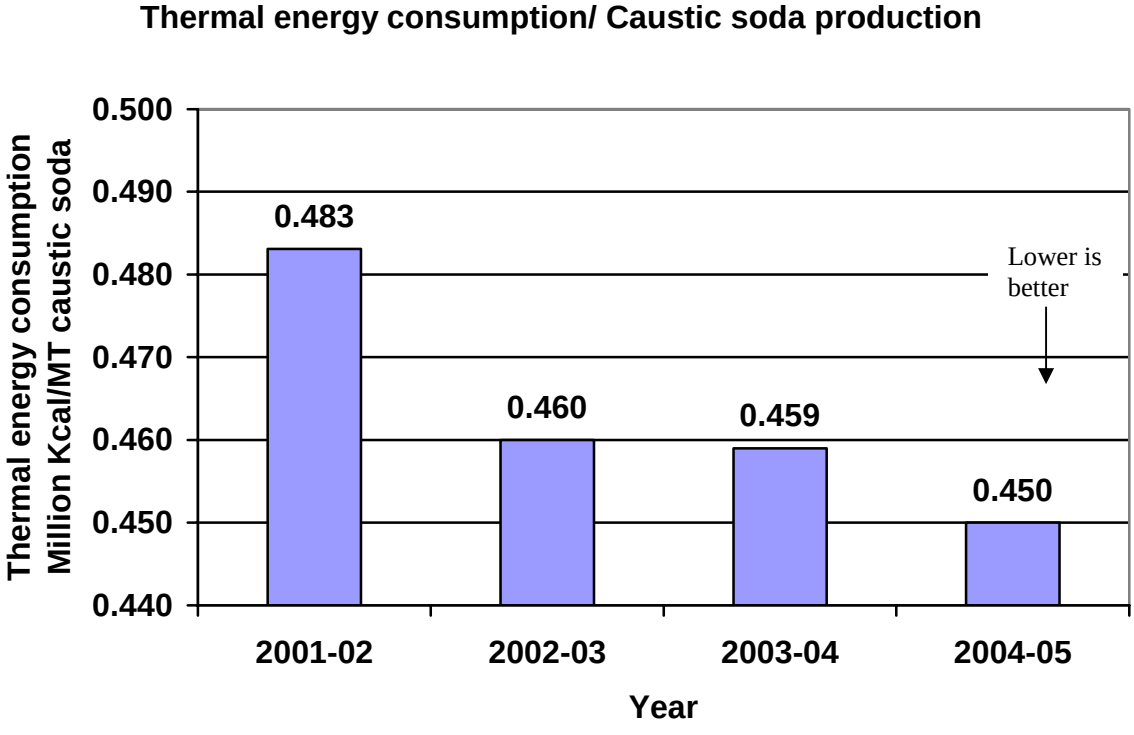
Year	Actual **KWH/T**	Target based on base figure of **2702 KWH/T in 1997-98**	**Reduction** in energy consumption **KWH/T**	**%age reduction over 1997-98**
1999-00	2710	2782	**72**	**2.7%**
2000-01	2719	2822	**103**	**3.8%**
2001-02	2650	2862	**212**	**7.8%**
2002-03	2692	2902	**210**	**7.8%**
2003-04	2664	2942	**278**	**10.3%**
2004-05	2672	2982	**310**	**11.5%**

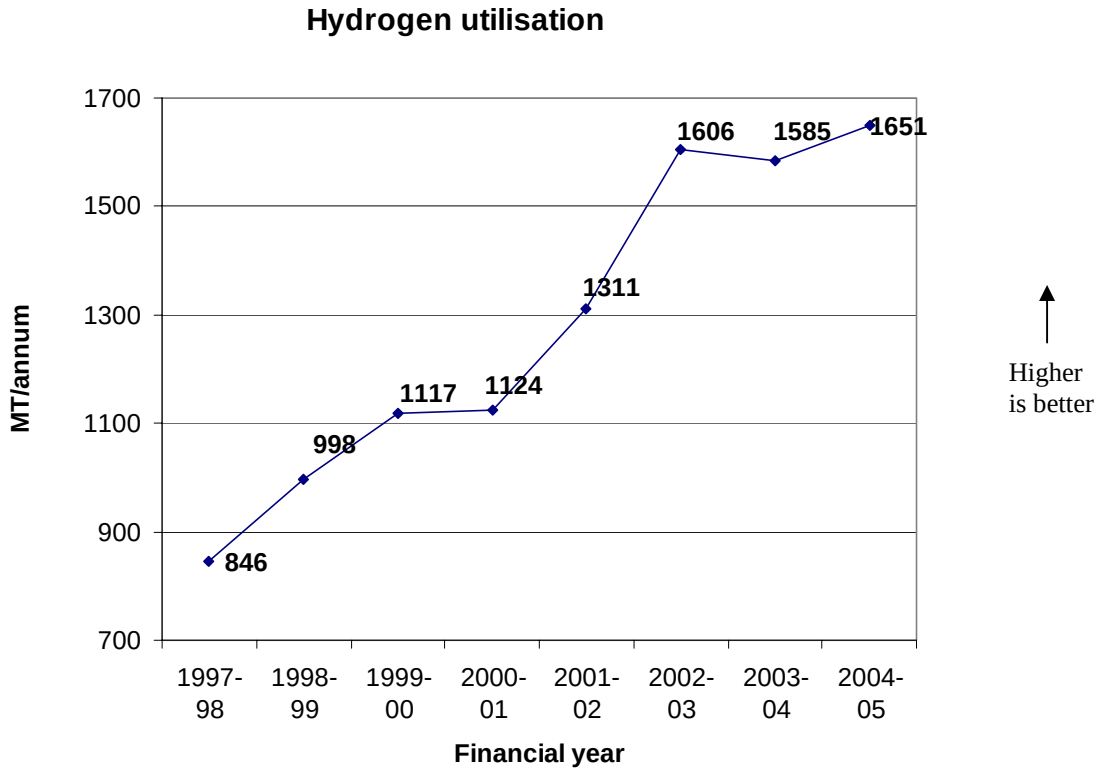


2. **Reduction in furnace oil consumption for process heating (flaker plant + auxiliary boiler)**

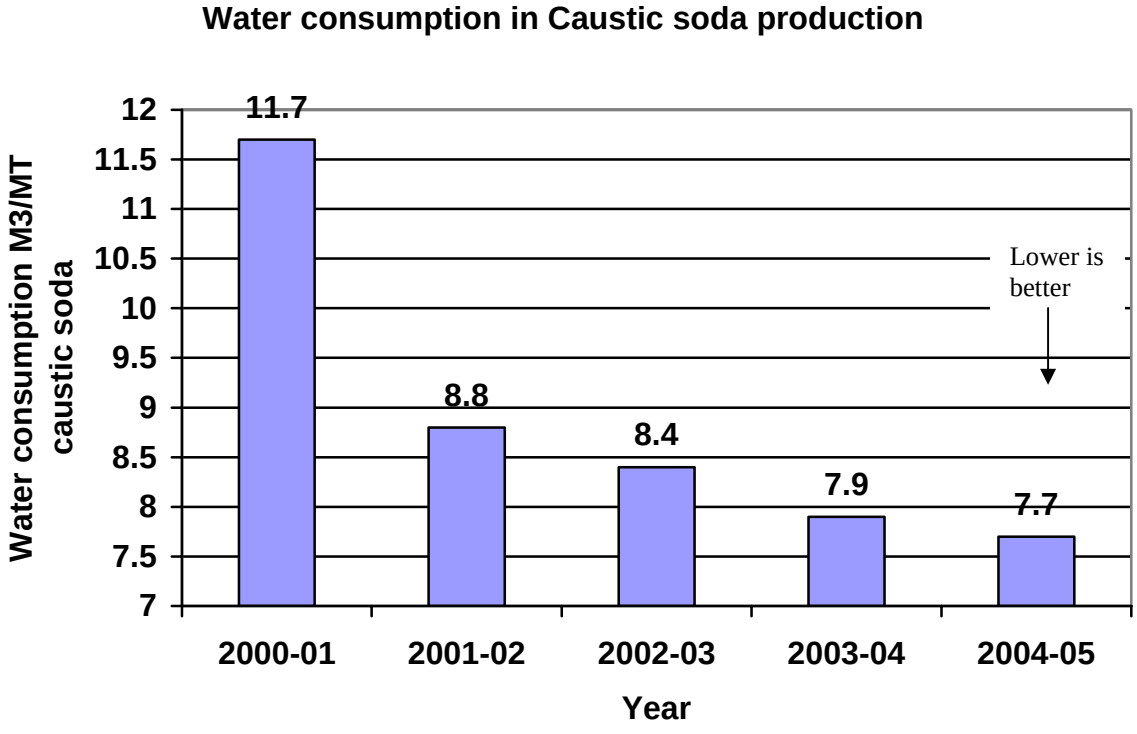


3. **Reduction in thermal energy consumption in process**
4. **Saving of furnace oil in flaker plant by substituting it by waste hydrogen gas** (earlier it was being vented)





5. **Reduction in water consumption**



Energy conservation commitment, policy and set up

The chlor alkali plant which has been set up at Shriram Alkali & Chemicals, Jhagadia (Bharuch Dist., Gujarat) is a state of the art membrane technology plant supplied by M/s Asahi Chemical Industries, Japan.
The plant is highly energy efficient & environment friendly.

Ever since the commissioning of the plant in March '96, there has been a continuous & dedicated effort by the team to strive and make it the most energy efficient plant in the Chlor alkali industry.

To achieve this, the management led by a team of professionals has been continuously looking for area where improvement is possible.

The whole approach has been to identify the problems, evaluate them in the most analytical manner, make cross-functional teams, carry out root cause analysis and successfully implement energy conservation schemes. The benefits are then monitored on regular basis.
As a result, substantial gains & benefits have accrued to our unit in the field of energy conservation during the last three years, which have drastically reduced our cost of production.

As per the information available, specific power consumption is one of the lowest in the Indian Chlor Alkali industry.

Energy conservation achievements
Due to consistent all around efforts, we have achieved considerable amount of savings by implementation of various energy saving schemes already explained in sr no. 16 (page no- 22-27) in this questionnaire.

During the period of 2002-2005 unit has achieved a **saving** of **Rs 990 lacs** with an **investment** of **Rs 874 lacs.**

Major projects implemented during the year 2004-05 are listed below:

1. **Reduction in power consumption by reducing the nos of Garo compressor running from 3 to 2 by replacing the Garo compressor internals.**

   - **Background of the project:**
     There are 3 nos Garo compressors for compression of chlorine gas from 0.2 to 3.5 kg/cm^2 g pressure. All the 3 compressors were run at more than 150 TPD chlorine load.

   - **Observations made:**
     Each compressor is of 75 TPD capacity. The capacity required at full plant load 160 ~ 170 TPD.

     It was analysed that one compressor can be stopped by marginal increase in the existing compressor capacity.

   - **Technical and financial analysis:**
     To increase the compressor capacity, the innovative actions taken are as follows:

     - **Reduction of chlorine gas inlet temperature**:
       This is a liquid ring type compressor where the volumetric capacity (m^3/hr) of the compressor is constant. Therefore the compressor capacity (in MT/hr) will increase with increase in gas density at suction.

       To take advantage of above the **chlorine gas temperature** has been **decreased** from **30^0 C to 20^0 C** by **increasing heat transfer area** in drying tower **cooler.** The density of gas increased from 3.42 to 3.54 kg/m^3.

       Due to above reduction in chlorine gas temperature the compressor capacity has been increased from **75 TPD to 78 TPD** (75 x 3.54 ÷3.42 = 78 TPD).

- **Innovative changes in compressor internals:**
  To increase the capacity and efficiency of the compressor, following changes have been carried out in the internals.
  - The impellor **vane angle** has been increased from **30^0 to 40^0**. This has increased the compressor efficiency thereby increasing margin on the existing motor for increasing compressor capacity.
  - The size of suction and discharge ports have been increased to handle more gas;

	Prot size in mm^2	
	Earlier	Now
Suction port	32700	36000
Discharge port	11800	13000

  - Previously, we have used SG Iron (Spheroidal Graphite Cast Iron) as material of construction.
    By changing the material of construction to ASTM A 351 Gr CF8M i.e SS 316 along with hard chrome plating, the flow surface is now free from friction and hence the power consumption is reduced.

  - Wear casing profiles has been modified to have more cross sectional area for flow resulting in increase in capacity.

  The impellers have been developed indigenously to reduce investment.

  Above have resulted in increase in the compressor capacity from 75 to 85 TPD

Now all the time we manage with only 2 Garo compressors

The power consumption has reduced from **11160 to 7920 kwh/day**.

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	11160
Now	7920
Savings	3240

	Rs./ lacs
Investment	: 6.0
Saving/annum	: 29.2
Payback period	**: 3 months**
ROI	**: 487%**

2. Reduction in power consumption by replacing cell units in electrolyser.

- **Background of the project:**
  We have 5 nos electrolysers having 104 ~ 110 cell units each. These cell units anode and cathode coated with precious metals to reduce voltage of cell units.

  Over potential (voltage drop) of anode and cathode also increases due to gradual de-activation of anodic and cathodic coating with ageing of cell units

- **Observations made:**
  The cell voltage keeps increasing as over potential (voltage drop) of anode and cathode increases due to gradual de-activation of anodic and cathodic coating with ageing of cell units.

The cost of replacement of cell units in one electrolyser is aprox Rs 450 Lacs

- **Technical & financial analysis:**

  Conventional practice
  Keep using the cell units till they are physically suitable for use

  Our initiative
  Replace the cell units based on economics of investment and saving in power consumption.
  .
  To reduce the power consumption, we have replaced all the cell units in electrolyser – B.

  The power consumption has reduced from **103490** to **89778** kwh/day in electrolyser-B.
  .

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	103490
Now	89778
Savings	13712

	Rs./ lacs
Investment	: 429
Saving/annum	: 148.1
Payback period	**: 28 months**
ROI	**: 35%**

Other projects implemented during the year 2004-05 are listed below:

Schemes	Power consumption (kwh/day)			Saving	Investment	Payback period
	Earlier	Now	Saving	Rs/Lacs	Rs/Lacs	Months
3. Reduction in power consumption for **filtered brine pump** by installing variable frequency drives	451	277	174	1.7	1.5	11
4. Reduction in power consumption for **depleted brine pump** by installing variable frequency drive.	222	158	64	0.6	0.9	18
5. Reduction in power consumption by replacing 'V' belt with flat belt in Freon compressor.	3291	3192	99	1.1	0.8	9
6. Reduction in power consumption by replacing Alumium blade with energy efficient **FRP blade in cooling tower fan**.	870	563	307	3.3	1.8	7
7. Installation of a small cooling water pump **(400 m^3/hr)** to reduce power consumption (Now, running small cooling tower pump with a big cooling tower pump **(2500 m^3/hr)** in place of two big cooling tower pumps **(2 x 2500 m^3/hr).**	12240	7920	4320	32.4	1.0	1
8. Reduction in power consumption by installing a **low pressure** (15 kg/cm^2)	4664	1920	2744	27.2	55	24

hydrogen compressor in place of running 150 kg/cm^2 compressor for pipeline supply to customer.	25872	22444	3428	37	85	28
9. Reduction in power consumption by replacing membranes in electrolyser.	163	54	109	1.1	0.8	9
10. Reduction in power consumption by replacing Electrolyser – E isolator with busbar.	-	-	12 KL FO	1.2	1.0	10
11. Reduction in furnace oil consumption in flaker plant by improving the insulation	-	-	25 KL FO	2.5	1.0	10
12. Reduction in furnace oil consumption in auxiliary boiler by improving the insulation on steam generation equipment and lines	612	581	31	0.3	0.5	20
13. Reduction in power consumption by installation of Installation of reflex glass (double glass arrangement, 5 mm reflex + 6 mm existing tinted with 12 mm gap) in power plant control room (east side)						

Energy conservation plans and targets

The company is consistently striving for further reduction in energy savings. Some of the energy saving schemes proposed for future are as follows:

- Replacement of cell units, which are consuming more power due to their deterioration of active anodes and cathodes surfaces with passage of time.
- Install variable voltage variable frequency drive for various pumps which normally do not run at its full capacity.
- Increasing the plant capacity by **de-bottlenecking** of the existing equipments to reduce auxiliary power consumption.

The details are as follows:

Year of Commissioning	Project description	Achievement of energy savings per year basis						Investment incurred on the project (Rs. Lakhs)
		Fuel					Total (Rs lakhs)	
		Power Lakh KWH)	Coal	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		

Year of Commissioning	Project description	Achievement of energy savings per year basis						Investment incurred on the project (Rs. Lakhs)
		Fuel					Total (Rs lakhs)	
		Power Lakh KWH)	Coal	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		
2002-2003	i. Replacement of chilled water pump (1pump for equivalent duty of 2 nos running pumps) to **reduce power consumption**	**1.8**					**3.6**	**0.2**
	ii. Reduction in power consumption for anolyte circulation pumps in electrolyser by installing variable frequency drives	**0.9**					**1.8**	**2.5**
	iii. Reduction in power consumption for purified brine pump by installing variable frequency drives	**0.6**					**1.2**	**1.3**
	iv. Replacement of drinking water pump with more efficient pump	**0.03**					**0.1**	**0.2**
	v. Installation of photo sensor control for switching ON/OFF for lighting in the works to reduce power consumption	**0.04**					**0.1**	**0.1**
	vi. Replacement of chlorine vaporiser condensate pump with higher efficiency	**0.04**					**0.1**	**0.2**
	vii. (a) Reduction in venting of hydrogen by **increasing merchant sale of hydrogen**.			**2704**		**24893**	**376** **206**	**NIL** **NII**
	(b) Reduction in furnace oil consumption in flaker plant by substituting it with waste hydrogen (**earlier it had been vented)**							

2002-2003	viii. Reduction in power consumption in electrolysers by - Preventive maintenance of electrolysers - Replacement/ better upkeeping of ➔ Anodes and cathodes. ➔ Membranes	**103**					**206**	**124**
	Total	**106**		**2704**		**24893**	**860**	**129**

Less (as the savings is recurring and has been considered in 2001-02)

	i (a) Reduction in venting of hydrogen by **increasing merchant sale of hydrogen**. (c) Reduction in furnace oil consumption in flaker plant by substituting it with waste hydrogen (**earlier it had been vented)**			**2704**		**24893**	**376** **270**	**NIL** **NIL**
	Total	**106**					**213**	**129**

Add (saving not mentioned in the questionnaire of 2002-03)

	i. Reduction in furnace oil consumption for process heating by: → Reducing auxiliary boiler running hrs <u>Earlier:</u> The load on caustic concentration plant (to concentrate 30% caustic from 30 to 50%) was kept constant. Therefore auxiliary boiler was run during DG set maintenance to fulfill the steam requirement <u>Now:</u> The load on caustic concentration plant is reduced during DG maintenance. The increased volume of 30% caustic is processed when all the DG sets are available → Reducing furnace oil consumption in flaker plant (The plant load has been adjusted based on availability of spare hydrogen gas)			**566**		**5210**	**55**	**Nil**
	TOTAL	**106**		**566**		**5210**	**268**	**129**

Year of Commissioning	Project description	Achievement of energy savings per year basis						Investment incurred on the project (Rs. Lakhs)
		Fuel					Total (Rs lakhs)	
		Power Lakh KWH)	Coal (Tonnes)	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		

2003-2004	i. Reduction in power consumption for anolyte circulation **pumps** in **Electrolyser -A** by installing variable frequency drives	**0.5**					**1.2**	**1.0**
	ii. Reduction in power consumption for anolyte circulation **pumps** in **Electrolyser -B** by installing variable frequency drives	**0.5**					**1.2**	**1.0**
	iii. Reduction in power consumption for anolyte circulation **pumps** in **Electrolyser -C** by installing variable frequency drives	**0.5**					**1.2**	**1.0**
	iv. Reduction in power consumption for anolyte circulation **pumps** in **Electrolyser -D** by installing variable frequency drives	**0.5**					**1.2**	**1.0**
	v. Reduction in power consumption for anolyte circulation **pumps** in **Electrolyser -E** by installing variable frequency drives	**0.2**					**0.4**	**Nil**
	vi. Reduction in power consumption by eliminating steam condensate pump requirement in caustic concentration plant (CCU).	**0.4**					**0.9**	**0.4**
	vii. Replacement of DM water pump (1 pump for equivalent duty of 2 nos running pumps) to **reduce power consumption**	**0.3**					**0.6**	**0.2**
	viii. Reduction in power consumption by replacement of process condensate pump for HPD plant by energy efficient spare pump available at another location	**0.4**					**0.8**	**0.3**
	ix. Reduction in power consumption by installation of Installation of reflex glass (double glass arrangement, 5 mm reflex + 6 mm existing tinted with 12 mm gap) in **power plant** control room	**0.4**					**0.8**	**0.3**
	x. Reduction in power consumption by installation of Installation of reflex glass (double glass arrangement, 5 mm reflex + 6 mm existing tinted with 12 mm gap) in **main plant** control room							

Year of	Project description	Achievement of energy savings per year basis		Investment incurr
		Fuel	Total	

		Power Lakh KWH)	Coal	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		
2003-2004	xi. Reduction in power consumption in electrolysers by - Preventive maintenance of electrolysers - Replacement/ better upkeeping of → anodes and cathodes. → Membranes	**189** **0.6**					**377** **1.2**	**129** **0.2**
	xii. Reduction in specific power consumption by changing the pulley of Freon compressor to increase the compressor capacity.	**0.2** **0.1**					**0.4** **0.2**	**0.4** **0.03**
	xiii. Providing of delta star starters for HFO separator motors	**0.1**					**0.2**	**0.03**
	xiv. Switching off of Non industrial lighting transformer	**0.5**					**1**	**1**
	xv. Reduction in power consumption by providing auto stop function based on temperature from DCS for Cooling tower ID fan - A.	**0.1**					**0.2**	**0.1**
	xvi. Replacement of V belt by flat belt in freon compressor to reduce power consumption.	**4.5**					**9.0**	**1.0**
	xvii. Replacement of body feed centrifugal pump by reciprocating pump			**221**		**2026**	**21.7**	**0.5**
	xviii. Substitution of furnace oil heating from 50 to 89^0 C before feeding to centrifuge from electrical heating to steam (generated using waste heat of flue gas).	**0.1**					**0.2**	**NIL**
	xix. Reduction in furnace oil consumption by eliminating/reducing brine-heating requirement. (A steam control valve is installed in dechlorination system for better control of vacuum and brine temperature)							
	xx. Installation of rainwater harvesting system to reduce power consumption in water transportation							
	Total	**199**		**221**		**2026**	**422**	**139**

Add

	i. Reduction in quantity of purchased water by utilising rainwater harvested.						**14.4**	**21**
		199		**221**		**2026**	**436**	**160**

Year of Commissioning	Project description	Achievement of energy savings per year basis						Investment incurred on the project (Rs. Lakhs)
		Fuel					Total (Rs lakhs)	
		Power Lakh KWH)	Coal (Tonnes)	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		

Year of Commissioning	Project description	Achievement of energy savings per year basis						Investment incurred on the project (Rs. Lakhs)
		Fuel					Total (Rs lakhs)	
		Power Lakh KWH)	Coal (Tonnes)	F. Oil (KL)	Gas (Lakh m^3)	Total (fuel) in MkCal		
2004-2005	1. Reduction in power consumption by reducing the nos of Garo compressor running from 3 to 2 by Replacing the Garo compressor internals.	**9.7**					**29.2**	**6.0**
	2. Reduction in power consumption for **filtered brine pump** by installing variable frequency drives	**0.6**					**1.7**	**1.5**
	3. Reduction in power consumption for **depleted brine pump** by installing variable frequency drive.	**0.2**					**0.6**	**0.9**
	4. Reduction in power consumption by replacing 'V' belt with flat belt in Freon compressor.	**0.4**					**1.1**	**0.8**
	5. Reduction in power consumption by replacing Alumium blade with energy efficient **FRP blade in cooling tower fan**.	**1.1**					**3.3**	**1.8**
	6. Installation of a small cooling water pump **(400 m^3/hr)** to reduce power consumption (Now, running small cooling tower pump with a big cooling tower pump **(2500 m^3/hr)** in place of two big cooling tower pumps **(2 x 2500 m^3/hr).**	**10.8**					**32.4**	**1.0**
	7. Reduction in power consumption by installing a **low pressure** (15 kg/cm^2) **hydrogen compressor** in place of running 150 kg/cm^2 compressor for pipeline supply to customer.	**9.1**					**27.2**	**55**
	8. Reduction in power consumption by replacing membranes in electrolyser.	**60.7**					**182**	**85**
	9. Reduction in power consumption by replacing Electrolyser – E isolator with busbar.	**0.4**					**1.1**	**0.8**

2004-2005	10 Reduction in furnace oil consumption in flaker plant by improving the insulation			**12**		**110**	**1.2**	**1**
	11 Reduction in furnace oil consumption in auxiliary boiler by improving the insulation on steam generation equipment and lines			**25**		**229**	**2.5**	**2**
	12 Reduction in power consumption by installation of Installation of reflex glass (double glass arrangement, 5 mm reflex + 6 mm existing tinted with 12 mm gap) in power plant control room (east side)	**0.1**					**0.3**	**0.5**
	Total	**94**		**37**		**339**	**286**	**156**

2. Reduction in power consumption by reducing the nos of Garo compressor running from 3 to 2 by replacing the Garo compressor internals.

- **Background of the project:**
  There are 3 nos Garo compressors for compression of chlorine gas from 0.2 to 3.5 kg/cm^2 g pressure. All the 3 compressors were run at more than 150 TPD chlorine load.

- **Observations made:**
  Each compressor is of 75 TPD capacity. The capacity required at full plant load 160 ~ 170 TPD.

  It was analysed that one compressor can be stopped by marginal increase in the existing compressor capacity.

- **Technical and financial analysis:**
  To increase the compressor capacity, the innovative actions taken were as follows:

- **Reduction of chlorine gas inlet temperature**:
  This is a liquid ring type compressor where the volumetric capacity (m^3/hr) of the compressor is constant. Therefore the compressor capacity (in MT/hr) will increase with increase in gas density at suction.

  To take advantage of above the **chlorine gas temperature** has been **decreased** from **30^0 C to 20^0 C** by **increasing heat transfer area** in drying tower **cooler.** The density of gas increased from 3.42 to 3.54 kg/m^3.

  Due to above reduction in chlorine gas temperature the compressor capacity has increased from **75 TPD to 78 TPD** (75 x 3.54 ÷3.42 = 78 TPD).

- **Innovative changes in compressor internals:**
  To increase the capacity and efficiency of the compressor, following changes have been carried out in the internals.

  - The impellor **vane angle** has been increased from **30^0 to 40^0**. This has increased the compressor efficiency thereby increasing margin on the existing motor for increasing compressor capacity.

  - The size of suction and discharge ports have been increased to handle more gas;

	Prot size in mm^2	
	Earlier	Now
Suction port	32700	36000
Discharge port	11800	13000

  - Previously, we have used SG Iron (Spheroidal Graphite Cast Iron) as material of construction.
    By changing the material of construction to ASTM A 351 Gr CF8M i.e SS 316 along with hard chrome plating, the flow surface is now free from friction and hence the power consumption is reduced.

  - Wear casing profiles has been modified to have more cross sectional area for flow resulting in increase in capacity.

  The impellers have been developed indigenously to reduce investment.

  Above have resulted in increase in the compressor capacity from 75 to 85 TPD

Now all the time we manage with only 2 Garo compressors

The power consumption has reduced from **11160 to 7920 kwh/day**.

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	11160
Now	7920
Savings	3240

	Rs./ lacs
Investment	: 6.0

Saving/annum	:	29.2
Payback	**:**	**3 months**

3. Reduction in power consumption for filtered brine pump by installing variable frequency drives

- **Background of the project:**
  There are filtered brine pumps (two nos) to feed brine from an intermediate tank (filtered brine tank) to Ion exchange columns for ultra purification of brine (to remove Ca+Mg in parts per billion level) .

  The capacity of these pumps as recommended by technology supplier M/s Asahi, Japan is more than the actual requirement to facilitate the margin for change in pressure drop across the Ion Exchange columns.

  The rating of the pumps is as follows:

	Actual requirement (normal conditions)	Pump rating
Flow (m3/hr)	70-75	90
Head (m)	30	45

- **Observations made:**
  As the pump's rating was high compared to actual requirement in normal working condition, the power consumption on these pumps was more.

- **Technical and financial analysis:**

  Earlier practice :
  Regulate the manual valve in pump discharge line to maintain the required flow rate.
  The power consumption was 451 KWH/day

  Now:
  To reduce power consumption, variable frequency drive (VFD) has been installed with pump to reduce the flow.

  The power consumption has been reduced to 277 KWH/day

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	451
Now	277
Savings	174

	Rs./ lacs
Investment	: 1.5
Saving/annum	: 1.7
Payback	**: 11 months**

4. Reduction in power consumption for depleted brine pump by installing variable frequency drive.

- **Background of the project:**
  There are depleted brine pumps (two nos) to transfer brine from an intermediate tank (Depleted brine tank) to Dechlorination tower for removal of chlorine before its sending to saturator.

  The capacity of these pumps as recommended by technology supplier M/s Asahi, Japan is more than the actual requirement to facilitate the margin for change in process conditions.

The rating of the pumps is as follows:

	Actual requirement (normal conditions)	Pump rating
Flow (m3/hr)	50-55	60
Head (m)	20	30

- **Observations made:**
  As the pump's rating was high compared to actual requirement in normal working condition, the power consumption on these pumps was more.

- **Technical and financial analysis:**

  Earlier practice :
  Regulate the manual valve in pump discharge line to maintain the required flow rate.
  The power consumption was 222 KWH/day

  Now:
  To reduce power consumption, variable frequency drive (VFD) has been installed with pump to reduce the flow.

  The power consumption has been reduced to 158 KWH/day

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	222
Now	158
Savings	64

	Rs./ lacs
Investment	: 0.9
Saving/annum	: 0.6
Payback	**: 18 months**

5. Reduction in power consumption by replacing 'V' belt with flat belt in Freon compressor.

- **Background of the project:**
  We also produce liquid chlorine which is a co-product of caustic soda.

  There are 3 nos freon compressors for liquification of chlorine gas.

- **Observations made:**
  All compressors are belt driven.

  The belt used is of "V" belt type.

  The losses on V belt is more compared to flat belt.
  This is due to the additional power loss in V belt during its action of wedging in and wedging out in belt fixing grooves.

- **Technical & financial analysis:**

  Earlier:
  The compressors were 'V' belt arrangement.

  Now:

The V belt system has been replaced with a flat belt system.

The power consumption has reduced from **3291** to **3192** kwh/day.

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	3291
Now	3192
Savings	99

	Rs./ lacs
Investment	: 0.8
Saving/annum	: 1.1
Payback	**: 9 months**

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6. Reduction in power consumption by replacing Alumium blade with energy efficient FRP blade in cooling tower fan.

- **Background of the project:**
  There are two fans (both working) for cooling tower.

  These cooling tower fans have been supplied by M/s Paharpur with cooling tower package.

  The air flow rate and power consumption for existing fans are as follows:

Air flow	9.8 Lac m^3/hr
Power consumption	37 kw

- **Observations made:**
  The power consumption on above fans for same air flow rate, can be reduced by replacing existing Aluminum fan by FRP fan which are designed aerodynamically for better efficiency.

- **Technical & financial analysis:**
  One fan has been replaced by FRP fan.

  The power consumption has reduced from **870** to **563** kwh/day.

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	870
Now	563
Savings	307

		Rs./ lacs
Investment	:	1.8
Saving/annum	:	3.3
Payback	**:**	**7 months**

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7. Installation of a small cooling water pump **(400 m^3/hr)** to reduce power consumption (Now, running small cooling tower pump with a big cooling tower pump **(2500 m^3/hr)** in place of two big cooling tower pumps **(2 x 2500 m^3/hr).**

   - **Background of the project:**
     There is common cooling tower of 4000 m^3/hr circulation flow rate capability. This cooling tower had 3 nos circulation pumps of 2500 m^3/hr capacity (two running, one standby). The discharge valve of one pump was throttled to maintain the desired flow rate.

   - **Observations made:**
     On details analysis of cooling water requirement we found that the actual flow required is 2900 ~ 3000 m^3/hr.

   - **Technical & financial analysis:**
     Therefore, a small pump of 400 m^3/hr capacity is installed to run with one big pump of 2500 m^3/hr capacity.

     Earlier practice:
     2 big pumps of 2500 m^3/hr capacity was run. The discharge valve of pump is throttled to maintain the desired flow rate.

     Now:
     One big pump of 2500 m^3/hr is run with one small pump of 400 m^3/hr capacity.

     The power consumption has reduced from **12240** to **7920** kwh/day.

   - **Impact of implementation**:

Power consumption (KWH/day)	
Earlier	12240
Now	7920
Savings	4320

		Rs./ lacs
Investment	:	1.0
Saving/annum	:	32.4
Payback	**:**	**1 months**

8. Reduction in power consumption by installing a **low pressure** (15 kg/cm^2) **hydrogen compressor** in place of running 150 kg/cm^2 compressor for pipeline supply to customer.

- **Background of the project:**
  We also produce hydrogen which is a co-product of caustic soda.

  The hydrogen gas is used at following locations:

  - Flaker plant as fuel substituting furnace oil
  - Raw material for producing Hydrochlooric acid
  - **Merchant sale**
    - **-** in cylinder bank (at **150 kg/cm^2** g pressure)
    - **-** pipeline supply to neighbor industries. (at **10 ±2 kg/cm^2** g pressure)

- **Observations made:**
  There are four compressors of 220 NM^3/hr capacity at 150 kg/cm^2 g pressure.
  The pipeline supply at 10±2 kg/cm^2 g pressure was also from the above compressors. There were PRDS installed to reduce pressure from 150 to 10**±**2 kg/cm^2 g pressure.

- **Technical & financial analysis:**

  Earlier practice
  The pipeline supply at 10±2 kg/cm^2 g pressure was from the 150 kg/cm^2 g pressure compressors.
  There were PRDS installed to reduce pressure from 150 to 10**±**2 kg/cm^2 g pressure.

  Now:
  A new compressor of 570 NM^3/hr capacity and 15 kg/cm^2 g pressure is installed for pipeline customers.

  The power consumption has reduced from **4664** to **1920** kwh/day.

- **Impact of implementation**:

Power consumption (KWH/day)

Earlier	4664
Now	1920
Savings	2744

		Rs./ lacs
Investment	:	55
Saving/annum	:	27.2
Payback	**:**	**24 months**

9. Reduction in power consumption by replacing membranes in electrolyser.

- **Background of the project:**

We have 5 nos electrolysers having 104 ~ 110 membranes each. The membranes separate the anodic and cathodic compartment. It is a semi permeable membrane which does not allow hydroxyl ion to pass from the cathodic compartment to anodic compartment.

- **Observations made:**
  The power consumption to produce caustic soda increases with aging of membrane due to following:
  - With deposition of calcium and magnesium on membrane, which enters the membrane cell (though in ppb level i.e. milligrams/MT) with feed brine, the resistance of membrane increases, resulting increase in cell voltage and hence power consumption.
  - Reduction in active area due to patch welding on membranes for stopping the pinhole leakage, increases the voltage drop and the power consumption.

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- **Technical & financial analysis:**

  Conventional practice
  Keep using the membrane till they are physically suitable for use

  Our initiative
  Replace the membrane based on economics of investment and saving in power consumption.

  All the membranes of electrolyser –B have been replaced.

- **Impact of implementation**:

  Savings in power consumption = 60.7 Lac KWH/annum

		Rs./ lacs
Investment	:	85
Saving/annum	:	182

10. Reduction in power consumption by replacing Electrolyser – E isolator with busbar.

- **Background of the project:**
  We have 3 nos rectifiers.

  Rectifier -1 & 2 has two electrolysers connected with each, where as the rectifier-3 has only one electrolyser connected at present.

- **Observations made:**
  All the electrolysers have been provided with isolators for individual electrolyser isolation. There is a voltage drop of 0.6 V across each isolator.

- **Technical & financial analysis:**
  Rectifier -1 & 2 have two electrolysers connected to one transformer/rectifier. Therefore individual isolator is required.

The rectifier -3 has only electrolyser-E connected. Therefore the isolation of electrolyser-E can be done by inlet circuit breaker of rectifier transformer.

The isolator in Elect-E was provided with a view that similar Electrolyser will be added in future.

The power losses on isolator for electrolyser-E has been reduced by replacing it with Aluminium busbar.

The voltage drop has reduced from 0.6 V to 0.2 V leading to reduction in power consumption from **163** to **54** kwh/day.

- **Impact of implementation**:

	Power consumption (KWH/day)
Earlier	163
Now	54
Savings	109

	Rs./ lacs
Investment	: 0.8
Saving/annum	: 1.1
Payback	**: 9 months**

11. Reduction in furnace oil consumption in flaker plant by improving the insulation

- **Background of the project:**
  There is flaker plant to convert caustic lye to caustic flakes. Furnace oil is used as fuel in addition to hydrogen gas based on availability of hydrogen.

- **Observations made:**
  We found that there were some places where the insulation type (thickness and MOC) was not sufficient leading to loss of thermal energy.

- **Technical & financial analysis:**

  Earlier:
  Increase the furnace oil flow to achieve the desired caustic flakes moisture content.

  Now:
  The insulation in following locations has been improved as follows:

  - Final concentrator tubes
    Material of construction has been changed from mineral wool to cera blanked(ceramic based)

  - Pipe line
    All the damaged insulation has been attended.

  Due to reduction in thermal losses, the furnace oil consumption has been reduced by 12 KL/annum

- **Impact of implementation**:

Saving in furnace oil consumption : 12 KL/annum

		Rs./ lacs
Investment	:	1.0
Saving/annum	:	1.2
Payback	**:**	**10 months**

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12. Reduction in furnace oil consumption in auxiliary boiler by improving the insulation on steam generation equipment and lines

- **Background of the project:**
  We have a captive power plant of 24 MW capacity comprising of 5 nos DG sets (3 X 6MW + 2 X 3 MW). Each DG set has waste heat recovery boiler to generate steam at 12 kg/cm^2 g pressure for process use.

  We also have a furnace oil based packaged boiler to produce steam at 12 kg/cm^2 g pressure. This boiler is run when any DG set is under maintenance.

- **Observations made:**
  We found that there were some places where the insulation is weak leading to loss of the thermal energy.

- **Technical & financial analysis:**

  Earlier:
  Operate the auxiliary boiler when the steam generation from waste heat recovery boilers is not sufficient for process use.

  Now:
  To reduce the thermal losses, following actions were carried out.

  - All the damaged insulation in following locations has been attended.
  - Insulation provided at all the places where it was not there.

  Due to reduction in thermal losses, the need of running furnace oil based packaged boiler has reduced leading to reduction in furnace oil consumption by 25 KL/annum

- **Impact of implementation**:

Saving in furnace oil : 25 KL/annum

		Rs./ lacs
Investment	:	2.0

Saving/annum	:	2.5
Payback	**:**	**10 months**

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13. Reduction in power consumption by installation of Installation of reflex glass (double glass arrangement, 5 mm reflex + 6 mm existing tinted with 12 mm gap) in power plant control room (East side)

Background of the project:
The power plant control room has glass window for better visibility/inspection of equipment.

The glasses installed are tinted type in single layer

Observations made:
Earlier:
There was single glass arrangement leading to additional load on air conditioning.

Now:
The heat ingress through tinted glass is 6347 Cal/hr. $^{o}C\ m^{2}$.

For a double glass arrangement (5 mm reflex + 12 mm gap + 6 mm tinted) the heat ingress is 1758 Cal/hr. $^{o}C\ m^{2}$.

Therefore the double glass arrangement reduces the air conditioning load by reducing the solar heat ingress through glasses.

Double glass arrangement, (5 mm reflex + 6 mm existing tinted with 12 mm gap) is installed in power plant control room (East side)

The power consumption has reduced from 612 to 581 kwh/day.

- **Impact of implementation**

	Power consumption (KWH/day)
Earlier	612
Now	581
Savings	31

		Rs./ lacs
Investment	:	0.5
Saving/annum	:	0.3
Payback	**:**	**20 months**

(V) Very Important: CD containing major energy efficiency projects/measures taken by the unit during 2004-05 is enclosed.