Ammonia Plant

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Ammonia Plant

Executive Summary

Ammonia plant is designed to produce 900 tons per day of ammonia, starting from various feedstocks, ranging from heavy refinery tails, like asphalt, to medium weight hydrocarbons, up to natural gas. In addition, plant can be fed with gassified coal.

Plant was started in 1984 and was in operations until December 2008.

Conservation status is good, many plant sections are sized for 1080 t/d.

Battery limits include all plant sections, starting from daily feed storage and covering all activities up to ammonia piping to the ammonia storage, which is excluded.

Complementary sections include Air Separation Unit (ASU), Coal Recovery section, Sulphuric Acid production, CO2 production.

Core production process starts with gasification of heavy hydrocarbons tails, which represented normal feedstock used at that site, and continues with absorption of H2S, followed by conversion of CO in CO2. CO2 is then removed by absorption, and then gaseous mixture is washed with N2 which increase the nitrogen content up to desired ratio. That mixture is fed to synthesis reactor generating ammonia. Ammonia is then sent to storage.

Process is controlled with single loops instruments elettro-pneumatics, as well as with some eletronics.

No license fee is involved. Documentation is available and kept in good order.

Areas are available for temporary storage and workshop during dismantling.

A certain number of spare parts are available, including some compressor rotors.
Energy consumption is around 720 KWh per ton of produced ammonia, while consumption of heavy hydrocarbons (raw feed) is 0.850 ton per ton of produced ammonia.
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Process Description

Plant for Ammonia production started-up in 1984 and may use as raw material any hydrocarbon liquid or gaseous. However, this plant is mostly oriented for use of heavier fractions from oil distillation, namely vacuum residues or even asphalt residues. The plant capacity is 900 Ton/day, 80% of this production was used for 3 Fertilizers plants and 20% for the external market.

Gasification section
Raw material is coming from a large storage outside B.L. and after passing through 2 intermediate tanks of 1000 Ton each, it is pre-heated at 200º C and fed to the partial oxidation reactors – 2 lines in parallel – where it is gasified with a mixture of oxygen and steam. From this reaction, at pressure of 60 bar and at temperature of around 1300º C, comes out a gaseous mixture composed mostly by hydrogen and carbon monoxide and with lower percentages, by carbon dioxide, sulphidric acid (H2S) and methane. Heat released by reaction is recovered by high pressure (80 bar) steam production.

Purification section
After being submitted to a washing for eliminating non gaseous carbon particles, the gaseous mixture is then sent to a purification unity, where H2S and part of the CO2 are removed with methanol at low temperature (-30ºC).
CO conversion
The gaseous mixture is then sent to a unity where, through a catalytic reaction, carbon monoxide and water steam are converted in carbon dioxide and hydrogen. In that way, hydrogen content is substantially increased, being this gas the only one coming from gasification step, with interest for ammonia production. The gas coming of this step is washed again with methanol at low temperature, to remove almost all carbon dioxide.

Sulphuric acid production
From recovery of the methanol used in previous purifying steps, it is obtained in separate plant units gas with a high content of H2S and CO2 respectively, almost pure. The first one is used for sulphuric acid production and the second one is used as raw material for urea production.

Nitrogen wash
After elimination of CO2, the gas is submitted to a final purification by washings at very low temperatures (-190ºC) with liquid nitrogen. From that washing it is obtained a mixture of hydrogen/nitrogen almost free of other components and in the required proportion for ammonia production.

Ammonia synthesis
This gas is then compressed from 45 to 200 bar and sent to synthesis reactor, where in the presence of an iron oxide catalyst, hydrogen and nitrogen react forming ammonia. This ammonia is stored in a sphere under pressure with the capacity for 1200 Ton and in a cooled tank at (-33ºC) with the capacity for 20 000 Ton. This storage vessel are outside BL.
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As Ancillary Sections for Production one should refer also:

Carbon Recovery Plant,
where solid carbon non gasified is recovered as pellets, which may be mixed with the raw material and recycled.

Cooling Unit,
where it is produced the necessary cooling load for compensating the thermal losses in the purifying and synthesis units.

Sulfur Recovery Unit,
where H2S removed from gaseous mixture is converted in sulphuric acid at 78%.

Air Fractionation Plant,
producing gaseous oxygen and gaseous nitrogen as required for the process as well as being able to produce liquid oxygen and liquid nitrogen for external supply.
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Plant flow sheets

Feedstock Gassification
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Purification Unit

CO Conversion
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Ammonia Synthesis Unit
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Ammonia Synthesis Reactor
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Air Separation Unit
UNIT 000 – Air compressor
J-001 - Air compressor (1)

UNIT 030 – Nitrogen compressor
J-031 - Nitrogen compressor (1)
T-031 - Steam turbine (1)

UNIT 070 – Oxygen compressor
J-071 - Oxygen compressor (1)

UNIT 100 – Air separation
C-101 - Main exchanger (1)
C-102 - Main exchanger (1)
C-103 - Turbine exchanger (1)
C-104 - Main vaporizer (1)
C-105 - Auxiliary vaporizer (1)
C-106 - Subcooler (1)
C-107 - Subcooler (1)
C-108 - Subcooler (1)
C-109 - Oxygen vaporizer (1)
E-104 - Medium pressure column (1)
E-105 - Low pressure column (1)
E-106 - Pure nitrogen column (1)
E-107 - Pure oxygen column (1)
G-101 - Liquid oxygen filter (1)
J-103/J-103R - Liquid oxygen pumps (1+1)
J-104 - Main expansion turbine (1)
J-105 - Additional expansion turbine (1)
C-110 - Regeneration heater (1)
C-111 - Defrosting heater (1)
E-101 - Cooling water tower (1)
E-102 - Chilled water tower (1)
E-103 - Waste nitrogen water tower (1)
G-102 – Epuration vessel (1)
G-103 – Epuration vessel (1)
J-101/J-101R - Cooling water pumps (1+1)
J-102/J-102R - Chilled water pumps (1+1)
L-101 - Vaporization device for liquids (1)
L-102 - Silencer on waste nitrogen (1)
C-112 - Nitrogen pressurization device (1)
C-113 - Oxygen pressurization device (1)
C-114 - Liquid nitrogen evaporator (1)
F-101 - Nitrogen storage (1)
F-102 - Oxygen storage (1)
F-105 - Water separator (1)

UNIT 150 – Wet catalysis

B-151 - Preheater (1)
B-154 – Combustion furnace (1)
B-155 – Stack (1)
C-151A/B/C/D – Acid coolers (4)
C-152 – Product acid cooler (1)
C-154 – Waste heat boiler (1)
D-151 – Converter (1)
E-151 – Condensation Venturi (1)
F-151 – Product acid tank (1)
F-164 – Product acid tank (1)
F-154 – Steam drum (1)
F-156 – Sour gas separator (1)
F-158 – Water head tank (1)
G-151A/G-151B – Candle filters (2)
G-152 – Air filter (1)
J-151/J-151R – Acid recycling pumps (1+1)
J-153/J-153R – Acid production pumps (1+1)
J-154 – Air blower (1)

UNIT 200 – Shell gasification

C-201 – Gasifier cooling water cooler (1)
C-202 – Raw gas heated desorber (1)
C-203A/C-203B – Carbon water coolers (2)
C-204 – Carbon scrubber circ. water cooler (1)
C-205A/C-205B/C-206 – Return water coolers (3)
C-221A/-C-221B – Waste heat exchangers (2)
C-222A/C-222B – Economizers (2)
C-223A/C-223B – Carbon oil preheaters (2)
D-201A/D-201B – Gasification reactors (2)
E-201 – Carbon scrubber (1)
F-201A/F-201B – Quench pipes (2)
F-202A/F-202B – Carbon separators (2)
F-203 – Gasifier cooling water tank (1)
F-204 – Slop oil vessel (1)
J-201A/J-201B/J-201R – HP feedstock pumps (2+1)
J-202/J-202R – Carbon scrubber circulation pumps (1+1)
J-203/J-203R – Gasifier cooling water pumps (1+1)
J-206 – Slop oil pump (1)
UNIT 250 – Pelletizing

C-252 – Stripper excess water cooler (1)
C-253 – Stripper circulation water cooler (1)
C-254 – Slurry off gas cooler (1)
E-251 – Waste water stripper (1)
F-258 – Slurry tank (1)
F-259 – Return water tank (1)
F-260 – Sink pellets drum (1)
F-261 – Carbon oil collecting pipe (1)
G-256A/G-256B – Sand filters (2)
L-251A/L-251B/L-251R – Pelletizers (2+1)
L-252A/L-252B/L-252R – Pellets sieves (2+1)
L-254A/L-254B – Mixing Throughs (2)
L-255 – Pellets fine sieve (1)
L-262A/L-262B – Homogenizers (2)
J-251/J-251R – Slurry pumps (1+1)
J-253/J-253R – Return water pumps (1+1)
J-254 – Filter backwash pump (1)
J-255 – Waste water pit pump (1)
J-256/J-256A – Filter feed pumps (1+1)
J-257/J-257A – Stripper circulation pumps (1+1)
J-258 – Sink pellets pump (1)
J-259/J-259R – Stripper excess water pumps (1+1)
J-261 – Exhaust air blower (1)
J-262 – Slurry pit pump (1)

UNIT 300 – CO-shift conversion

C-301 – HP boiler feedwater preheater (1)
C-302 – Circulation water heater (1)
C-303A/C-303B – Circulation water heaters (2)
C-304A/B – LP boiler feedwater preheaters (2)
C-305 – Final cooler (1)
C-306 – Start-up heater (1)
C-307 – Circulation water cooler (1)
C-308 – Hot water heated desorber (1)
D-301 – Shift converter I (1)
D-302 – Shift converter II (1)
E-301 – Saturator (1)
E-302 – Cooler (1)
F-301 – Separator (1)
F-302 – Condensate separator (1)
F-303 – Ammonia water vessel (1)
J-301/J-301R – Cooler feed pumps (1+1)
J-302/J-302R – Saturator feed pumps (1+1)
J-303/J-303R – Ammonia water pumps (1+1)
UNIT 350 – N2-wash

C-351 – Nitrogen exchanger (1)
C-352 – Raw gas exchanger (1)
C-353 – Gas subcooler (1)
C-354 – Regeneration heater (1)
C-355 – Blow down heater (1)
E-351 – Washing column (1)
F-351 – Blowdown drum (1)
G-351 – Methanol and CO2 adsorber (1)
G-352 – Methanol and CO2 adsorber (1)
L-351 – Silencer (1)

UNIT 400 – H2S-wash

C-401A-K – Lean/semi lean methanol heat exchangers (10)
C-402/C-402R – Hot regenerator reboilers (1+1)
C-403/C-403R – Methanol water column reboilers (1+1)
C-404 – Hot regenerator condenser (1)
C-406 – Prewash methanol heat exchanger (1)
C-421A – H2S raw gas cooler (1)
C-421B – H2S raw gas cooler (1)
C-422 – Sourgas cooler (1)
C-423 – Sourgas heater (1)
C-425 – Recompressor gas cooler (1)
C-451 – H2S raw gas end cooler (1)
E-401 – H2S absorber (1)
E-402 – Hot regenerator (1)
E-403 – Methanol water column (1)
E-404 – H2S flash (1)
F-401 – Raw gas separator (1)
F-402 – Hot regenerator reflux drum (1)
F-403 – Recompressor gas separator (1)
F-405 – Sourgas separator (1)
F-408 – Raw gas separator (1)
F-409 – Fresh methanol tank (1)
F-410 – Underground slop tank (1)
J-401/J-401R – Lean methanol pumps (1+1)
J-402/J-402R – Hot regenerator reflux pumps (1+1)
J-403/J-403R – Hot regenerator feed pumps (1+1)
J-404/J-404R – Methanol water pumps (1+1)
J-425 – Recompressor (1)
J-454 – Fresh methanol pump (1)
J-455 – Slop pump (1)
UNIT 450 – CO2-wash

C-409A-E – Methanol/methanol heat exchangers (5)
C-452 – Methanol cooler (1)
C-453 – CO2 gas end cooler (1)
C-454 – Flash methanol cooler (1)
C-455 – Methanol cooler (1)
C-456 – liquid ammonia cooler (1)
C-457 – Liquid ammonia cooler (1)
C-471 – CO2 feed cooler (1)
C-477 – Vacuum blower cooler (1)
E-451 – CO2 absorber (1)
E-452 – CO2 flash column (1)
J-451/J-451R – CO2 absorber methanol pumps (1+1)
J-452/J-452R – Cooling pumps (1+1)
J-453/J-453R – Feed pumps H2S wash (1+1)
J-477 – Vacuum blower (1)

UNIT 500 – Syngas compressor

J-501 – Synthesis gas compressor (1)
T-501 – Steam turbine (1)

UNIT 550 – NH3-synthesis

B-551 – Start-up heater (1)
C-560 – Hot NH3 exchanger (1)
C-561 – Waste heat exchanger (1)
C-562 – BFW preheater (1)
C-563 – Air cooler (1)
C-564 – Water cooler (1)
C-565 – Cold exchanger (1)
C-566 – NH3 chiller (1)
C-567 – Reflux cooler (1)
C-568 – NH3 product cooler (1)
C-569 – NH3 product after chiller I (1)
C-570 – NH3 product after chiller II (1)
C-571 – Subcooler I (1)
C-572 – Subcooler II (1)
D-551 – NH3 converter (1)
F-551 – NH3 separator (1)
F-552 – Let down vessel (1)
F-553 – Flash vessel (1)
F-554 – BFW KO drum (1)
J-551 – NH3 bleed pump (1)
J-552 – Water pump (1)
UNIT 600/UNIT 630 – Boiler/Steam superheater

B-601 – Steam boiler (1)
C-601 – BFW – preheater (1)
C-602 – Fuel oil preheater (1)
C-603 – Analysis cooler (1)
C-604 – Air preheater (1)
C-605 – Analysis cooler (1)
F-601 – Boiler steam drum (1)
F-602 – Fuel-oil tank (1)
F-603 – Dosing tank (1)
F-604 – Hydrazine tank (1)
F-605 – Blow-down vessel (1)
G-601/G-601R – Fuel-oil filters (1+1)
J-601A/J-601B/J-601R – Air blowers (3)
J-602/J-602R – Fuel-oil pumps (1+1)
J-603/J-603R – Dosing pumps (1+1)
J-604/J-604R – Hydrazine pumps (1+1)
J-605A/B/C/D – Soot blowers (4)
B-631 – Steam superheater (1)
C-631 – Economizer (1)

UNIT 700 – Refrigeration

F-451 – Evaporator bleed receiver (1)
F-730 – Suction separator (1)
J-426 – Bleed pump (1)
J-478 – Bleed pump (1)
J-725 – Bleed pump (1)
J-730 – NH3 compressor (1)
C-710A/C-710B – NH3 condensers (2)
C-720 – Steam heated desorber (1)
C-721 – Solution heat exchanger (1)
C-722A/C-722B – Absorbers 1st stage (2)
C-723 – Absorber 2nd stage (1)
C-724 – Ammonia evaporator (1)
C-725 – Subcooler (1)
C-726 – Bleed exchanger (1)
C-730/C-730R – NH3 vapour coolers (1+1)
E-701 – Rectifying column (1)
F-710 – Ammonia receiver (1)
F-722 – Solution receiver 1st stage (1)
F-723 – Solution receiver 2nd stage (1)
J-710/J-710R – Reflux pumps (1+1)
J-722/J-722R – Solution pumps 1st stage (1+1)
J-723/J-723R – Solution pumps 2nd stage (1+1)
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Plant Areas Layout
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