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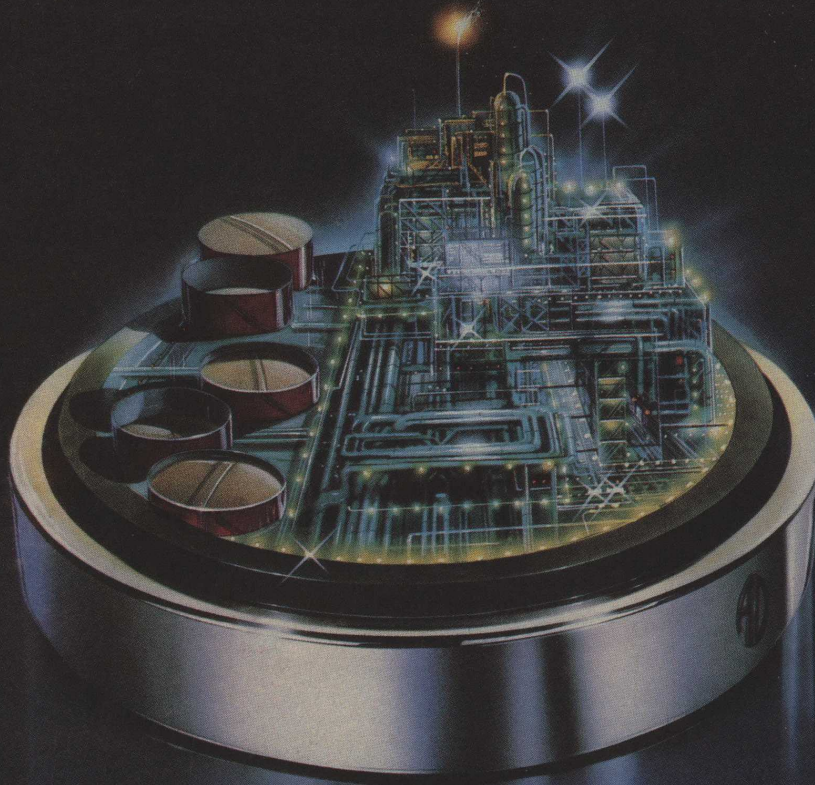
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PURGE GAS AS FEED IN AMMONIA PLANT

— R. P. Sharma

In 1981 R.C.F. had commissioned the new giant Ammonia Plant of 900 MTPD capacity. The commercial production of this single stream Ammonia Plant was started on 1st July, 1982. The Plant is based on process know how from M/s. Haldor Topsoe, Denmark and M/s. Benfield Corporation, U.S.A. The engineering work was done by M/s. Snamprogetti, Italy. The Plant is based on Associated gas as feed and fuel from Bombay high. The Associated gas mainly contains Methane alongwith other higher hydrocarbons.

The Associated gas composition is as follows :-

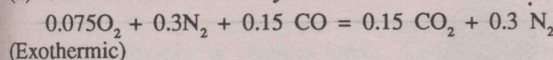
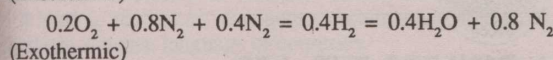
Methane	= 78.55%
Ethane	= 8.44%
Propane	= 5.31%
i - Butane	= 1.00%
n - Butane	= 0.93%
i - Pentane	= 0.22%
n - Pentane	= 0.17%
Hexane plus	= 0.02%
Carbondioxide	= 2.19%
Nitrogen	= 1.00%
Moisture	= 2.16%

In recent years, majority of high-capacity single stream Ammonia synthesis plants of the conventional type, use the hydrocarbon - steam reforming process to produce synthesis gas for ammonia production.

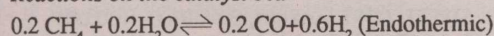
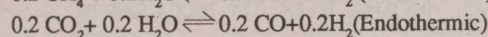
The nitrogen required for ammonia synthesis is derived from air supplied to secondary reformer. The oxygen portion of the air is consumed by combustion with methane and provide the necessary heat required in Secondary reformer.

The main reactions occurring in the secondary reformer can be summed up as follows :-

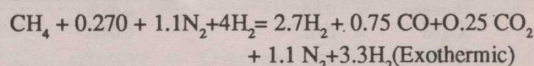
(a) Combustion above catalyst bed



(b) Reactions on the catalyst bed



(c) Overall Reaction



Carbonmonoxide of reformed gas is converted to carbondioxide in shift convertors and is removed by absorbing in Benfield solution. The synthesis gas contains mainly hydrogen, nitrogen and small amounts of unconverted methane together with inert gases like argon and helium from the air supplied. Argon, helium and Methane of the synthesis gas acts as an inert gas for the synthesis reaction and go on accumulating in the synthesis loop recycling system. Due to presence of inert gas in the synthesis gas the rate of ammonia conversion is reduced. The synthesis gas introduced in the loop has the following approximate composition.

Hydrogen	= 73.10%
Nitrogen	= 25.54%
Carbon Monoxide	= 5 ppm
Methane	= 0.98%
Argon	= 0.38%

To maintain the synthesis reaction in forward direction same amount of inert gases are required to be purged from the synthesis loop at a constant rate because the inert gases disturbs the reaction equilibrium. Approximately 7957 NM³/hr of Purge gas is vented from Synthesis loop of 900 MTPD Ammonia Plant installed at RCF Bombay to maintain the equilibrium of the reaction.

The typical composition of the Purge gas is as follows :-

Hydrogen	= 62.16%
Nitrogen	= 18.82%
Argon	= 3.89%
Ammonia	= 4.48%
Methane	= 10.52%

Formerly this Purge Gas was partially used in Reformer as fuel in conjunction with associated gas and the remaining was vented to atmosphere causing problem of pollution.

Since the purge gas is rich in hydrogen and methane content so it was conceived that this gas may be used in reformer as feed on 3rd January 1986, purge gas was fed to

The author is Dy. Chief Engineer, RCF.

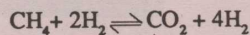
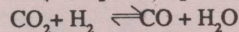
reformer along with feed gas. All the process parameters were monitored closely and compared with design parameters for any significant change. Reformed gas at exit of primary reformer was analysed and was compared with earlier results (without purge gas). No significant change was observed in any process parameters.

Reformed gas compositions at the exits of primary reformer are given below :-

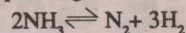
Reformed Gas without Purge Gas		Reformed Gas with Purge Gas
Methane	= 10.08	10.15%
Hydrogen	= 66.12	67.14%
Nitrogen	= 0.66	0.67%
Argon	= 0.02	0.04%
Carbon		
dioxide	= 13.28	12.45%
Carbon		
Monoxide	= 9.84	9.54%

Subsequently all the available amount (2500 NM³/hr) Ammonia production went up by approximately 40 MTPD.

The methane content of the purge gas is reformed with hydrogen, carbon monoxide and carbon dioxide in primary reformer. The ammonia content of purge gas is also decomposed to nitrogen and hydrogen. The nitrogen and hydrogen contents of the purge gas directly take part in synthesis reactions.



When ammonia of purge has been fed to reformer at high temp. it begins to decompose into components i.e. H₂ and N₂.



So, by feeding purge/gas reformer, there is a high increase in ammonia production in reaction of additional hydrogen and nitrogen available from purge gas for synthesis of ammonia.

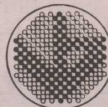
In addition to rise ammonia production, the Ammonia content of purge gas also helps to keep the reformer catalyst in reduced atmosphere which is highly favourable for catalyst.

Ammonia plant has been operated at 104% of the rated capacity by consuming approximately 2500 NM³/Hr of purge gas as feed along with associated gas. Now no purge gas is being vented to atmosphere resulting in reduction in pollution and increase output of ammonia. By this modification R.C.F. Bombay is able to produce additional 35-40 MTPD ammonia. So far R.C.F. ammonia plant is the only plant in India, where purge gas is used as feed gas. In other high capacity single stream ammonia plants either the purge gas recovery unit is installed or is being vented to atmosphere. By RCF's experience it is established that purge gas may partly be used as feed along with main feed in other Ammonia plants also.

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