National Fertilizers Limited Nangal Punjab

Steam Generation Plant

The steam generation plant of Nangal unit has three coal fired Boilers in addition to one oil-fired boiler. The coal fired Boilers are of the radiant, outdoor, bi-drum, high head, non re-heat type industrial Boilers of the modified "VU-40" type, suitable for firing pulverized coal as principle fuel. These boilers has been specially selected to meet the varying process steam requirements, and to deliver superheated steam at a steady rate and arranged for pulverized fuel firing.

The maximum continuous rating of these pulverized fuel-fired boilers, corresponds to 117 MT/Hr of generated steam and 65 MT/Hr. of external import steam. The final superheated steam conditions in the boiler will be 91 Kg/Cm^2 and 510^oC at battery limit of the boilers. Of the (117+65) =182 MTPH of superheated steam supplied from each boiler, a maximum of 12 MTPH per boiler, under two boiler operating conditions, will be tapped off for home consumption and a net quantity of 170 MTPH will be supplied to the process from each service boiler.

4^{th} boiler is supplied by ISGEC JOHN THOMPSON, Yamunanagar to produce 80 MTPH of generated steam and to superheat 60 MTPH of Import steam along with the generated steam. The total steam exits the boiler at the superheating stage of 515^oC temperature and 91-ata pressures. The boiler is supported with four burners of steam atomized M26 type, which uses FO/LSHS as fuel at a pressure of 10 Kg/cm2 and at a temperature where the viscosity of fuel should be less then 15 CST.

AMMONIA PLANT

The Ammonia Plant-II is designed to produce 900 TPD ammonia based on shell gasification partial oxidation process of Fuel Oil/ HPS. Ammonia Plant –II comprises of following sections :-

- **Gasification Section :**

In this section raw gas is produced by gasification of fuel oil / LSHS in three parallel oil gasification reactors using the shell gasification partial oxidation process. The fuel oil is first preheated in the section and then fed to gasifier. The reaction takes place in the presence of oxygen and steam at an operating pressure of 55 kg/cm2 and temperature of 1300 ^0C. The raw gas produced is a mixture comprising of CO- 46.79 %, H_2 – 45.77 %, H_2S – 0.74 % and CO_2 – 5.55 %. It also contains organic sulphur, hydrogen cyanide, methane and carbon particles in small quantity.

A special waste heat boiler down stream of reactor recovers heat from hot gases and producing steam at a pressure of 105 kg/cm2. The gas after heat recovery is quenched with water which removes bulk of soot. The raw gas is given final water wash in carbon scrubber to remove carbon down to 1 ppm . A special features of the process is recovery and recycle of the carbon.

- **Gas Purification :**

Gas purification is carried out in the different sections :

i) Rectisol–Desulphurisation Section (H_2S Removal) :

In the rectisol process, developed jointly by M/s Lurgi and M/s Linde, the raw gas is counter currently scrubbed with cold anhydrous methanol at the temperature of (-) 31 ^0C. The cold methanol serve the purpose of drying of raw gas. COS is also absorbed in cold methanol. H_2S and COS are being removed in rectisol process as these are more soluble in cold methanol selectively. This raw gas, after removal of H_2S and COS, is called de-sulphurised gas.

ii) CO-Shift Conversion Section :

The de-sulphurised gas is preheated and saturated with water vapour in a saturator at 216 ^0C and then fed to a shift converter where catalytic conversion of carbon mono-oxide to carbon di-oxide and hydrogen takes place. This reaction is called shift reaction and is carried out in two converters by

using conventional iron based catalyst in 1st converter and copper doped catalyst in 2nd converter. Almost 92 % of carbon mono-oxide, present in desulphurised gas, is converted into carbon di-oxide by shift reaction over catalyst. The converted gas is then pre-cooled and dehumidified before it is sent to Decarbonation section.

iii) Rectisol – De-carbonation Section (CO_2 Removal) :

The converted gas from shift conversion section enters the main CO_2 absorption tower after getting cooled to a temperature of (-) 25 ^{0}C. The cold methanol at (-) 70 ^{0}C is used for absorption of carbon di-oxide. The methanol from the CO2 absorber is flashed in two stages and then stripped with nitrogen for regeneration. The decarbonated gas from the CO_2 absorption tower contains less than 5 ppm CO_2 is then fed to Liquid Nitrogen Wash Section for removal of residual impurities (CO, CH_4 etc.).

iv) Liquid Nitrogen Wash Section :

The de-carbonated gas at (-)54 ^{0}C and 40 kg/cm2 is passed through molecular sieve adsorbers to remove methanol and trace CO_2 content present in de-carbonated gas. The feed gas is cooled in main exchanger to a temperature of (-)184 ^{0}C by return purified gas and evaporation of tail gas. The feed gas is fed to the bottom of liquid nitrogen wash tower. Here residual CO, CH4 is scrubbed from the fed gas by liquid nitrogen wash and separated as residual tail gas. The gaseous nitrogen is pre-cooled, condensed and enters the top of the wash column to wash the feed gas.

The purified gas containing residual 5 ppm of Carbon monoxide as contaminant comes out from Nitrogen Wash Section at (-) 189 ^{0}C. This gas contains about 11 % nitrogen and 89 % hydrogen. Later gaseous nitrogen is injected into the purified gas out side the cold box to maintained the ratio of H_2 : N_2 (75 : 25) and this gas, known as synthesis gas, is then sent to the suction of the synthesis gas compressor for compression and re-circulation in the synthesis loop.

v) Ammonia Synthesis Section :

Synthesis gas after nitrogen wash section is compressed to a pressure of 185 ata with the help of a centrifugal synthesis gas compressor. The compressor is driven by steam turbine. This compressed synthesis gas at high pressure passes through ammonia synthesis loop having ammonia synthesis converter loaded with promoted iron oxide catalyst. A part of the circulating synthesis gas gets converted to ammonia in this converter.

The ammonia formation is highly exothermic and consequently there is sharp rise in the temperature of the process gas. The flow to the converter inlet, therefore, is so adjusted that maximum rate of reaction is achieved without lowering the equilibrium of ammonia concentration. The heat of reaction is removed by generating steam in a Waste Heat Boiler down stream of ammonia converter. The converted gas is further cooled down in number of heat exchangers to a temperature of 0 ^{0}C so that maximum ammonia gets separated in ammonia separator. Ammonia collected in ammonia separator is flashed to a pressure of 40 ata in a flash tank to get rid of the dissolved gases. The product ammonia is then sent to Horton Sphere for storage and pumped to different consuming centers.

UREA PLANT

The Urea Plant, based upon Technimont total recycle improved 'C' process, is laid in single stream. Its original capacity was 1000 MTPD of Urea. Recently, the Urea Plant capacity has been revamped and its capacity has been raised to 1450 MTPD of Urea by absorbing Urea Casale High Efficiency Combined (HEC) Technology in Feb, 2001 with 104 M high natural draft Prilling Tower. The ammonia obtained from the Ammonia Plant-II is reacted with Carbon dioxide at a temperature of 195^0 C and pressure of 219-220 Kg/cm^2 to produce Urea as per the following reaction :

$2NH_3$ + CO_2 ---------- NH_2CONH_2 + H_2O

(Ammonia) (Carbon di-oxide) (Urea)

The reacted effluent is separated from the unconverted carbamate in three pressure stages and two vacuum stages and the urea solution is gradually concentrated to over 99.5% as urea melt. The separated carbamate is recovered and recycled into the system. The urea melt is taken to the top of the 104 metre high natural draft prilling tower and sprayed through a rotating Tuttle bucket against natural counter current draft of air. As the urea melt comes into contact with air, it solidifies into prills. The prilled urea is collected in a hopper at the bottom of the tower and transported through a conveyor belt to the bagging plant or silo.

METHANOL PLANT

The Methanol Plant was installed and commissioned in 1984 to produce 50 TPD of methanol. It is having two sections:

1) Methanol Synthesis Section, where raw methanol is produced by iso-thermic reaction of H2, CO & CO2.
2) Distillation Section, where raw methanol (93% methanol) is processed to produce pure methanol (99.99% methanol).

The Plant was designed by M/s. HTAS. The methanol synthesis is carried out in two numbers reactors operating at about 45 kg/cm^{2}g pressure and 210 to 280 deg. C temperature. The Methanol Plant was revamped in October, 1998 and its capacity was raised to 67 TPD of methanol by installing one more methanol synthesis reactor alongwith a waste heat boiler and an additional methanol distillation unit to process about 17 TPD of methanol.

The make-up gases to methanol synthesis section comprises of the following streams:

1) The Gas – A or de-sulphurised gas (DSG, 3400 Nm3/hr) containing about equal amount of CO and H2 is obtained from the rectisol (de-sulphurisation) section at 45 kg/cm2 g pressure and about 35 deg. C temperature. It is supplied to the discharge side of the recycle gas compressor in the methanol synthesis loop.
2) The Gas – B or de-carbonated gas (DCG, 3300 Nm3/hr) containing 94% of H2 and about 5% of CO is supplied to the suction side of the recycle gas compressor in the methanol synthesis loop.
3) A small rate of Gas-C or converted gas (760Nm3/hr) is supplied to the suction side of the recycle gas compressor.

There are two recycle gas compressors and both the compressors operate in parallel to produce 67 TPD of methanol. The gas from the recycle gas compressor is pre-heated in a feed/effluent exchanger and then feed gas heater to about 210 to 225 deg. C temperature and passed through 1st converter containing layer of sulphur guard catalyst and remaining copper zinc based methanol synthesis catalyst. The gas from the 1st converter is pre-cooled to about 210 deg. C in waste heat boiler where 11 ata steam is raised and the gas then enters the 2nd converter. The exit from the 2nd converter is again pre-cooled to about 210 deg. C in the 2nd waste heat boiler and the gas then enters the 3rd converter. The exit gas from the 3rd converter is cooled in feed/effluent heat exchanger then in water coolers before it enters the methanol separators (2 nos. in parallel). The raw methanol formed in the reactors is condensed in the water coolers and separated from the gas in the separators. The gas from the methanol separator goes to the suction of the recycle gas compressor. The liquid Raw methanol product from the separator is depressurised to about 3 Kg/cm2 and taken to the letdown drum where most of the dissolved gases of methanol are flashed. The methanol evaporated is recovered in the water wash column.

The purification of the Raw methanol takes place in a two tower distillation system. In the ether column, various low boiling compounds, in particular di-methyl ether and methyl formate are stripped off. In the concentration column, water, methanol and higher boiling components are separated and 67 TPD of AA grade methanol is drawn from few trays below the top of the concentration column.