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International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

ENERGY CONSERVATION AT GNFC

R.T. BHARGAVA
GNFC, India

Ces dernières années, GNFC s'est révélé comme multisecteur, multiproduit. Société géante grâce à l'équipe de professionnels qui a défié la récession que traverse la plupart des industries. Grâce à des efforts volontaires en vue de tirer le meilleur parti des ressources disponibles, soit matières premières soit sources d'énergie, GNFC a toujours œuvré pour réduire les coûts de production. Il est réconfortant de noter les performances réalisées par des unités de 20 ans d'âge qui ont été excellentes, mais un niveau soutenu de production ne peut être atteint que grâce à "KAISEN". Des idées nouvelles innovantes et la mise en pratique du concept "Regarde, Ecoute, Ressens" nous a beaucoup aidés à surmonter les difficultés rencontrées pour maintenir la continuité de marche. La gestion par objectif (MBO) est encore un autre concept chez GNFC pratiqué dans la lettre et dans l'esprit. "Conserve pour créer" sera le slogan des années 2000 et au-delà. Dans cet article on souligne comment les défis sont transformés en opportunités chez GNFC.

ABSTRACT

During the past few years, GNFC has emerged as multi-sector, multi-product giant. The Company through its team of competent professionals have successfully defied recession in which most of the industries at present is passing through. Due to conscious efforts to make best use of available resources, either raw materials or any energy input, GNFC has always strived to bring down cost of production. It is heartening to note that performance coming from 20-year old plants has been excellent, but sustained production level can only be achieved through “Kaizen”. New innovative ideas and practising LOOK, LISTEN and FEEL concept has helped us a lot to overcome various difficulties encountered for maintaining continuity of operation. Management by Objective (MBO) is yet one more concept at GNFC which is practised in letter and spirit. “ Conserve to create” will be the slogan for the year 2000 and beyond. In this article it is emphasised how challenges are being converted to opportunities at GNFC.

1.0 Introduction to GNFC and its plants :

Gujarat Narmada Valley Fertilizers Company Ltd., (GNFC**)** is located at Bharuch i.e. in industrial belt of Gujarat, the state which itself is humming with rapid industrialisation. Phase-I plant started commercial production in July, 1982 which includes ammonia plant, urea plant and related off site facilities. **Phase-II** was diversification in the field of chemicals, petrochemicals and power generation. This includes formic acid methanol-I and captive power plant. In early 90’s, new methanol-II, ANP, CAN, WNA and CNA plants were added as **phase-III** expansion. Close on the heels, acetic acid, syn gas generation unit and CNA-II were commissioned successfully. Necessary augmentation of MRS and off-site facilities were also done. Recently WNA revamp, CPP, boiler retrofitting and modification in CO-shift section of ammonia plant including revex replacement have added more stability to operation.

Chief Manager
E-mail : pmg@gnvfc.guj.nic.in

1.1 Technology Suppliers to GNFC :

Plant	Process Know/how/Licensors
Ammonia	**Linde-Germany/Texaco-USA/BASF-Germany/Holdor Topsoe, Denmark.**
Urea	**Snamprogetti, Italy.**
Methanol-I	**ICI, U.K.**
Methanol-II	**ICI, U.K.**
Formic acid	**Kemira, Oy Finland.**
Acetic acid	**BP Chemicals, U.K.**
WNA	**KRUPP-UHDE, Germany.**
CAN(I+II)	**Plinke, Germany.**
ANP	**BASF, Germany.**
CAN	**KRUPP-UHDE, Germany.**

1.2 Production Records of GNFC :

The various yearly production records established of all the plants operating at GNFC with percentage capacity utilisation are presented as under :

Plant	Licensed capacity (MTPA)	Year	Production (MTPA)	Capacity utilization (%)
Ammonia	**445,000**	**1995-96**	**520,810**	**116.90**
Urea	**594,000**	**1991-92**	**717,454**	**120.78**
Methanol-I	**20,000**	**1999-2000**	**33,862**	**169.31**
Methanol-II	**100,000**	**1999-2000**	**133,185**	**133.19**
Formic acid	**5,000**	**1997-98**	**9,314**	**186.28**
Acetic acid	**50,000**	**1998-99**	**65,098**	**130.2**
WNA	**207,900**	**1999-2000**	**242,166**	**116.48**
CAN(I+II)	**66,000**	**1999-2000**	**48,134**	**53.63+92.23**
ANP	**142,500**	**1999-2000**	**155,889**	**109.4**
CAN	**142,500**	**1997-98**	**170,738**	**119.82**

2.0 GNFC's View for Energy Conservation :

We, at GNFC, are always conscious at consumption of energy per MT of product. There are continuous efforts in this direction to examine increasing cost of energy and difficulties in availability of resources, whether it may be gas, oil, coal, water or even clean air. All input sources of energy are rising. Due to the massive complex, our hard efforts may not always yields desired result on all fronts every time, however few statistics on energy front prove the point.

SPECIFIC ENERGY CONSUMPTION (MKCAL/MT) :

Plant	Design	82-83	87-88	96-97	97-98	98-99	99-00
Ammonia	**12.06**	**14.27**	**12.2**	**11.93**	**12.19**	**12.06**	**12.06**
Urea	**8.08**	**9.34**	**8.05**	**7.68**	**7.91**	**7.71**	**7.82**
ANP	**5.32**	**-**	**-**	**4.32**	**4.73**	**4.20**	**4.10**
CAN	**3.92**	**-**	**-**	**4.48**	**4.23**	**4.26**	**4.38**

At GNFC, the operations of all the plants have reached a production level which are one of the best in the country, hence there is a little scope to improve the subsequent production levels. In a highly competitive global environment and with fertiliser industry being mainly dependent on the government policies in India, productivity at GNFC can be further increased by cost reduction efforts only.

To improve upon the efficiency and profitability of the company , the managemement of GNFC has targeted to reduce the energy consumption. In conjunction with above, the company declared 1997-98 as "Energy Conservation Year" which speaks of deep commitment by top management. The energy consumption of GNFC during the year 1998-99 was $ 47.91 million.

2.1 Energy Policy :

The Energy Policy of GNFC states :

"We at GNFC are committed to reduce, to the maximum extent possible, the consumption of energy without impairing company's economic growth, and thus increase the profitability of the company. This is sought to be achieved through the prevention of the wastage of energy in all forms and its use at the highest possible level of efficiency."

The major planks of Energy Policy are :

a) The company believes in concept of **"Total Energy management"** and **"Safe and efficient production".** Safety of equipment, machines and persons are of prime importance.

b) Energy management is of prime importance and this shall be achieved by conducting all operations safely and by properly integrating all activities related to production.

c) With limitation of raw materials and utilities like steam, power and water, our endeavour shall be to set realistic targets for specific consumption of raw materials, as any deviation will result into cutting of the profit.

d) **GNFC management** will provide leadership, direct participative enthusiastic support. All levels of management will be involved for efficient conservation of energy. All practicable and reasonable efforts and arrangements shall be made for educating, training and retraining employees at different levels for effective implementation of energy conservation.

f) Motivational strategies will be adopted and incentives in the form of certificates as well cash award for suggestion implemented for energy conservation will be given to the employees.

g) Positive discrimination shall be done in favour of **'green'** energy conservation schemes with longer pay back period. Also, more investment will be done for increasing energy efficiency in productivity.

2.2 Objectives for Energy conservation :

- To reduce energy consumption and hence improve profitability.
- Developing energy consciousness and ethics.
- Implementation of schemes which have more of energy conservation benefits, even with slightly higher pay back period (3 to 5 years).
- Looking each and every operation critically from energy saving point of view.
- Developing and encouraging on-line maintenance techniques.
- Building reliability and thereby minimising nil production days.

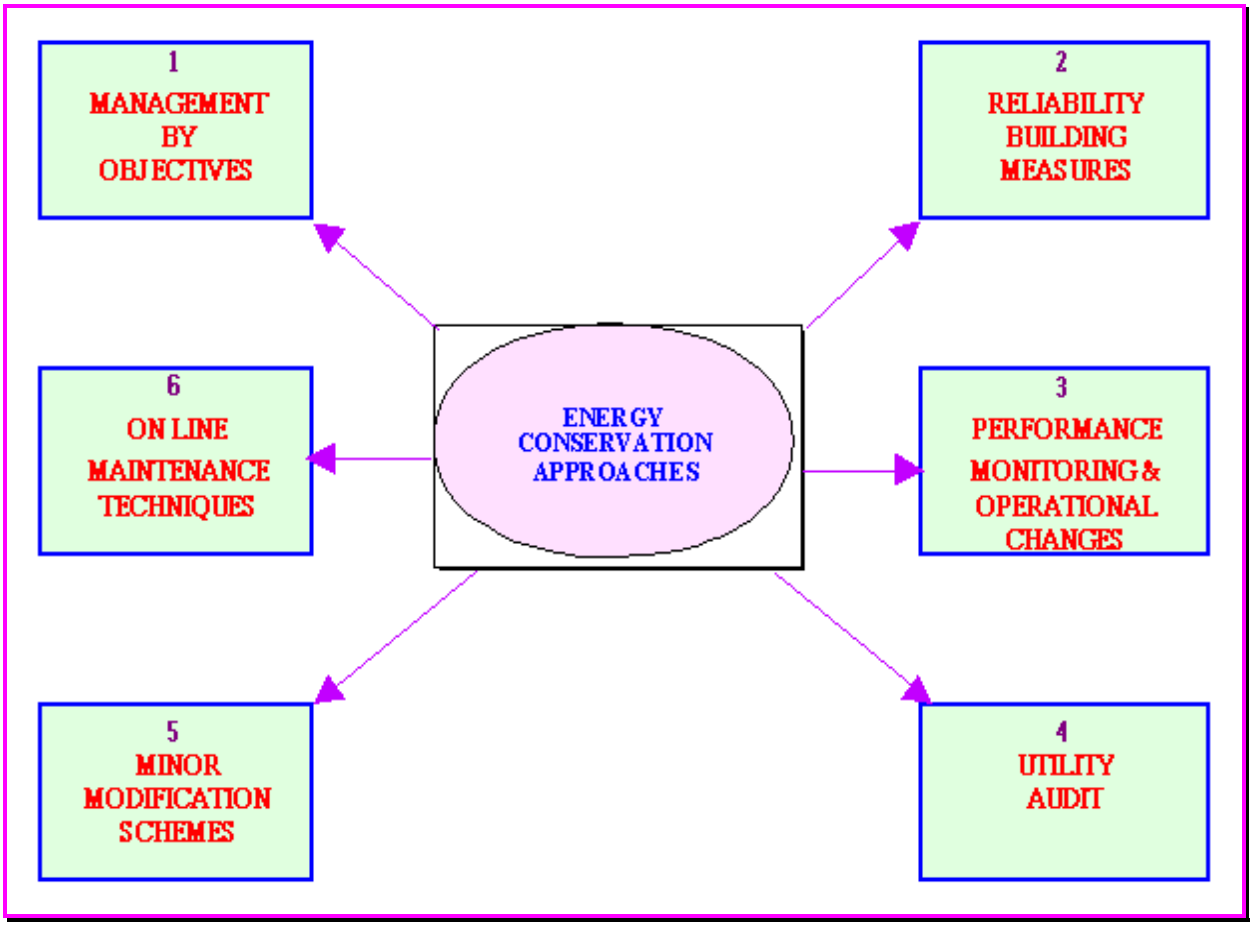
2.3 Organisational structure for Energy conservation :

GNFC being a joint sector government company, the approach towards energy conservation has been pragmatic. However with growing competition from other fertiliser industries using cheap source of raw material i.e. natural gas, the management of GNFC has further realised the need for energy management. While keeping excellent track record of higher production, all efforts are made in plants for minimum consumption of energy and resources. Presently at GNFC, additional two groups fully integrated into the management structure are functioning to achieve the objectives of energy conservation. One group is **'Technical Services',** having a team of competent engineers and are well equipped with computer software for doing simulation for all the chemical processes taking place in the plants and thriving for optimisation of energy conservation. All the modification schemes generated by the plant or by technical services themselves are being reviewed from energy conservation angle and implemented after doing **HAZOP study.**

Another such cell is **'Performance Monitoring Group'**. This group is connected with micro levels details of plant and continuous monitoring of various critical plant parameters which not only identifies problematic areas but also helps for corrective action to be taken.

2.4 Methodology of Energy conservation :

The **GNFC's** energy conservation programme involves goal setting throughout the organisation, this facilitates planning and co-ordination by clarifying what is expected of each person on an ongoing basis. This systematic approach has helped us to ensure reasonable success level. The broad base methodologies for Energy conservation are :



1) Management By Objectives :

a) Thrust areas/objectives for energy conservation are identified with active participation of the concerned plant personnel. The objectives include reduction in specific consumption of raw materials and improvement in productivity. Targets set for energy conservation are challenging yet reasonable as they are set in consultation with floor level engineers and managers, who are well aware of limitations, effort level required and the tools available to achieve such objectives.

b) The objectives are circulated to all concerned with delegation of authority and responsibility. The individual plant manager is encouraged for achieving the set targets, as they are the persons who are in actual charge of the plant and can get the things going in the right direction.

c) Day to day monitoring of the specific consumption of raw materials, as well as comparison of trend on weekly and monthly basis with budgeted norms, provides useful guidelines for necessary corrective action. This helps in bridging the gap between actual performance and the desired results.

d) An environment of motivation has been created in the company since its inception in 1982 by introduction of suggestion scheme and the same has been sustained. Suggestion scheme is one of the best managerial approach for inducing creativity in the minds of employees for energy conservation. The employees are encouraged to give suggestions for energy conservation in their area of work or any area where they feel energy can be conserved without hampering productivity level. The employees are given cash award for each implemented suggestion to a maximum limit of Rs. 11,000/- on 15th August or 26th January by the Managing Director.

e) Our engineers and managers are visiting other similar fertiliser units, where they can share knowledge, have close look of the new technologies and pick up few ideas of energy conservation which can be implemented in GNFC. Similarly participation in energy conservation seminar also benefits the company.

2) <u>Reliability building measures</u> :

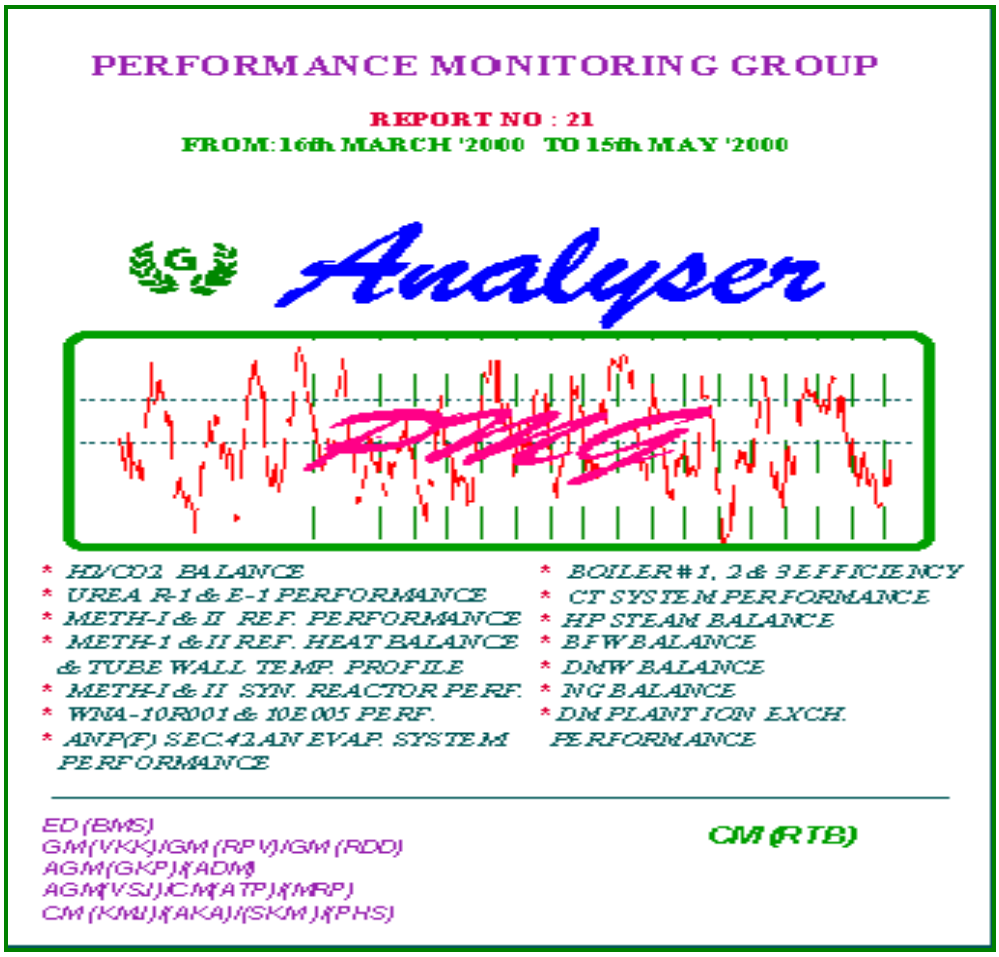
It is known that mostly increase in specific consumption of raw materials and thereby higher energy requirement is due to unwanted interruptions in operation. In **GNFC** most of the interruptions/ abnormalities occurring in the plants are systematically studied in detail through interactions and discussions with production, maintenance and other concerned departments. This trouble shooting helps in increasing the reliability of the plants as well as potential savings in energy consumption.

<u>FORMAT OF TRIP/ABNORMALITY REPORT</u>

- Date and time of interruption.
- Observations
- Reason for the interruption.
- Downtime in hours.
- Production loss in metric tonnes.
- Remedial measures proposed.

3) <u>Performance Monitoring of Key equipments and Operational changes :</u>

Performance monitoring of major energy consuming equipments always helps in judging their performance, taking corrective action as well as in building trend of parameters.



Various in-house programmes have been developed to monitor the performance of cooling towers, rigorous heat balances in reformer, conversion efficiency of various reactors, compressor efficiency, boiler efficiency, waste heat boiler heat balance, energy consumption in evaporators etc. The same are used to reduce the energy consumption by minor operational changes.

4) <u>Utility Audit :</u>

The objective of survey and auditing of various utilities consumption is to track the requirement of each utility at grass root level and identify the areas where utilities are not utilised properly. In GNFC, monthly auditing of all major utilities like instrument air, plant air, steam, boiler feed water, DM water, natural gas etc. is carried out. Also lube oil audit, surveys of steam leakages, insulation, etc are done to minimise the losses.

5) Minor modification schemes :

A major savings in energy consumption can be achieved by implementation of minor modification schemes. In GNFC, energy conservation schemes evolved out of suggestions of employees as well as generated in-house from various plants are studied in detail by our own **"Technical services"** department. The schemes having potential for energy conservation as well as improvement in environment are successfully and safely implemented after processing thoroughly by in-house **HAZOP group.**

6) On-line maintenance techniques :

The most popular technique of attending the on-line leakages is also practised at GNFC and as far as possible steam, gas and utility leakages are attended on line by providing box, clamp or furmaniting method. Spare equipment/pumps are always kept in healthy condition with regular change over. Use of cold welding compound has also been successfully tried at GNFC. These techniques help to reduce interruptions and thus increase productivity.

3.0 Schemes for Energy Conservation :

As a result of adopting various energy conserving strategies, a number of schemes have evolved and after due scrutiny, most of these schemes have been implemented. Some of the Energy conservation aspects adopted by GNFC are :

EVALUATION FORMAT FOR ENERGY CONSERVATION SCHEMES

- Project/scheme number
- Current energy used in Kcal/Mkcal
- Description of energy saving scheme
- Calculated energy savings in Kcal/Mkcal
- Annual net savings in rupees
- Investment cost in rupees
- Pay back period in months

a) Various novel methods are tried to improve quality of cooling water namely, super magnet (Magnegen) application, use of propriety and in-house cooling water treatment formulations, achieving 5.0 cycles of concentration. Use of hollow FRP blades for cooling tower fans in all plants of GNFC, saving @ 30% of power. Addition of cooling tower cell in ammonia, urea, and methanol-II plant. Change of packing/fill material carried out in formic acid plant cooling tower. This has helped in improved performance of CW system at elevated load.

b) Pumps and control valves are examined critically to check energy loss by way of pressure drop across control valve.

c) Most of the street lights and plant lights are converted to sodium vapour lamp which also saves energy.

d) We have absorption refrigeration system for generation of 2800KWS of refrigeration in ODDA section of nitrophosphate unit and lithium bromide vapour absorption unit for refrigeration requirement of acetic acid as well as new CNA unit. This saves lot of

energy as steam used is very nominal 5Kg/TR and there is no major mechanical maintenance due to absence of moving machinery.

A summary of major energy conservation schemes implemented in GNFC in the year 1998-99 as well as major technical innovations implemented which have resulted in energy savings are enclosed at Annexure-I.

4.0 Proposed Revamp plans :

Ammonia Plant :

1) Installation of third gasifier train to improve production and reliability of plant.

2) Improvement in performance of high speed turbines and compressors for energy saving e.g BHEL, Hyderabad make CO_2 compressor and nitrogen compressor.

3) Series S-250 (S-200+S50) basket for ammonia synthesis. Approximately 0.3 Mkcal/MT energy is expected to be lower. Offer from Haldor Topsoe is under study.

4) Revamp of refrigeration compressor by GHH, Germany which is partly implemented.

Urea Plant :

1) To improve the capacity and to reduce energy consumption (pre concentrator, deep hydrolyser, ammonia and carbamate preheating), end to end survey has been conducted by Siirtec Nigi Italy.

Methanol-II Plant :

1) Debottlenecking of methanol-II plant study given to Toyo Engineering Corporation, Japan to increase the plant capacity from 300 MTPD to 400 MTPD.

Acetic Acid Plant :

1) Agreement for supply of technology with B.P. Chemicals, U.K. have been signed for increasing the capacity of existing plant from 50,000 MTA to 100,000 MTA.

ANP Plant :

1) During the production of ANP, due to solid handling, some times lumps and off-spec material gets generated. The problem becomes more severe during monsoon because of material being hygroscopic. Off-spec recycle scheme is almost over and will be commissioned soon.

2) Debottlenecking of ANP capacity is under active consideration.

3) Wet scrubbing system for ANP and CAN plants to further reduce SPM level in the off gas going through stack.

Steam and power generation plant :

1) Additional chimney for BHEL boilers to improve boiler performance.

2) Small capacity steam generation facility based on coal as fuel.

5.0 Recognition for energy conservation schemes :

Our efforts towards energy conservation has also been recognised at national levels and we have won following awards from government of India and other statutory bodies :

1)	Ministry of Power, Govt. of India	2nd Prize	1990
2)	Gujarat Electricity Board		1992
3)	Jawaharlal Nehru Memorial National Award		1992-93
4)	Ministry of Power, Govt. of India	Commendation Certificate	1993-94
5)	Ministry of Power, Govt. of India	1st Prize	1995-96
6)	Ministry of Power, Govt. of India	2nd Prize	1996-97
7)	International Greenland Society	Gold award	1996-97
8)	Ministry of Power, Govt. of India	Cert.of Merit	1998
9)	Federation of Gujarat Industries	Excellence in Energy Conservation	1999

6.0 Future planning and conclusion :

1) Use of advance technology which is energy efficient and environmental friendly for new projects.

2) Advance instrumentation and DCS system.

3) Use of co- generation principle for meeting power and steam demand.

4) Use of by products and waste material to make value added product.

7) Recycle of effluent in nitrophosphate and reuse of treated effluent in other plants.

8) Identification and implementation of water conservation schemes.

9) Adoption of energy conservation measures at the project stage itself.

Any energy management programme followed by strategic planning, dynamic action plan and continuous monitoring along with top management support would result into good success.

Annexure-I

Schemes implemented for Energy Conservation : Year 1998-99 :

Sr. No.	Description of the scheme	Annual saving (Rs. Lakhs)	Cost of the scheme (Rs. Lakhs)
1	**CO2 enhancement scheme :** This was from process engineering point of view, one of the most complex scheme which was completely engineered and implemented by in-house efforts during the year. A scheme was generated to recover CO_2 from waste CO_2 going to atmosphere. This scheme was implemented in Nov.'98. Additional 3000 Nm^3/hr of pure CO_2 at low pressure is generated, which is supplied to ANP plant. Ammonia absorption efficiency in ammonium carbonate synthesis section of ANP plant has improved and perennial CO pollution problem of ANP plant is also solved. This scheme has also helped to improve urea production.	206.00	300.00
2	**R-401/402 Parallel scheme to increase on stream days of Ammonia Production :** We had three CO shift convertors in series containing Co-Mo catalyst. Due to impurity settled on catalyst, it use to increase the pressure drop, however catalyst activity remains almost normal. At every 4 to 5 months we had to open the reactor and partially screen & replace CO shift catalyst to bring down the pressure drop which required shut down of 5 days for ammonia and all downstream plants. After detail study modification in the piping loop of these three reactors was carried out. First two reactors were made parallel and third one remained in series. Henceforth a shut down after 4 to 5 months is eliminated, thus higher productivity is achieved for ammonia and downstream plants.	310.35	956.00
3	**On line blocking of Revex battery with innovative idea averting 7 days Ammonia plant shut down :** In ammonia plant in January'99, there was a major anxiety due to revex battery E-101B of air separation unit leakage. The blinding of the battery required the shut down of 7 days which was avoided by arresting the leakage successfully by preferential choking of the air path of E-101B.	271.55 (One time saving)	Nil

1 lakh = 100, 000 rupees (≈ USD 2, 500).

Sr. No.	Description of the scheme	Annual saving (Rs. Lakhs)	Cost of the scheme (Rs. Lakhs)
4	**Supply of SGGU gas to Methanol-II Plant :** The scheme is put in operation in Sep.'98 and has helped to increase methanol-II production by 15-20 MTPD. This scheme has also offered flexibility of operation and effective utilisation of SGGU capacity.	120.00	92.00
5	**Recirculation of DM Water used during Gasifier R-201B heating and cooling down in Ammonia Plant :** During start up of gasifier, we are draining DM water for a period of 6-10 days depending on the maintenance job carried out in the gasifier. We are also draining D.M. water during cooling down of gasifier. A new scheme was prepared to recirculate D.M. water. Expected saving of D.M. water is @ 30000 m^3/year.	6.30	8.97
6	**Pumps bearing/jacket C.W. outlet return to C.T. basin in Ammonia Plant :** To reduce load on effluent in SA-1 pit, cooling water drains of pumps P-202A/R, B/R. P-1001 A/R are connected to cooling tower basin. A separate header of 6" was laid. After observing the performance the same will be extended for other pumps	10.00	1.19
7	**Clarifloculator sludge recycling by blending with rock :** Phosphate bearing sludge form ETP is dried and blended with rock. This results into recovery of nutrient P_2O_5. Same is done on trial basis and approx. 40 MTs of sludge has been recycled	1.21	Nil
8	**Sewage Water treatment :** A scheme for utilisation of sewage water after primary treatment as a cooling tower make up was implemented in urea plant. After gaining experience the same will be implemented for ammonia and other plants. This will save @ 1000 m^3/day of water.	23.10	3.55

Sr. No.	Description of the scheme	Annual saving (Rs. Lakhs)	Cost of the scheme (Rs. Lakhs)
9	**Use of utility air in Air separation Unit of Ammonia Plant :** Presently, 10,000 to 12,000 Nm^3/hr of utility air is being supplied to air separation unit (ASU) of ammonia plant from new ATLAS COPCO centrifugal compressor, through existing pipe lines. Old reciprocating compressors have been stopped. There is a additional 20-25 MTPD of ammonia production.	51.26	Nil
10	**100 % coal firing in 3 nos. of BHEL Boilers :** With installation of visible light scanners in BHEL boilers, 100% coal firing without oil support is made possible. This helped to save 4130 KLs of LSHS as a supporting fuel in BHEL boilers during the year.	360.00	79.00
11	**Use of imported coal in 3 nos. of BHEL Boilers :** The indigenous Indian coal has ash content of @ 40% and calorific value of @ 4000 Kcal/kg. As against this, the imported coal is having ash content 15% maximum and calorific value of @ 6000 Kcal/kg. Thus, a drastic reduction of 60% ash generation in BHEL boilers equivalent to 375 MT/day has been achieved from Dec.'97 onwards.	Reduction in ash gen. by 375 MT/day	-
12	**Use of micro processor based controllers in Electrostatic Precipitators (EPs) in BHEL Boilers :** Microprocessor based controllers were installed and commissioned in EPs of 3 nos. of BHEL make boilers to reduce emission levels and to save energy. Primary aim of the scheme is to reduce emission level but it also helps for energy conservation in the form of electrical energy due to precise controlling action.	16.25	75.00

Sr. No.	Description of the scheme	Annual saving (Rs. Lakhs)	Cost of the scheme (Rs. Lakhs)
13	**Recycle Products Belt conveyor 36W004 modification in ANP Plant :** In ammonium nitrophosphate (ANP) we were facing the problem of 36W004 belt conveyor failure thus resulting into plant stoppages at an interval of 30~40 days repetitively since commissioning. The type of failure was continuous spillage of material and tearing of the belt along the length which was mainly due to nature of product, and because of granules being trapped between skirt and belt. Apart from maintenance cost of Rs. 2 lacs/year, production loss of @ Rs. 20 lacs/day was occurring. It was observed that high speed of the belt (1.5 mtr./sec) along with specific nature of the product was resulting into conveyor belt failure. After due analysis, belt speed was changed from 1.5 mtr./sec to 0.8 mtr. /sec and belt width increased from 800 mm to 1000 mm.	60.00	5.50
14	**Installation of Acoustic horn to reduce high vibrations in 50K003 blower in CAN Plant :** In calcium ammonium nitrate (CAN) plant, we were facing problem of high vibrations in the blowers namely 50K003 (Fan for drying drum) and 50K007 (Cyclone exhaust blower). The main reason for the vibrations was found to be dust deposition inside impeller vanes causing unbalance and high vibrations. This necessitated plant stoppages and caused a downtime of 154.98 hrs in the year 1997-98. As an innovative measure an acoustic horn was made fully operational within one month from the date of installation. Its performance can be judged by the fact that, only on one occasion CAN plant underwent shutdown due to high vibration in 50K003 on 30.05.99 with total downtime of 3 hrs only.	30.00	1.00

Sr. No.	Description of the scheme	Annual saving (Rs. Lakhs)	Cost of the scheme (Rs. Lakhs)
15	**Improvements in Lime Drying Unit to reduce emissions and increasing continuity of operations in CAN Plant:** We were facing problem of higher stack emissions connected with Lime Drying unit (LDU) bag filter. A significant breakthrough was achieved with the help of innovative technique by installing expanded PTFE membrane laminated bags which is the latest concept and breakthrough in the filtration technology. This has helped us to bring down the emission levels below 100 mg/Nm^3 most of the times, increase continuity of operations, minimizing number of interruptions and reducing maintenance considerably.	2.33	25.00

Few schemes which are currently implemented and have given benefits includes,

1) Installation of steam injection nozzles in ammonia water bath heater E1002 to maintain the temperature of liquid ammonia. The scheme was implemented at the cost of Rs.5.0 lacs thereby saving cost of new equipment worth Rs. 100 lacs.

2) Improvement in the performance of methanol- water tower T505 in amonia plant by changing the reflux tray location and some minor modifications, costing Rs. 3.0 lacs, thereby saving 40 MTs of methanol and avoiding capital expenditure of @Rs.25~40 lacs for packing replacement. It also improved effluent quality as methanol in effluent got reduced to 300~400 ppm from level of 7500 ppm.

3) In urea plant ammonia feed pump P801, was having oil as sealing fluid. Its capacity was also limited which required three pumps to run at higher load. Modification was done to increase the capacity as well as change the sealing system from oil to DM water. This saved power and oil considerably.

4) To start methanol I and SGGU plant ahead of ammonia plant, HP N_2 is required. The scheme was worked out to supply LP N_2 from NCPL and compressing in Methanol II plant This helped independent start up of both plants. Similar scheme was worked out to supply CO_2 to Methanol-I plant from Methanol II plant, which improved production level.

5) Gadkhol water supply pond was lined with impervious lining to reduce seepage losses of @ 35%. Total saving of water is ~10,000 M^3/D , valued at Rs.234 lacs annually. Cost of the scheme is Rs. 700 lacs.

6) Use of ejector in CNA plant in place of vacuum pump and DM water pump was replaced by inserting orifice in the supply line.