

**PREFEASIBILITY PROJECT REPORT  
(PPR)**

**ON**

**ENERGY IMPROVEMENT PROJECT**

*Of*

**AMMONIA AND UREA PLANTS**

*By*

**MODERNISATION AND CAPACITY ENHANCEMENT**

*Of*

**AMMONIA FROM 2,47,500 t/y TO 3,28,500 t/y**

**&**

**UREA FROM 4,29,000 t/y TO 5,69,400 t/y.**

**JUNE 2016**

**MANGALORE CHEMICALS & FERTILIZERS LIMITED  
PANAMBUR, MANGALORE – 575 010.**

## **1) PREAMBLE**

Mangalore Chemicals & Fertilizers Ltd (MCF) is an 'Adventz' Group Company, a large and diversified business house. The main products of MCF are Urea, Di-Ammonium Phosphate (DAP), NP 20:20:00:13, Ammonium Bi-Carbonate (ABC) - Food grade, Sulphuric Acid, Specialty Mixtures of Plant Nutrients consisting of Water Soluble Fertilizers, Micronutrients & Soil Conditioners and an Industrial Product called Sulphonated Naphthalene Formaldehyde (SNF) used in construction industry.

MCF is the only manufacturer of chemical fertilizers in the state of Karnataka. The factory is strategically located at Panambur, 9 km north of Mangalore City, on the banks of the Gurpur River, along the National Highway 66, opposite to the New Mangalore Port Trust. MCF is an ISO 14001, OHSAS 18001 and ISO 22000 certified Company.

The main products are Urea, Di-Ammonium Phosphate (DAP), NP 20:20:00:13, Ammonium Bi-Carbonate (ABC) - Food grade, Sulphuric Acid, Speciality mixtures of plant Nutrients consisting of Water Soluble Fertilizers, Micronutrients & Soil Conditioners and an Industrial Product called Sulphonated Naphthalene Formaldehyde (SNF) used in construction industry.

While fertilizers and Plant nutrient products are marketed in all the Southern States and Peninsular India, the food grade ABC, which is used mainly in Confectionery Industries is marketed in domestic as well as international market. The requirement of power for the production facility (process plants) is met by a Captive Power Plant. Ammonia & Phosphoric Acid, the raw materials required for DAP & NP production are imported.

The consented capacity for the intermediates and products manufactured are as below:

| Sl. No. | Product                                | t/y      |
|---------|--|----------|
| 1       | Ammonia                                | 2,40,900 |
| 2       | Urea                                   | 4,19,750 |
| 3       | DAP & NP (16:20 & 20:20)               | 4,01,500 |
| 4       | Ammonium Bicarbonate (ABC)             | 24,750   |
| 5       | Sulphuric Acid                         | 1,46,000 |
| 6       | Sulphonated Naphthalene Formaldehyde   | 85,000   |
| 7       | Speciality mixtures of plant nutrients | 2,21,000 |
| 8       | Handling of imported fertilizers       | 4,00,000 |

Construction of Ammonia and Urea plants commenced in 1972 and commercial production started in 1976. Di-ammonium Phosphate (DAP) production commenced during 1986. Commercial production of Ammonium Bicarbonate started in 1982. Sulphuric Acid Plant was commissioned during March 2006. Captive Power Plant consisting of 8 Diesel Generators of 6 MW each were commissioned during 1986. The power plant has been revamped in 2012-2014.

A new construction chemical product Sulphonated Naphthalene Formaldehyde facility was installed in 2010 as part diversification. MCF also has installed a Speciality fertilizer plant to make Water Soluble Fertilizers & Micronutrients in 2011.

MCF Intends to modernize the present facilities in existing location at Mangalore.

**Energy Improvement Project of Ammonia & Urea Plants by modernization and capacity enhancement of Ammonia from 2,47,500 t/y to 3,28,500 t/y and Urea from 4,29,000 t/y to 5,69,400 t/y.**

## 2) NEED FOR THE PROPOSED PROJECTS

**Energy improvement Project of Ammonia & Urea plants by modernization and capacity enhancement of Ammonia from 2,47,500 t/y to 3,28,500 t/y and Urea from 4,29,000 t/y to 5,69,400 t/y.** : MCF intends to do energy improvement revamp of existing Ammonia / Urea plants. The revamp is necessitated due to recently announced new urea GOI policy No. 12012/1/2015-FPP dated 25-05-2015 on Urea. All Ammonia/Urea manufacturers are mandated to improve their energy norms to particular levels by 2018-19 to keep themselves in black. The norms prescribed for MCF vintage is 6.5 Gcal/t of urea. As the operation profitability depends only on energy and payment of all subsidy costs are energy dependent, it becomes necessary for manufacturers like MCF to bring down energy norms to best achievable industry levels to continue operation.

The existing Ammonia and Urea plants are running efficiently and scope for energy improvement is seen due to vintage of plants.

Also, Urea is an important fertilizer segment. The supply/demand gap is huge and more than 8 million tons of urea imports are done as of now. The estimated total demand supply gap by 2015-2016 was 8.2 Million MT of urea alone. Government of India is bound to support this industry through conducive policies/subsidies. All southern states of India namely Karnataka, Tamilnadu, Kerala and Andhra Pradesh have enough demand for Urea. The capacity enhancement proposed by MCF will help towards filling the supply/demand gap.

### **3) PROCESS DESCRIPTION**

**Energy improvement Project of Ammonia & Urea plants by modernization and capacity enhancement of Ammonia from 2,47,500 t/y to 3,28,500 t/y and Urea from 4,29,000 t/y to 5,69,400 t/y.**

#### **3.1) Process Description – Ammonia Plant.**

Brief Description of the Process. Ammonia plant has the following sections:

- a) Naphtha Pretreatment
- b) Reforming
- c) Shift Conversion
- d) Co<sub>2</sub> Removal
- e) Methanation
- f) Compression
- g) Synthesis
- h) Purge Gas Recovery

##### **a. Naphtha Pretreatment Section:**

In this section the feed naphtha is purified of sulfur from say 200 ppm to 1 ppm. The naphtha is heated to 380°C and reacted with hydrogen to convert all the sulfur into hydrogen sulfide in the reactor filled with CoMox Catalyst of volume.

##### **b. Reforming section:**

Reforming of the feed naphtha is carried out in primary and secondary reformer. In the primary reforming process naphtha is reacted with the steam in the reformer tubes where the hydrocarbon is converted to hydrogen, methane, carbon dioxide, carbon monoxide in the presence of the nickel catalyst. The overall reaction is endothermic and heat is supplied by means of burners on the top of the reformer. There are four rows of 56 tubes each and 5 rows of burners with 12 burners in each row. In the secondary reforming the process gas from the primary reformer is made to react with the preheated air. Here the methane content is reduced to say 0.30% and the nitrogen which is required for the ammonia synthesis is added to the process.

**c. Shift Conversion:**

The process after giving the heat for steam generation in the waste heat boilers enters the high temperature and the low temperature shift conversion vessels where Carbon monoxide in the process gas is converted to carbon dioxide in two steps. The catalyst used is copper promoted iron oxide. At the end of the shift conversion, the CO in the process gas is reduced below 0.20%.

**d. CO<sub>2</sub> Removal Section:**

In this section, Benfield process is adopted. The gas coming out of the shift converter contains hydrogen, nitrogen, carbon dioxide, carbon monoxide, methane, argon and excess of the steam added in the reformer. Only hydrogen and the nitrogen are desirable for the production of the ammonia. CO<sub>2</sub> which is the raw material for the production of the urea is separator in this section and sent to the urea plant.

**e. Methanation:**

In this process the residual Carbon monoxide from the shift conversion process and the carbon dioxide from the CO<sub>2</sub> removal process is converted to methane in the nickel catalyst bed as these are poisons for the synthesis catalyst.

**f. Compressors:**

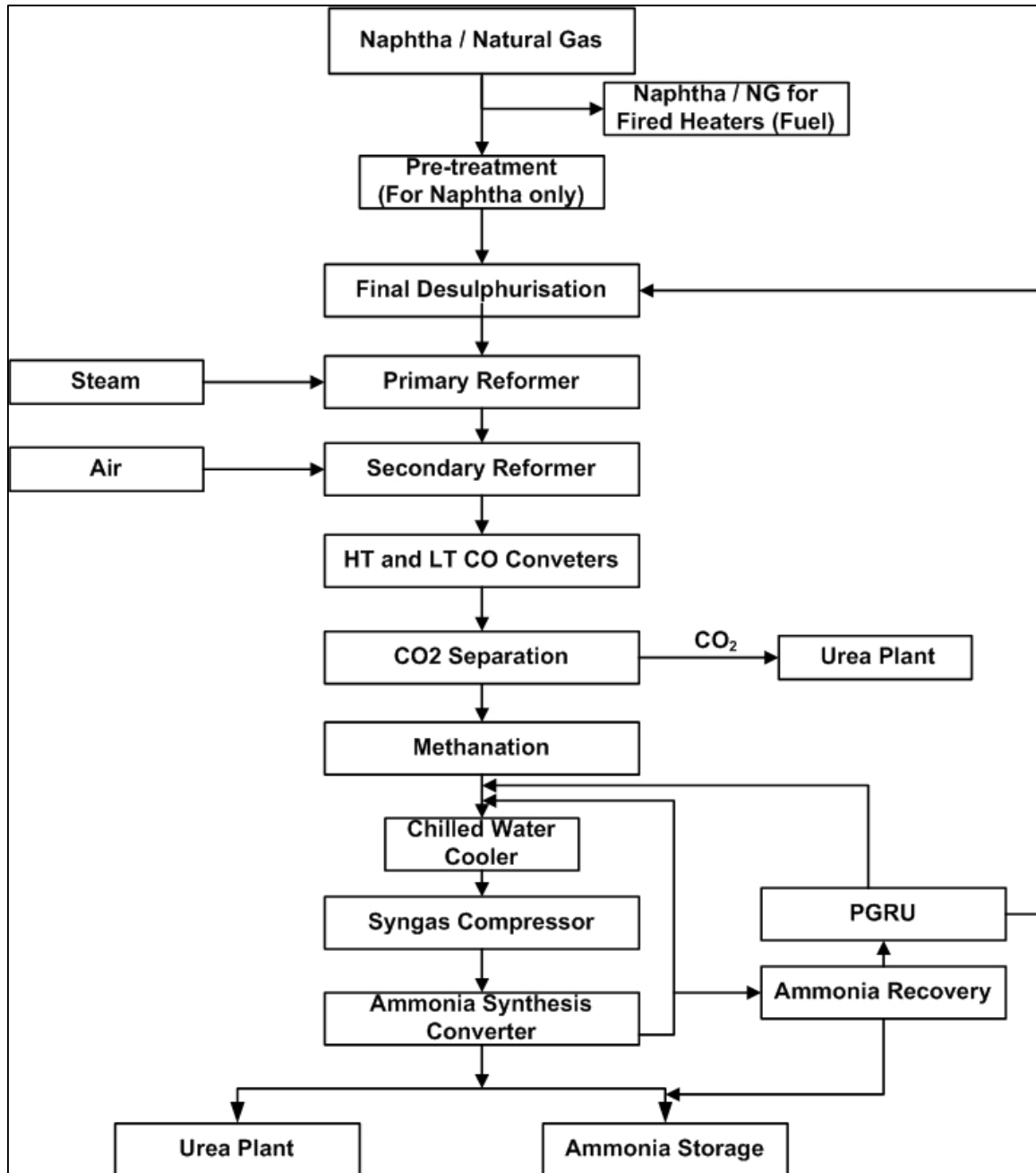
Synthesis gas compressor increases the pressure of the make-up gas to the synthesis pressure as well as it is used to recirculate the recycle gas. The synthesis section operates at pressure of 200 kg/cm<sup>2</sup> as the ammonia reaction is favored by high pressure. Air compressor is used to compress the air and supply it to the secondary reformer. A refrigeration compressor is used to cool the synthesis converter outlet gases to condense and separate the product ammonia.

**g. Synthesis:**

Synthesis converters are Haldor-Topsoe design S200 configuration. Here the process gas containing hydrogen and nitrogen in the ratio of 3.0 is passed over the iron catalyst in the two beds arranged in series with intercoolers and quenches to control the reaction temperatures. The conversion to ammonia is only partial and hence the requirement of the recirculation.

**h. Purge gas recovery:**

Purge gas recovery is a cryogenic process, where in the hydrogen from the purge gas is recovered and recycled to the compressor suction. This helps to increase the production and the process efficiency. Purge is generally given to maintain the inert in the circulating gas to the converter.



Flow diagram for the existing plant.

### **3.2) Revamp Process: Ammonia Plant.**

The plant is currently operating with naphtha as feed and fuel and operates at about 700 MTPD with an energy consumption of around 9.6 GCal/t ISBL (inside battery limit). In the revamping process the production of the ammonia plant will be increased to 900 MTPD with a decrease in the energy consumption to around 8.0 Gcal/t ISBL. The revamped plant will use RLNG / NG as the feed and fuel. The plant is already converted to take Natural gas as feed and fuel. The revamping process will include the following modifications.

#### **Revamp details.**

##### **a) Reformer section:**

In the reformer section in the convection side two coils will be added. One is for preheating the NG before it enters the fired heater and the other is to heat the NG and the steam before it enters the primary reformer. This will increase the inlet temperature to the primary reformer thereby bringing down firing and the heat flux in the tubes. This calls for the replacement of the cross over line and the inlet pig tails. It also calls for replacement of some of the coils in the super heater section and replacement of the tubular combustion air heater with a plate heat exchanger. The temperature to stack will be brought down to less than 140°C versus the current value of 170°C.

##### **b) CO<sub>2</sub> removal section:**

The current CO<sub>2</sub> removal section with UOP consisting of a single stage regeneration consumes around 1100 Kcal/Nm<sup>3</sup> of CO<sub>2</sub>. Whereas going forward using the GV low heat two stage regeneration the regeneration energy can be brought down to around 700 Kcal/Nm<sup>3</sup> of CO<sub>2</sub>. It calls for an additional regenerator operating at very low pressure (1.05 kg/cm<sup>2</sup>a) and the current one to operate at close to 2.0 Kg/cm<sup>2</sup>a. In addition to this a blower will be required to boost the CO<sub>2</sub> from the low pressure regenerator. The CO<sub>2</sub> will be available to the urea plant at 1.40 kg/cm<sup>2</sup>a compared to the current value of 1.25 Kg/cm<sup>2</sup>a.

##### **c) Compression section:**

###### **i. Synthesis gas compressor**

The option is to go ahead with a completely new set of compressor and turbine eliminating the motor altogether.

**ii. Air compressor**

The new compressor purchased for the gas conversion project along with the existing compressor will be adequate for the revamped requirements.

**iii. Refrigeration compressor**

To optimize the load on the refrigeration compressor, additional high pressure ammonia chiller, an interstate cooler and a parallel flash drum will be added.

**iv. Synthesis section:**

Based on the option selected for the synthesis compressor revamp the loop will operate at 240 kg/cm<sup>2</sup> or 185 kg/cm<sup>2</sup> with or without the additional converter. The modalities for the same are being worked with the process licensor. An additional converter of a single bed with intercooler with catalyst volume of 30m<sup>3</sup> will be required to increase the per pass conversion. This converter will be a cold walled design operating in series with the existing S200 converter of HTAS design. Additional BFW heater is provided for heat balance.

**d) PGRU**

The current PGRU though may not be able to take the additional load and hence will be left untouched. The additional purge will be used as fuel in the primary reformer.

**e) Naphtha Pre-treatment:**

The whole revamp is considered with the NG as feed and fuel, hence the pretreatment of Naphtha section is not considered for any change.

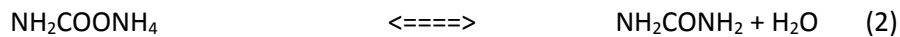
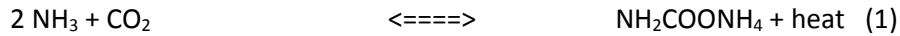
**f) MP stripper:**

Process condensate from the plant will be stripped using a medium pressure stripper. But the condensate so produced can be used as a make up to the de-aerator thereby bringing down the water requirement.

For increasing the capacity of the urea plant to 1560 MTPD, KRES / HTER system will be required to meet the CO<sub>2</sub> demand. Additionally recovery of CO<sub>2</sub> from the stack can also be considered.

#### 4) Process Description – UREA Plant

4.1) Urea is produced by reacting liquid ammonia and gaseous carbon dioxide at about 180-185° C and 140-150 kg/cm<sup>2</sup> abs. according the following reactions:

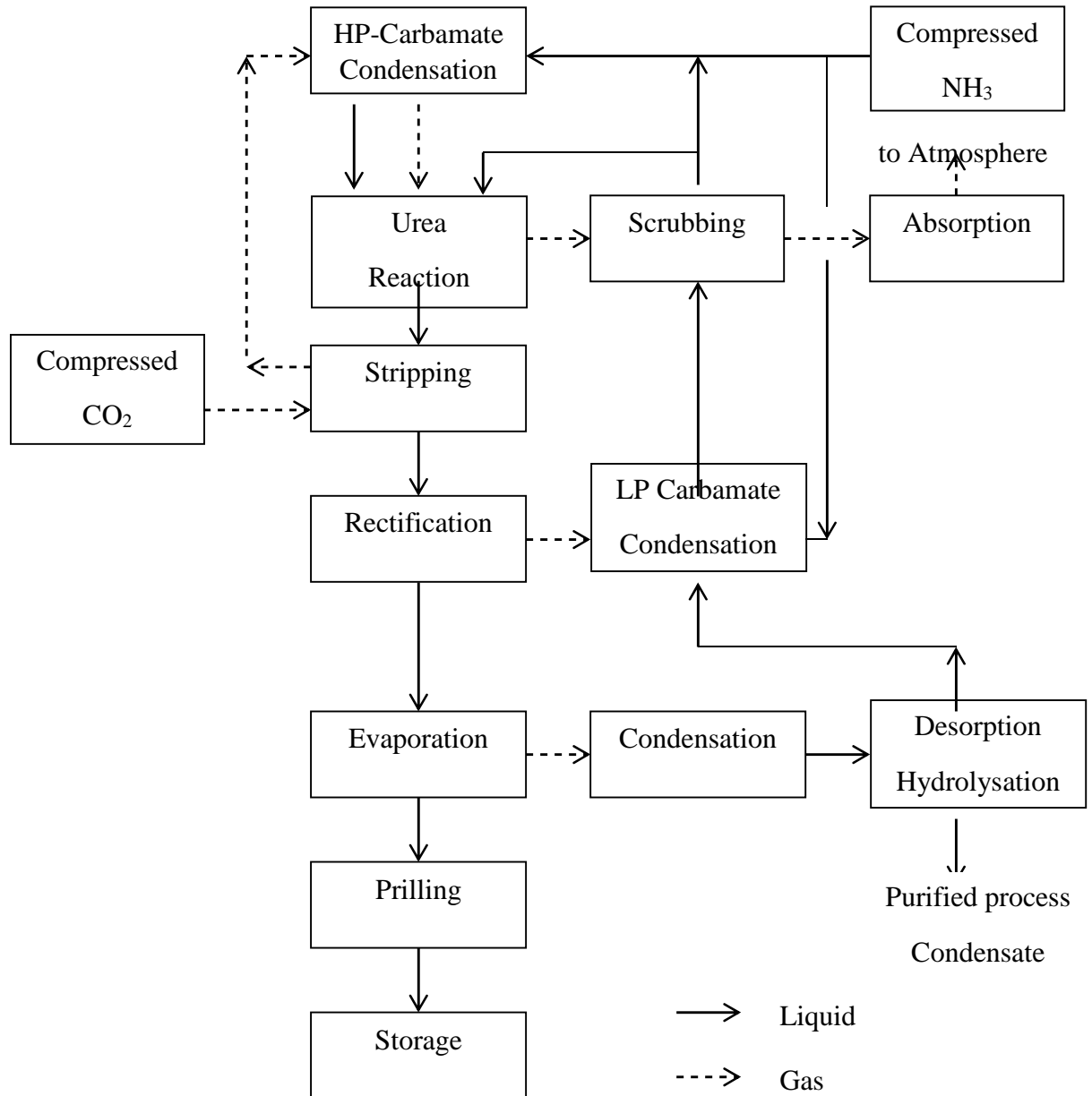


In the first reaction carbon dioxide and ammonia are converted into ammonium carbamate. This reaction is fast and exothermic. In the second reaction, which is slow and endothermic, the ammonium carbamate dehydrates to produce urea and water.

Urea Plant is designed based on CO<sub>2</sub> stripping process licensed by Stamicarbon. Vs. Netherlands. Ammonia (NH<sub>3</sub>) and Carbon Dioxide (CO<sub>2</sub>) are the main raw materials for Urea production. Initially, NH<sub>3</sub> and CO<sub>2</sub> are passed through a High Pressure Condenser where Ammonium Carbonate is formed. This is sent to autoclave where a portion of it is converted to Urea. The unconverted Ammonium Carbonate is stripped into NH<sub>3</sub> and CO<sub>2</sub> gases in a High Pressure Stripper using fresh CO<sub>2</sub> and recycled back to the HP condenser along with fresh Ammonia and dilute Ammonium Carbonate to again form concentrated solution of Ammonium Carbonate. This cycle thus continues.

The Urea solution thus coming from the Stripper is separated and concentrated in low pressure section consisting of a rectification column, a flash vessel, Pre-evaporator and two stages of evaporation. The molten Urea solution coming from the final evaporator is sent to a revolving prill bucket at the top of the Prill Tower. The Urea solution is sprayed in the form of fine droplets by rotation of the prill bucket. The droplets solidified into prills before reaching the bottom of the Prill Tower as they come in contact with an upward flow of air. The prills are collected and sent for bagging or storage in silo.

**BLOCK DIAGRAM UREA PROCESS**



## 4.2) Revamp of Urea Plant.

Stamicarbon being the process licensor has come up with a new concept called EVOLVE for revamp and shall be adopted.

Main objectives of the revamp are:-

- Reduce HP steam consumption in HP stripper - using Stamicarbon low energy concept to achieve 550 - 600 kg/t (38 bar A & 400° C).
- Capacity expansion from 4,29,000 t/y to 5,69,400 t/y.
- Reduction in particulate matter to atmosphere from Prill tower fans – install Granulation Plant.
- To improve the quality of the prilled Urea product.

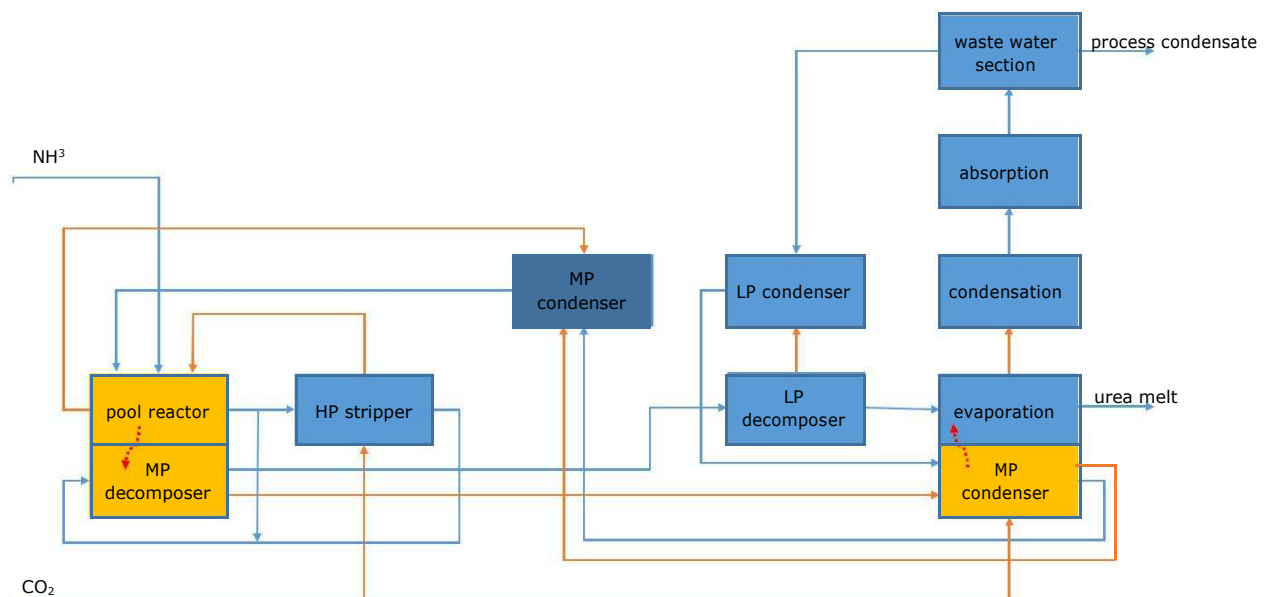
### STAMICARBON Revamp Technology

The revamp concept is targeting the below:

- Increasing the current plant capacity from 4,29,000 t/y to 5,69,400 t/y.
- Reduction of the extraction steam consumption from the current consumption from 850 kg/ton to about 550-600 kg/ton (400°C, 38 bar)

### Process retrofit concepts to fulfil the revamp objectives

In the following block diagram the conversion of the existing plant to a low energy urea plant is outlined.



In the synthesis section the existing high pressure falling film carbamate condenser is replaced by a pool reactor/condenser which integrates reaction volume and efficient condensation operating at an N/C ratio of about 3 and a pressure of about 145 bar, generating LP steam (4 bar). The choice between pool condenser with existing reactor or a completely new pool reactor will be done in the study phase together with the client. The function of a MP decomposer heater is integrated into the pool reactor/condenser by direct heat exchange to a second tube bundle inside this pool reactor/condenser. Liquid from the stripper is sent to this additional tube bundle. To avoid flooding of the stripper part of the liquid from the reactor is bypassing the stripper and sent directly to this bundle.

Additional heat integration is achieved by using the heat of condensation from the gas of this integrated MP decomposer to evaporate water from the urea solution in the evaporation section in the pre evaporator. The rest of the downstream sections remain essentially unchanged, if no additional requirements are formulated from the side of the client. It is assumed that these sections like the low pressure recirculation, evaporation, condensation and prilling have sufficient margin to handle the new higher plant capacity or do require only small adjustments. The additional required CO<sub>2</sub> compression capacity is added in the form of a medium pressure compressor which introduces CO<sub>2</sub> to the medium pressure section if insufficient compression capacity is available at present.

#### **4.3) SAILENT FEATURES OF ENERGY IMPROVEMENT PROJECT OF AMMONIA AND UREA PLANTS.**

|    |   |                           |
|----|---|---------------------------|
| 1. | Product   | <b>Ammonia &amp; Urea</b> |
| 2. | Annual Production - Ammonia/Urea (t/y)                | 328500 / 569400           |
| 3. | Project Time Schedule                                 | 24 months                 |
| 4. | Energy After revamp- Gcal/t Ammonia/Urea              | 8.5 / 5.75                |
| 5. | Total Project Capital Cost (Rs. Crores)               | 540                       |
| 6. | Cost towards pollution control equipment (Rs. Crores) | 70                        |

## **5) ENVIRONMENTAL MANAGEMENT**

### **5.1) Modernization of Ammonia & Urea Plants**

#### **5.1.1) Ammonia Plant**

There will not be any increase in pollution load due to increase in production. This is achieved by the energy improvement schemes which will be implemented in the plant. The total firing in the primary reformer will be lower resulting in reduction of fuel consumption. Also there will be reduction in steam and power requirement for the plant.

In addition there is going to be power generation using a STG. All this is possible only because of the improvements going to be achieved with the revamp. There is no additional liquid effluent generation from the plant. The plant will remain zero liquid effluent discharge plant.

It is proposed to replace the present low pressure stripper with medium pressure (MP) stripper which will ensure removal of Ammonia from process condensate. The gases from the MP stripper will be carried by the steam going to primary reformer.

The effluent generated in the plant shall be treated in the existing effluent treatment facility and recycled back to the system.

#### **5.1.2) Urea Plant**

The particulate matter (PM) from prill tower emissions will come down from existing levels due to decrease in load on existing Prilling tower and introduction of granulation plant to take care of increase in capacity.

The emission of Particulate matter from the urea prill tower would be well within 150 mg/Nm<sup>3</sup>. The expected emission level of particulate Matter from Granulation unit would be less than 50mg/Nm<sup>3</sup>.

The Ammonia / Urea revamp project will not have impact on Environment as energy norms will improve further there by reducing the consumption norms on fuel resulting in reduction of emissions. The proposed project will not have any adverse impact on the existing environment

as sufficient pollution control measures are incorporated in the process technology like medium pressure scrubber in ammonia and granulation plant for urea.

The additional trade effluent generated due to modernization shall be collected and treated in the existing waste water recovery system and urea hydrolyser stripper. The details of the existing system are given below.

MCF has installed and commissioned urea hydrolyser stripper at the cost of Rs. 8.5 crores in 1990 and same is being operated for the treatment of effluent streams from ammonia plant process, urea plant process and condensates from urea plant compressors. The urea hydrolyser stripper system consists of hydrolyser, which is operated at high temperature and high pressure, where urea gets hydrolyzed to ammonia and carbon dioxide. Ammonia thus produced is separated in the second desorption column. The liquid outlet of second desorption column contains less than 10 ppm of ammonia and urea. The ammonia vapours from the second desorption column is fed to the first desorber. The desorber overhead vapours are condensed in a condenser and reused in Urea plant. The treated effluent from urea hydrolyser stripper is reused as cooling tower makeup water.

Till end of June 2010 water treatment plant ion exchange regeneration effluent streams, the cooling tower blow down and backwash water effluent from water treatment plant sand filter and cooling tower side stream filter were treated and collected in the final effluent pond. Then it was pumped to green belt area for watering purpose during summer and to Arabian Sea during monsoon months

#### **6) Waste Water Recovery Plant:**

As corporate social responsibility, with the aim of reusing the entire treated effluent and to achieve the target of zero effluent discharge MCF has installed Waste Water Recovery Units during 2009-2010 by investing about Rs. 7.0 crores for treating the effluent streams consisting of the following:

1. Sand filter back wash water from water treatment plant and cooling tower
2. Water treatment plant resin regeneration effluent - acidic and alkaline
3. Cooling tower blow down.
4. Domestic effluent

Based on the characteristics of the effluent streams, trade effluents are categorized and is treated as given below:

1. Sand filter back wash water from water treatment plant and cooling tower containing high suspended solids effluent is treated by using Lamella Clarifier technology.

Static mixer, Lamella clarifier, centrifuge and sand filter are major equipment for treating the high suspended solids effluent streams. Back wash water of sand filter and activated carbon filter from water treatment plant and cooling tower side stream filter are treated in this unit. The treated water is reused in cooling tower as makeup. The slurry containing solids is pumped to a centrifuge for separating liquid which is recycled to static mixer. The thickened slurry is used in DAP plant.

2. Water treatment plant resin regeneration and cooling tower blow down effluents containing high dissolved solids is treated by Reverse Osmosis technology.

The high dissolved solids effluent stream containing water treatment plant resin regeneration effluent and cooling tower blow down is passed through clarifier, pressure sand filter and Ultra Filtration (UF) units to remove suspended solids and colloidal particles. Then it is treated in Reverse Osmosis (RO) units to remove dissolved solids. Treated water is reused in cooling tower as makeup.

The high dissolved solids effluent streams are collected in an equalization tank. This stream after dosing with NaOCl, Coagulant, Lime, Dolomite & Polymer is pumped to High Rate Solids Contact Clarifier (HRSCC). The clarified water from HRSCC is passed through Multi Grade filter for reduction of suspended solids.

Then the filtered water is fed into the Ultra filtration unit (UF) to remove colloidal silica and related colloids of iron and aluminium in water causing fouling, scaling and poor performance of the plant. The stream which is free from suspended and colloidal particles will be passed through Reverse Osmosis unit (RO). The Dissolved solids are removed in 2 stages of RO unit. In the first stage RO<sub>1</sub> about 75 % of desired quality water will be recovered and reject is fed to second stage RO<sub>2</sub> wherein further 10% is recovered. The RO<sub>2</sub> reject containing high dissolved solids is used in DAP plant.

The recovered water is used in cooling tower as makeup. The sludge collected in the HRSCC is pumped to centrifuge to remove water. The separated liquid is recycled to equalizing tank and thickened slurry is used in DAP plant.

### **7) Sewage Treatment Plant:**

The domestic effluent generated due to new 1 million ton DAP/NPK & PCE complex also shall be collected and treated at existing sewage treatment plant (STP). The details of the existing STP is given below:

MCF has put up a centralized sewage treatment unit. The combined sewage from the factory is collected in the sump tanks and pumped to the bar screen chamber and oil trap to remove floating solids and oil traces respectively. After this preliminary treatment the effluent is fed to equalization tank.

Effluent from the equalization tank is fed to the Membrane Bio-Reactor (MBR) tank at constant flow rate. The high amount of bacteria gives better and complete removal of organic matter from the raw effluent in relatively small area. Aeration is done both to the equalization and MBR tanks through diffuser membranes by using blowers.

The suction pumps directly sucks permeate and the filtration is carried out by the membrane. The suspended solids, turbidity, bacteria and viruses in permeate water are removed to the levels required for reusing treated water. The treated water is reused in cooling tower as makeup.

By installation of the above wastewater treatment plants with latest technologies, MCF has achieved the aim of reusing the entire treated wastewater and the target of zero wastewater discharge.

### **8) Green Belt**

MCF has already developed and maintained a green belt covering an area of about 64 acres. The green belt contains around 60,000 trees of different species viz. Mangium, Casurina, Subabul, Acacia, Gulmohar, Jack, Cashew, Mango, Banyan, Peepal, etc.

----- X -----