International Fertilizer Industry Association

IFA Technical Conference

Chennai, India

24-27 September 2002

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

PRODUCTIVITY IMPROVEMENTS IN MURUGAPPA GROUP'S PHOSPHATIC FERTILISERS UNITS AT VISAKHAPATNAM AND ENNORE (a)

N.Seetaram, Coromandel Fertilisers Ltd. and M.S.Srinivasan, EID Parry, India

The Chennai-based Murugappa Group operates two phosphatic fertiliser units viz. Coromandel Fertilisers Limited at Visakhapatnam and EID Parry (India) Limited at Ennore. The paper describes briefly about the unit and various modifications, retrofits carried out in the respective units to improve production much beyond originally installed capacities, energy conservation and environment management.

Murugappa Group is South India based Corporate, having a turnover of 1000 million US dollars, with a variety of product range namely: fertilisers, pesticides, engineering products, confectionaries, agri products and financial services. The main plants in fertilizer business are Coromandel Fertilisers Limited, Visakhapatnam and EID Parry Limited, Ennore, producing variety of phosphatic fertilisers including related intermediates.
Both the plants were incorporated more than 30 years ago, but had undergone various retrofits / modifications and currently are able to produce about 800,000 MT/annum with 100% capacity utilization. The paragraphs below describe the efforts put in by these units plant wise.

IMPROVEMENTS AT COROMANDEL FERTILISERS

1. Sulphuric Acid Plant

This plant was originally designed by Chemico, USA, and was commissioned in 1967 with nameplate capacity of 600 MT per day. At that time, based on the then predominant technology, it was designed as single contact single absorption system.

As the requirement for sulphuric acid increased, the plant was revamped to 900 MTPD in 1975 with DCDA technology for the first time in India. Though there were no problems with the main plant, over a period old serpentine type acid coolers, because of frequent shutdowns became a bottleneck. As the downtime caused by these acid coolers increased, it was felt necessary to change to a new type of coolers. Coromandel was the first in India to use anodically protected cooler supplied by Chemetics of Canada. This happened to be the boldest decision ever made by Coromandel in capital investment and really changed the picture of entire fertilizer complex. The downtime due to cooler leaks, which used to be about 70 days in a year, has come down to zero. With increased availability of acid, there was pressure on down stream units of phosphoric acid plant and granulation plants and provided impetus to

Email: seetaram-n@murugappa.co.in
srinivasanMS@murugappa.co.in

(a) received on: 02/07/02

improve performance in those units as well. We are proud to say that IAC cooler, which was installed in 1987, has not experienced a single tube leak so far.

As the down streams caught up and acid demand increased further, the plant was revamped to 1200 MTPH in 1994 with a new converter and high volume of ring shaped catalyst. The converter and certain gas coolers were changed to meet new capacity requirement. The revamp was smooth and no difficulty was experienced in achieving the capacity.

Coromandel was also the first in India to install an environment friendly molten sulphur facility even though this involved additional capital investment. Today more than 80% of sulphur requirement is met by molten sulphur and handling of much problematic solid sulphur has been minimized. For this purpose, we installed storage tanks having a total capacity of 15000 MT (2 x 7500 MT) so as to enable us to receive ships up to 10000 MT.

To be in line with modern times, the control system of sulphuric acid plant has been changed to Distributed Control System.

Emission levels allowed for Coromandel has always been much less than those prescribed for other plants and/or by MINAS. The following table gives the picture of emission levels allowed for Coromandel vis-à-vis to other plants by MINAS.

Permissible levels of SO_2 (Kg / MT of H_2SO_4)

By MINAS	For CFL
12	4
4	2
2	1.5
1.5	1.0

Coromandel is always responsive to meet the standards set by authorities. Presently, we are using about 340,000 liters of catalyst in our converter and able to meet the standards. Our present SO_2 emission level is around 180-200 PPM as against allowed 224 PPM.

2. Phosphoric Acid Plant

The Phosphoric Acid Plant, designed by Dorr-Oliver, USA and commissioned in 1967 with name plate capacity of 255 MT per day of P_2O_5, is based on dehydrate process with single tank reactor having annulus and central compartments and a separate filter feed tank arrangement. The cooling system of reactor slurry, as per original design was based on air cooling mechanism and involved, part of heat removal by dilution of sulphuric acid from 93% to 77% concentration, cooling it in a graphite heat exchanger and the remaining part by an air swept cooling mechanism.

The plant is provided with a 24-B Bird-Prayon rotating tilting pan filter. The plant is now able to produce about 450 MT per day of P_2O_5, in spite of the fact that it is 33 years old and many times won the award of the best operating phosphoric acid plant in India from Fertilisers Association of India. A number of additions, modifications in equipment and operating practices were introduced over a period to sustain and improve the capacity of the plant which is pointed out below:

2.1 Rocks

This plant traditionally operated with single rock source for more than 25 years. The plant used to be operated with Florida rock of 72 BPL of IMC origin. However, with depletion of high-grade rocks, Coromandel was forced to look for alternative sources. It is to be borne in mind Coromandel's Phosphoric Acid Plant is designed for low chloride operations with agitators of SS 317L and pumps of Cd 4M Cu and/or alloy-20. This limited the choice of rocks and we could not process the relatively abundant Morocco and Jordan rocks thus narrowing down our choice to Senegal rock. We found the Senegal rock a good substitute for some time. However, with decreasing quality of Senegal rock over a period and for obvious commercial reasons, usages of other rocks were also explored. In this process, we identified Nauru and Chinese rocks can also be used in our plant. These latter two rocks, being relatively coarse compared to Senegal and since we have grinding and reactor slurry cooling limitations, are being used as a mix with base rock of Senegal rock. This exercise has helped us to eliminate single source dependence and gave us much needed commercial leverage.

2.2 Rock Grinding Section

To supply the necessary ground rock, the original design provided a rock grinding section with air swept closed circuit ball mill, supplied by Kennedy Van Saun, USA. The mill was designed for 40 MT per hour to produce 60% minus 200 mesh product. Various modifications were carried out in this section to improve throughput and these are enumerated below:

- The grinding section was first modified from the original closed circuit operation to open circuit to increase throughput. Though this decreased the fineness of the ground rock from earlier 60% minus 200 mesh to 45% minus 200 mesh, it was found not to be a limitation.
- Once we had gone for open circuit, as there was no real advantage of any classification, we removed the internals of classifier as it was found to be offering substantial resistance. This helped in increasing the air handling capacity of the mill fan, improving the capacity of the mill and reducing the downtime caused by mill system plugging.
- Mill internals were changed from original lift type to classifying type liners. Though the improvement was not to the extent of envisaged increase of 5 MTPH, it did increase the capacity by about 2 MTPH.
- As the demand for ground rock increased and the necessity of using different rocks became unavoidable a small new ball mill of 20 MTPH was added to the existing one. To minimize the capital cost, an open circuit mill with an elevator lifting the product was adopted.
- Since air lifting of old mill product used to consume lot of power, we changed this mill to elevator lifting type (similar to new mill) thereby reducing power consumption and minimizing all downtimes caused by plugging in classifiers and cyclones associated with airlift type.
- Unground rock feed system with series of conveyors and elevator was replaced with a higher capacity, single belt conveyor. These eliminated frequent shutdowns of ball mill caused by unground rock availability and improved the on-stream factor of the mill.
- The mill feeder, which used to be with a fixed speed drive in the beginning, required operator interference to change the load to mill. Since this was a little far away from control room, it used to take time to affect the changes in mill load. This was changed to a variable speed so that operator can fine tune the load from control room itself.

- Operating control philosophy, which used to be generally of 60% minus 200 mesh is now changed to not more than 5% plus 35 mesh. This has also helped in increasing the grinding throughput.

2.3 Dust Transfer System

Rock grinding system at CFL, unlike in most other plants, is situated far away from main phosphoric acid plant. The original design envisaged pneumatic conveying by Fuller-Kinyon screw pump. There was no installed spare and capacity of the pump was also limited. To improve the situation, a blow tank system with higher capacity was added. Old dust pump was also changed to a better designed, higher capacity and served as a standby. These two changes though helped in increased ground rock transfer rate, when operating, were found to be highly power consuming in addition to their regular maintenance requirement. The reliability of these systems was also not to the desired extent. Accordingly, a closed belt conveying (pipe conveyor) system was employed in the recent past. We find the system highly power saving compared to earlier operations and also environment-friendly eliminating dust nuisance associated with pneumatic conveying.

2.4 Reaction Section

- Since slurry temperature control was based on air cooling arrangement, it was always a limitation with higher loads. Over a period, we experimented with high slurry temperature operation. We found that Florida and Senegal rocks can withstand a temperature of 90 plus, still remaining in the dehydrate region. We took advantage of this phenomenon to increase the loads.
- Further, at the time of renewal of dilution cooler, we went for a higher capacity cooler. Simultaneously, we increased the dilution of sulphuric acid from 77% to 70%. This helped us to remove about 2 million Btu outside the reactor and helped in containing the temperature.
- With air cooling arrangement and unavoidable splashing of slurry inside the reactor, there used to be heavy build-up on walls and roof of the reactor affecting the ventilation of the reactor. In original design, there was no provision to clean the build-up when the plant was in operation. Unable to clean the build up, there used to be heavy fumes from the reactor. This used to force us to reduce the quantity of cooling air thereby limiting slurry cooling. We used to operate only 3 nozzles in place of 5 available. We modified the cooling in nozzles such that we could get access to clean inside build up of reactor. By being able to clean the scales and build-up, while in operation, we could improve the ventilation of the reactor, which in turn permitted us to put more and more cooling air finally reflecting in reduced slurry temperature.
- Since efficiency of air cooling depends to a great extent, on the gap between slurry level and tip of the air nozzle, we installed a gate at the exit of slurry overflow nozzle to precisely control this gap. This helped in increased pick up of heat for the same quantity of air.
- Further, when old cooling air fan was due for replacement, the same was replaced with a fan of higher capacity to improve the cooling further.
- When the dilution cooler was replaced with a new one, the old one was repaired and kept as installed standby. Now both coolers are in parallel operation. This has helped us to remove more heat outside the reactor and also enabled us to feed more sulphuric acid, which used to be a limitation with single dilution cooler.

- With these modifications, the temperature of slurry is no longer a limitations and we are able to maintain the same at around 82 – 84°C (compared to 92–94°C of earlier operation) even at increase plant loads of almost up to 500 MT per day.
- Filtration Section:
- This section essentially remains same as the original design except for the fact that the entire filter was renewed in 1986 with sloped bottom pans. Various modifications carried out in this section are as follows:
- Though the original filter was provided with three wash systems, over a period of operations, not much difference was observed between 2 and 3 washes. Accordingly, distribution boxes were relocated such the mother liquor area is increased to take of increased plant loads and help in proper control of solids ratio in reactor slurry.
- With the above modification, the unused filtrate pump enabled to modify filtrate pumping circuit to provide a dedicated spare for #1 filtrate and #2 filtrate pumps. This has helped to reduce the downtime caused by much problematic filtrate pumps.
- In the recent past, when filter pans developed cracks on the bottom plate and reduced vacuum affecting filtration rate and plant load, we purchased twice the numbers of spare pans. With these, we replaced all pans one after the other after carrying out the necessary repairs / welding.
- The practice of keeping filter clothes till they are plugged has been changed to renewal of the same on fixed time scale. At present, we change them every month at the time of planned shutdown at which time various pending maintenance job are also taken up.

2.5 Evaporation Section

The original plant was provided with only two evaporators. However, over a period, three more evaporators are added to meet the demand of the concentrated acid. These evaporators are operated in two parallel streams of 2+3 to facilitate necessary flexibility in feed, product acid and transfer lines. Various modifications were carried out in this section.

- Earlier for the sake of flexibility all evaporators' feed lines and product acid lines were interconnected so that any evaporator can be operated in any sequence. However, this never served any purpose because of the passing of valves and plugging of unused portions of pipelines. Piping modifications and simplifications were carried out during one of the annual turnaround. This helped in easy identification of problems, avoiding mixing of weak and concentrated acid, etc.,
- A redundant control valve on common steam line was removed to reduce the pressure drop and increase the steam flow.
- The low pressure steam from exhaust of sulphuric acid blower turbine, which was the heating media for evaporation, used to be at superheated condition at the battery limits of evaporator section. To improve heat transfer and to maintain the steam temperature within the limits of graphite material specifications, a desuperheating station was provided.
- Earlier they were no steam chest pressure indicators. Now all are provided with pressure controllers, which can be observed from control room. This has helped to maintain condensing steam pressures within the design limits, eliminated frequent lifting of relief valves and to know when the calendria is due for scrubbing.
- The scrubbing and cleaning practice of calendria tubes has also been changed. The earlier practice of cleaning with rods has been stopped. A portable high pressure hydro blast pump is now used to manually clean the tubes. This has definitely helped in minimizing the breakage of tubes due to roding.

- The ejector used for vacuum generation are now being replaced with vacuum pumps as we find lot of steam energy saving. The payout of this modification is found to be less than a year with annual savings of about 1.5 million rupees (circa USD 30 000) /annum/evaporator.

2.6 Fluorine Recovery Unit

There was no fluorine recovery in the original design. As a measure to reduce pollution load on effluent treatment and recover valuable by-product, this unit was installed in 1994. Fluorine, evolved during concentration of acid from 28 to 48% is absorbed in spray tower and recovered as 20-21% H_2 Si F6. It is sold to an aluminum fluoride manufacturer.
We resort to addition of silica to evaporator feed acid to improve the yield of hydrofluosilicic acid. This not only improved the production of acid but also correspondingly reduced the lime requirement for neutralization of the effluent.

2.7 Effluent Treatment Unit

Coromandel, being situated in a water scarcity area, used seawater extensively for scrubbing, condensing and gypsum pulping. The water is kept in closed circuit with gypsum pond serving as settling and cooling pond.
The bleed of steam is neutralized with lime and the pH is increased to about 9 to 9.5 at which level most of the fluorine and P_2O_5 bearing compounds precipitate as insoluble ones. These are settled in delay pond and the final effluent is maintained within limits stipulated by the pollution control authorities.

3. Complex Plant

The plant was originally designed by Wellman-Lord, USA for urea based 20-20-0 grade and was commissioned in 1967. Based on pilot plant trials carried out by IFDC, the plant immediately switched over to high analysis grade of 28-28-0 and has been our main and premium product for about 25 years. However, in line with market demands Coromandel streamlined manufacturing the following grades over a period.

28-28-0 (Urea-Ammonia-Phosphate)
14-35-14 (Potash-Ammonia-Phosphate)
20-20-0 (Ammonia-Sulphate-Phosphate)

The plant, which was designed for 300,000 MT per annum, is now producing about 600,000 MT per annum.

To achieve this, the granulation plant, which was originally provided with two trains, is augmented with a third train based on INCRO, Spain, technology in 2000. This train is designed for 100% production with pipe reactor to conserve on fuel energy. It is provided with a good scrubbing system involving dual mole ratio, dedusting and a final tail gas scrubber with ammonia in stack being less than 50 PPM. We are currently producing 20-20-0 and14-35-14 grades in this train.

Since the old trains were designed for low level of ammoniation, scrubbing system became a bottleneck when we switched over to high analysis grades. Further, to improve good house keeping, we completely revamped the scrubbing system of two older trains with the design supplied by Thermax. This also involves 4 stages scrubbing of dedusting, dual mole ratio scrubbing with a final tail gas scrubber. With this, we are able to contain ammonia escape through stacks below 100 PPM level compared to 600 PPM prior to revamp. No liquid effluent is let out of the factory. All waters coming from pump seals, washings, overflows etc., are collected in a pit and taken back into the process which not only minimize environmental degradation and also help in recovering valuable nutrients.

4. Other Sections

We used to operate both the ammonia and urea plants earlier. But with increased cost of naphtha and cheaper imports, these plants became unviable and we had to take the decision of closing down these units. Accordingly, we quickly installed an atmospheric ammonia storage tank to receive imported acid and closed down our ammonia and urea operations. We were earlier provided with 2 Horton spheres for storing ammonia. However, these were more than 30 years old and posed potential hazard. Accordingly, we took the decision of dispensing with a much safer atmospheric storage tank. We installed one more atmospheric ammonia storage tank and decommissioned our older Horton spheres. Both the ammonia storage tanks are based on design supplied by UHDE and are of double walled double integrity type.
As imported ammonia is cheaper, we undertook an ammonia unloading pipe line project to directly transfer ammonia from ships to storage tanks. This involved a pipe line of about 6 kms and associated facilities.

Earlier, the plant was heavily dependent on state grid for electricity and was exposed to vagaries of erratic supply of power by the state distribution network. There used to be a number of breakdowns, affecting various critical equipment in ammonia and urea plants, which were operating at that time. The management took a decision of becoming independent of these uncertainties and over a period installed diesel generators of 2 x 4 MW, 1 x 6 MW (operating on LSHS). This was in addition to the existing turbo generator of 5 MW. This decision has helped us to be practically insulated from erratic supply of state grid. With closure of ammonia and urea plants, we became self-sufficient with respect to power and no longer dependent on grid supply.

With the closure of the ammonia and urea plants, the demand on steam came down drastically and criticality of supporting with alternative source also had gone. Accordingly we stopped our utility boilers completely and were able to conserve on LSHS. The excess HP steam available in the sulphuric acid plant is now used in turbo generator for power generation.

The closure of ammonia and urea plants also greatly reduced the demand of sea water used for various cooling operations. This has also helped us in optimizing the seawater usage and reducing pumping energy equipment.
In line with modifications in various plants and other sections, the bagging plant was also revamped and is now provided with automatic bagging machines with improved output and optimized usage of manpower.

5. Summary

In essence, the success of Coromandel, which has been adjudged frequently the best operating plant in India by Fertilisers Association of India can be ascribed to the following:

- Constant efforts for possible improvements
- Adoptation of latest technologies
- Proactive decisions
- Judicial equipment replacement philosophy
- Continual improvements in operating practices

IMPROVING PRODUCTIVITY AT A PHOSPHATIC FERTILIZER PLANT EXPERIENCE OF EID PARRY INDIA LIMITED

1. Background

EID Parry has a complex fertilizer plant at Ennore, near Chennai. This plant has the distinction of being the first chemical fertilizer plant in the private sector in India and commenced operations in 1963. In line with technological status at that time, an integrated plant with following configurations was set up:

Unit	Capacity, TPA
Complex fertilizer grade 16:20	52000
Ammonia	11000
Phos acid , as P2O5	11000
sulphuric acid	54000

Over the years 1963-75, the unit performed well and the product had established as a niche product for basal applications in the South Indian market. However with the post oil crisis of the late 1970s, the unit was plunged into a difficult situation as the ammonia plant became unviable. Further, attempts at diversifying the product base by getting into production of ammonium sulphate using by product phosphor-gypsum failed due to unreliable plant operations.
Post 1980s, the Murugappa Group acquired the unit and bold decisions to restore viability were taken such as:

- Stopping ammonia plant operations
- Scrapping the ammonium sulphate plant
- Strengthening the complex fertilizer plants by renovation/ replacement of equipment.

The efforts gave good results and the unit returned to profitability in the late 1980s.
The Management at that time evaluated the future and saw that the Subsidy regime may end in the near future and that to survive in a globally competitive manner, significant productivity improvements are needed. Accordingly, significant capital expenditure was incurred and the unit was modernized to reduce costs and to increase capacities. This resulted in the unit becoming one of the lowest cost producers of phosphatic fertilizers. The details of the modernization and the results achieved have been dealt with in a paper elsewhere.

2. Further Improvements in Productivity Enhancement

This paper deals with the efforts taken subsequently in furthering the gains. Three examples are given to illustrate the work taken up. These are:

- Reducing the power cost by captive generation using by product steam in a sulphuric acid plant
- Optimizing the operation of the desalination plant by systematic de-bottlenecking
- Reducing maintenance costs by systematic root cause analysis and problem solving.

As can be seen in line with the external business reality of excess production and limited demand for finished product, our focus has shifted from production increase to cost reduction.

3. Captive Generation of Power

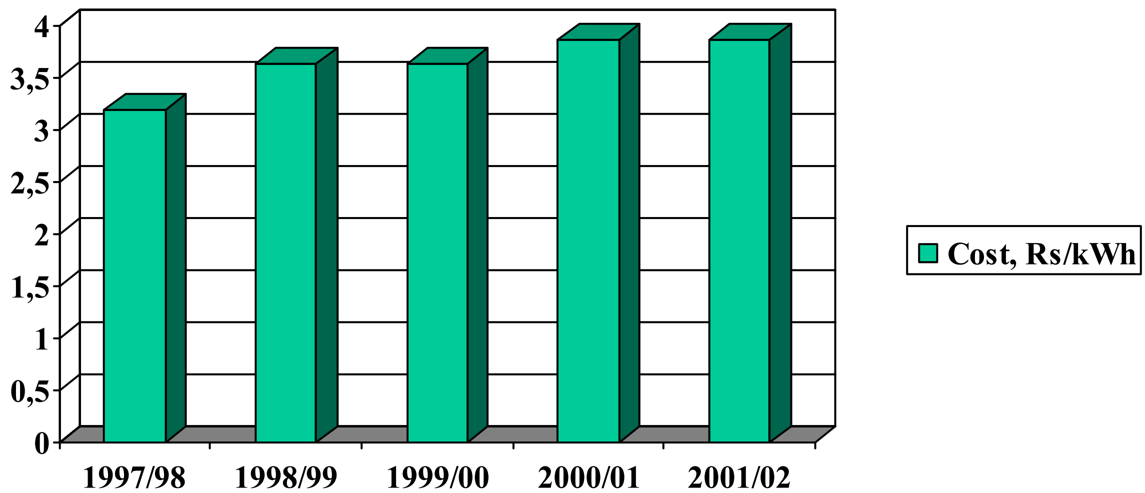
There are two sulphuric acid plants at the site. Both are sulphur burning plants and have 300 tpd and 400-tpd capacities respectively. The older plant is the 300 tpd and the second 400-tpd plant was set up in 1995.

a. The 400-tpd plant is based on 40-bar steam circuit and the steam is mainly used for running the process air blower. Excess steam is used in a turbo alternator to generate power. The design is such that after start up, the plant is fully self-sufficient with respect to power and does not need to import any external power. In this way, it is protected against any grid disturbances. The turbines are of backpressure type and the exhaust steam is taken to the desalination plant nearby. This is a Multiple Effect Distillation unit based on sea water and pure boiler feed quality water is generated at an economy ratio of nearly 6.0

b. So far as the 300-tpd plant is concerned, the original design also had a backpressure turbine driving the main air blower. The steam system was of 26-bar design and additional steam was used for process heating elsewhere in the complex. The exhaust steam from the turbine was condensed in air-cooled condensers and condensate was returned to the plant. Air-cooled condensers were chosen over other options in view of acute water shortage at site.

c. With ever increasing electricity tariff rates, it was realized that it is profitable to convert the turbine driven blower to an electrically driven blower and utilize all the steam in a condensing type turbo alternator to generate more power. Fig 1 refers to for the electricity tariff increases that were experienced at the site.

Fig 1 Trend of Power Cost Increase



d. The steam balance diagram as it existed and as proposed is shown in Fig 2 and 3 respectively.

Fig 2 Steam Balance As Existed

Source		Use	
SAP1	14 t/h, 26 bar	Turbo blower	10 t/h
		Heating	4 t/h
SAP 2	21 t/h, 40 bar	Turbo blower	9 t/h
		Turbo alternator	8 t/h
		MED unit	4 t/h
LP avail	27 t/h, 0.5 bar	MED unit	9 t/h
		Air condenser	18 t/h

Fig 3 Steam Balance Modified

Source		Use	
SAP1	14 t/h, 26 bar	New TA set	14 t/h
SAP2	21 t/h, 40 bar	Turbo blower	9 t/h
		Turbo alternator	8 t/h
		Heating	4 t/h
LP avail	17 t/h, 0.5 bar	MED unit	13 t/h
		Air condenser	4 t/h

e. After detailed evaluation of several vendors, a final decision was made and the project started in June 2000 and was completed in Sept 2001. After start up, all design expectations were met satisfactorily and the unit is now producing as per design. There has been a reduction of nearly 60 kW/t of power in terms of the final product. The cost benefit of this retrofit is shown in Fig 4.

Fig 4 Cost Benefit of Power Plant

Capital cost, Rs million		Benefit	
Building	9	Power generated/year	13.5 million kWh
Turbo alternator	52	Less power used/year	4.8 million kWh
Electrical system	9	@ Rs 3.7/kWh, this equals	Rs 32 million
Utilities	10	Less other expenses	Rs 10 million
Air cooled condenser	20	PBIT	Rs 22 million
Total	100	Return on investment	23.6 %

4. Optimizing Performance of Desalination Plant

Mention was made earlier about the desalination plant attached to the 400 tpd sulphuric acid plant at site. This unit is a six-effect vacuum multiple distillation unit and is based on seawater. The exhaust steam from the turbo lower as well as the turbo alternator is used as motive steam to produce pure water. The unit was also started up in 1995 along with the sulphuric acid plant. However within a short period of operation, it became apparent that performance was not consistent. The output dropped over a period of time and physical inspection showed that the first effect tubes were getting scaled rather quickly. Descaling operations restored the output back to design level but within a short period again scaling occurred. After a few cycles it was noticed that even descaling did not have the desired effect of restoring the capacity fully. After extensive analysis of scales and the feed water quality, it was concluded that:

a. The input water quality varied very considerably from design levels. Investigation showed that there is a stream of wastewater from the neighborhood that joined the backwater upstream of where the seawater intake is situated. Thus the variations.

b. The most significant impurity was the presence of suspended solids in the feed water. This settled down on top of the scales in the heat transfer area causing fouling. The descaling arrangement was such that, the interior of the tubes could not be reached and therefore as time progressed, progressive deterioration had occurred.

Thus it was decided to completely strip down the internals during an available opportunity and do a physical cleaning. Further to avoid future problems, a recycle system was adopted to minimize intake of water. The design of the feed water reservoir was modified to improve the settling and thereby to prevent solids from entering the unit. As an additional measure, "in-line" filters were installed in the line feeding the heat transfer effects.

All these modifications were completed during a planned shut down of the unit. On start up, it was found that design performance could be reached. The unit is now in operation for nearly two months without any apparent loss of output as was experienced before. This has saved the unit the need to purchase water from the Municipal sources at a higher cost and the annual saving is estimated at about Rs 3 million, (Fig 5).

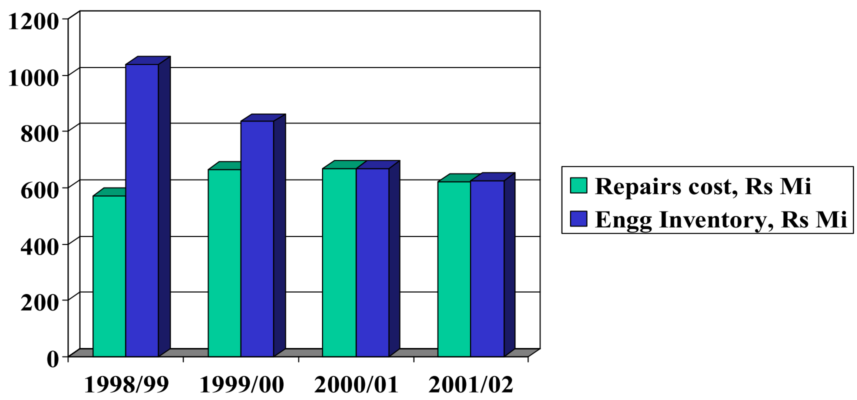
Fig 5 Cost Benefit of Revamp of Desalination Unit

- Capital investment Rs. 10.5 million
- Benefit
  - Increase in output from 40 m3/h to 60 m3/h
  - Reduction in sea water use by 350 m3/h
  - Total savings Rs 3 million
  - Return on investment 28.5 %

5. Reducing Maintenance Costs by Systematic Root Cause Analysis

It is the experience of nearly all plant operators that getting to the root of any failure of a component is made difficult by the absence of reliable failure history/ account of previous maintenance activity. This is especially the case with an old unit where over time people internalize the knowledge and documentation is not given adequate importance. However when either the technology or the key people change, continuity becomes an issue. Realizing this, the Company invested in an Enterprise Resource Planning (ERP) system in the year 2000. The Plant Maintenance (PM) module in particular was designed and implemented to capture on line, reliable information of component-wise failures and history maintenance. It is now two years since the system is in full operation and there are benefits in terms of reduce expenditure, lower inventory and less work for the maintenance crew. Root cause analysis is regularly done and the results are documented for every one to see and get trained. Over the intranet, discussion forums are held to gather views, collect observations and to refine the inspection schedules. Fig 6 shows the trend in repairs expenditure and inventory levels

Fig 6 Reduction in Repairs Cost and Inventory



6. Conclusion

With the continual pressure on margins in a competitive environment and with limitations to increasing sales, the focus of manufacturers has shifted to reducing costs in an effort to ride out the present recession. This paper gives a few examples of how this has been achieved in a complex fertilizer plant.

7. Acknowledgements

The authors wish to thank the Management of our Companies for the permission to present the paper. They would also like to thank their colleagues in the operations and technical services divisions for assistance in sharing the information on costs and savings as actually incurred/achieved.