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COUNTRY PAPER FROM BANGLADESH

UREA FERTILIZER FACTORY, GHORASAL, DACCA, BANGLADESH
660 MT/D NATURAL GAS BASED AMMONIA PLANT *

by

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1. Introduction

Bangladesh has potentiality of huge reserves of natural gas of good quality (97 to 98% CH_4). Up till now 9 gas fields discovered and the gas reserve estimated about 9.1 x 10^9 MCF. Further investigation of the reserves are under progress.

There is substential demand of N_2 fertiliser in the country for agriculture. First fertiliser factory based on natural gas came up in 1961 capacity of which is 340 MT/D urea (200 MT/D ammonia).

Second fertiliser factory based on natural gas came up in 1970 capacity of which is 1137 MT/D urea (660 MT/D ammonia).

Third fertiliser factory based on natural gas is under erection capacity of which is 1600 MT/D urea (925 M.T./D. ammonia).

2. History of Second Fertiliser Factory

Urea Fertiliser Factory, Ghorasal situated on the bank of River Sitalykha about 30 miles away from Dacca, the capital of Bangladesh. Factory constructed by Toyo Engineering Corporation of Japan under Turn Key contract. Total land for the factory is 44 acres, 120 acres for housing estate and about 80 acres for the provision of expansion of fertiliser factory. Total cost involvement for the factory is 70 million dollar (U.S.) out of which 35 million dollar in foreign exchange.

Turn Key Contract signed on 8th May 1967. Construction started on 9th Sept., 1967. Construction completed on 28th May 1970. Trial production started on 10th July 1970.

Performance:

Year	Ammonia Prod. M.T.	Capacity Utilization	Stream days	No. of shut down
1970-71	28206	14.24 %	85	7
1971-72	Nil	Nil	Nil	-
1972-73	109761	55.43 %	212	20
1973-74	137919	69.65 %	258	13
1974-75	6871	3.47 %	15	1
1975-76	145371	73.42 %	289	7
1976-77	131679	66.50 %	231	8
1977-78	97520	49.25 %	190	20
1978-79	150121	75.82 %	275	16

1971-72 factory under shutdown for liberation war and 1974-75 under shutdown for ammonia control room explosion.

Process

Reformation - ICI
CO_2 Removal - Geamerco Vetrocoke
Synthesis - Toyo Engineering Corp.

Process description (Flow sheet):

The flow sheet is conventional for the steam reforming route. Natural gas received at the battery limit at 27 Kg/Cm^2G pressure is compressed to 35 Kg/Cm^2G by reciprocating compressor and preheated in 2 stages by 2 Kg/Cm^2G steam and in convection section of reformer duct. Preheated gas desulphurised in one stage by ZnO.

Process steam is supplied from high pressure steam header at 37 Kg/Cm^2G. The reformer is top fired with natural gas. There are 300 catalyst tubes in 12 rows and 78 burners in 13 rows. Process gas leaves the reformer at about 31 Kg/Cm^2G and 750°C.

Waste heat from the reformer flue gas is recovered in the convection section where it is used to generate and superheat extra high pressure steam (100 Kg/Cm^2G). Preheating of process air, process steam & feed stock

Since there is not sufficent waste heat to generate extra high steam, one auxiliary boiler (Combined firing of natural gas & purge gas of syn. loop) of 108 T/H capacity at a pressure of 100 Kg/Cm^2G is provided separately. Reformed gas from first reformer passes through 2nd reformer where process air introduced. Temp. of reformed gas leaving 2nd reformer is around 1000°C.

There are two vertical natural circulated water tube waste heat boilers after 2nd reformer. Reformed gas after loosing heat in waste heat boiler further cooled by process condensate before entering into high temp shift converter. CO conversion is done in two stages, namely high temp shift and low temp shift converter. Converted gas further cooled with boiler feed water and CO_2 stripper reboiler preedes CO_2 absorber where the CO_2 content of the make up gas is reduced to 0.2 percent with G.V. process. The methanation stage reduces residual carbon oxides in the syn. gas to less than 20 ppm and the gas is finally cooled and condensate knocked out before the syn. gas compressor inlet at a pressure of 24 Kg/Cm^2G.

The make-up gas is compressed in two stage compressor inter cooling and passed to the ammonia loop at about 140 Kg/Cm^2G. It is introduced into the condensing part of the loop so that the trace of carbon oxide and moisture is washed out. Product is liquified by NH_3 refrigeration and sent to storage tank at 19 Kg/Cm^2G pressure and 30°C.

Catalyst:

CCI FE catalyst is being used in all the catalyst vessels. The overall performance of the catalyst is excellent.

a) DSV (Vol. $5.66M^3x2$)
There are two separate beds of catalyst. Only one bed (lead bed) replaced in 1978. Long life of the catalyst is possible due to the purest quality of feed stock.

b) Ist Reformers (15.32 M^3)
Catalyst replaced in 1977 due to the cooking of catalyst at the time of heating up by NG instead of N_2 (N_2 comp. was out of order at that time).

c) 2nd reformer (Chromium catalyst $3.69M^3$ & Ni catalyst $14.1M^3$).
Catalyst replaced in 1978 for high Δ P due to the dust carry over 1st reformer at the time cooking and to facilitate replacement of catalyst grating and arches.

d) Low Temp shift(8.04 M^3 ZnO Guard & 33.2 M^3)
From 1977 3rd charge of catalyst is under operation

c) High Temp shift (37 M^3), MTN (16.1 M^3) & syn. conv. ($50M^3$) catalysts all are of initial charge.

Design/Manufacturer or defects

1. Tube failure of 1st and 2nd cold Exchanger

Tube leakage detected in the trial operation of the plant and subsequently plugged (just after guarantee test 33 tubes of 1st cold exchanger and 103 tubes of 2nd cold exchanger.

2. RGWHE drain line

Reformed gas waste heat boiler water tube bottom header drain failed initially and drain line plugged just after guarantee test.

3. Auxiliary Boiler

Super heater tube failed in June 1973 due to design defects. Modified the desuperheating system in 1974. (Initially steam leaving the superheater at $530^{\circ}C$ and then desuperheat it to $490^{\circ}C$. After modification desuperheating is in intermediate stage and steam leaving the superheater at $490^{\circ}C$).

4. Bottle neck for capacity utilization

The plant can run maximum at 85% load in summer (March to October) and 90% in winter (November to February) for the following reasons:

a) Cooling Tower: (Cross flow type)

Design basis: Tower inlet temp - $45^{\circ}C$
Tower outlet temp - $33^{\circ}C$
Wet bulb temp - $29^{\circ}C$
Relative humidity - 80%
Circulating water flow - 11600 T/H
Air rate - 124200 M^3/Min.

But most of the year relative humidity is above 90% and wet bulb temp goes up to $31^{\circ}C$ & tower Δt is only 6 to $7^{\circ}C$ instead of $12^{\circ}C$. Cooling tower outlet temp goes up to $37^{\circ}C$.

So, for cooling water alone, we cannot operate the plant more than 85% in summer and 90% in winter.

b) Air compressor: (Steam driven centrifugal type)

Design capacity - 29100 NM^3/H (36.5 Kg/Cm^2G)
Performance test at - 27000 NM^3/H
Present condition - 26400 NM^3/H

Instrument air extracted from inter-stage quantity:

Design - 1200 NM^3/H
Present condition - 1600 NM^3/H

Over and above we can not get full quantity i.e. 26400 NM^3/H for process and instrument due to high moisture content in air in summer season as well as some unknown reason which might be back flow within stages.

For 100% load we need 26000 NM^3/H but actually we are getting 23000 NM^3/H in summer and 24000 NM^3/H in winter.

c) Ammonia Condensers:

There are two ammonia condensers in refrigeration loop:

Design condition:
Cooling surface 835 M^2
Cooling water flow 1000 M^3/H
Cooling water inlet temp $33^{\circ}C$

In practice we are getting 850 to 900 M^3/H water at 35 to 36°C for each condenser. So, after proper cleaning (mechanically in tube side and degreasing in shell side) we can not handle more than 85% syn load in summer and 90% in winter.

2. The plant can not run for 300 or above stream days due to following reasons

a) Duration of yearly turnaround is high (about 60 days)
b) Tripping of the plant by false signals (some times repetitive nature)
c) Design defects of steam let down system. (Total failure of the plant necessary for syn. gas compressor failure due to timely non supply of steam to the process.)
d) Frequent power failure (Both captive as well national grid)
e) Shortcoming in supply of natural gas from gas field
f) Equipment failure, storing problem (in case of urea plant trouble) etc.

Problems encountered so far:

a) Up till now we have no major problem in gas reformer. No tube (Hk 40) failure occured. Minor repair was done in the welding point of outlet pig tail due to crack developed at welding point which also due to hammering of tube at the time of unloading catalyst after cooking. We had to replace 2nd reformer burner (Incoloy material) in 1974 for crack developed, and Alumina grating and arches replaced in 1975. These failures of burner and grating might be due to thermal shock occured for plant ups and downs.

b) There are reformed gas waste heat boilers (vertical) out of which high temp. one creates problem due to the failure of plug point in the header drain. As the header drainer shorter now we may not face further trouble (no problem for last one year). Fouling of tube surface occured frequently after startup (might be due to silica and other foreign material deposition) which causes less generation of steam.

c) Leakage of tube sheets of methanator effluent economizer (hot end) started from 1973. Ultimately we replaced the economizer in 1977 (Mfr. HITACHI ship building and Engineering Co. Ltd. Japan) with same manufacturer's product.

d) There is frequent failure of welding joint in the elbow portion on the outlet line of methanator.

e) Welding joint failure occured in the inlet of synthesis economizer at the outlet of syn. converters in 1977. Welding joint repaired in 1978 overhaul.

f) Tube failure of 1st cold exchanger and 2nd cold exchanger started after commissioning of the plant. So, each annual overhaul we had to plug the tubes.

g) Tube failure of the following exchangers (except GV process, which will be described separately) are experienced.
  1) Syn. gas compressor inter cooler (10% of the tube already plugged)
  2) Refrigerating compressor both inter coolers
  3) Gas final coolers (After methanator, before knock out drum)
  4) Only one tube of air compressor inter cooler

h) Welding joint failure of low pressure steam line to deaerator

i) Failure of BFW line control valves, gasket of steam valves

j) G.V. process
  1) Reboiler tubes failure (photo attached) ultimately replaced tube bundle without major modification in 1978. (Mfr. Mitsui ship building and Engg. Co. Ltd.)
  2) Reboiler vapour line failure in elbow portion due to corrosion and erosion. Replaced elbows in 1978.
  3) Regenerator shell leakage in two points, one in 1st bed & 2nd bed, another in between 3rd bed and 4th bed. Mild steel plate welded overloping the crack point (drawing attached)
  4) Tube failure of both heat exchangers in the top zones
  5) Tube failure of all the three (one stand by) solution coolers
  6) Sludge formation in packed column of both absorber and regenerator (ceramic rashing ring used as tower packing). Initial charge of r. ring is there in the tower. In 1977 r.ring of absorber unloaded, washed and re-loaded (picture attached). 100 times than design make-up is necessary in the year for sludge formation.
  7) Foaming of solution started from last one year, we are helpless to do anything except using antifoam and preceat on side stream filter. Foaming seems to be due to foreign material coming from tower packings:
  8) Failure of C.V. solution pump for coupling failure (photo attached)

<u>Preventive measures against corrosion</u>

a) Arsenic pentavalent in solution maintaining as per design. Chloride and iron content in solution maintaining at design value.

b) Limited dose of Hydrazine is added in BFW after deaerator to minimize dissolved O_2 (limiting the dose necessary to prevent NH_3 formation in boiler which can affect turbine condensers).

c) Polyphosphate is added in the boiler regularly

1) Quality of BFW is (normally) as follows:

Conductivity	1 Mu/CM Max.
Silica	0.02 PPm Max.
pH	8.5-9.0 Max.

2) Quality of boiler blow down is as follows:

Conductivity	50 Mu/Cm Max.
Silica	0.3 to 0.4 PPm Max.
pH	9.5-10.5

We can not maintain above quality in winter season due to the interference of collodial silica in BFW.

d) Cl_2 and Orgafilm (Polyphosphate & chromate) are added regularly in the cooling tower.

Cr content	9 to 10 PPm
Free Cl_2	0.1 to 0.2 PPm
pH	7 to 8

pH of cooling water comes down to 5 in the winter due to microbilogical phenomena. (Formation of nitrifying bacteria.)

e) In long shut down time, we keep catalyst vessels blanketed by N_2 and boiler drums by water with sufficient Hydrazine.

f) Up till now we checked the following:

1) Reformer tubes & pigtails diameter measurement, and dye penetration method on welding joints.
   Periodically we check skin temp of the tubes at running times by optical pyrometer. The skin temp is around 825-850°C. This lower temp is due to low load operation, high steam carbon ration and low temp operation.

2) We checked welding joints of CO_2 absorber in 1977 and found O.K.
3) We checked welding joints of one of the ammonia storage tanks in 1978 and found O.K.
4) We used to replace all gaskets packing of steam line valves in annual shut downs
5) Painting is done every year to prevent atmospheric corrosion.

Conclusion

Some internationally reputed agencies (1) Bresler and Associates Inc., New York.

(2) Toyo Engineering Corporation, Japan

(3) UNIDO as well as local experts are studying to find out ways and means to improve the situation so that capacity utilisation and stream days efficency can be achieved in near future.