PRODUCTION OF AMMONIA VIA STEAM REFORMING OF NATURAL GAS

BACKGROUND:

This flowsheet was developed as part of Course on wheels project (2018-19).Ammonia is synthesized using the traditional Haber's process, the required raw material are Nitrogen and Hydrogen, while Nitrogen is obtained by Air separation, the source of Hydrogen are the Hydrocarbon. In this case Methane is the source for Hydrogen, when Methane undergoes steam reforming Carbon monoxide and Hydrogen are formed which are together called as synthesis gas. This synthesis gas undergoes water gas shift reaction to produce more Hydrogen, then the gaseous mixture is treated with either amines or methanol at very low temperatures to remove the acid gas, and Hydrogen is then sent for synthesis, commercially Ammonia synthesis reaction require harsh conditions, Pressure about 200 bar and temperature about 450^{o}C.

MAIN REACTIONS:

1.$N_2 + 3H_2 = 2NH_3$ (Ammonia synthesis reaction)
2.$CH_4 + H_2O = CO + 3H_2$ (Steam reforming)
3.$CO + H_2O = CO_2 + H_2$ (Water gas shift reaction)

DESCRIPTION:

At first the Natural gas undergoes steam reforming, then the heat is removed from the exit gas, then it undergoes water gas shift reaction one at high temperature and the other at low temperature as the reaction is exothermic so to improve conversions we use two reactors then the gas stream is cooled to remove as much water as possible, then the gas contains Hydrogen, Carbon monoxide, Carbon dioxide, Water vapor, Methane and the gas should be made free from acid gas(CO and CO_2) which are poison to catalyst, this is done by washing with methanol in an absorption column at low temperatures, then high purity Hydrogen stream is obtained using PSA, then it is mixed with Nitrogen which is obtained by cryogenic distillation of Air, the Hydrogen-Nitrogen mixture is compressed to 200 bar and preheated to 450^{o}C and fed to the reactor, Ammonia is synthesized and finally it is separated as it is condensable at low temperature.

RESULTS:

Master Property Table					
Object	Pure N_2	Pure H_2	Natural gas	Final ammonia	
Mass Flow	7115.4	1534.89	3600	3847.14	kg/h
Volumetric Flow	402.546	1206.21	1713.38	5.91047	m3/h

CONCLUSION:

Ammonia was synthesized and the yield was close to the theoretical yield at present, we were able to obtain Hydrogen from Methane and synthesized Ammonia using it.

REFERENCE:

1. https://eng.umd.edu/~nsw/chbe446/Ammonia-Aspen.pdf
2. https://pubs.acs.org/doi/abs/10.1021/ie50402a012
3. https://www.sciencedirect.com/science/article/pii/S0378775303006141