Syngas Production from Regasified Liquefied Natural Gas

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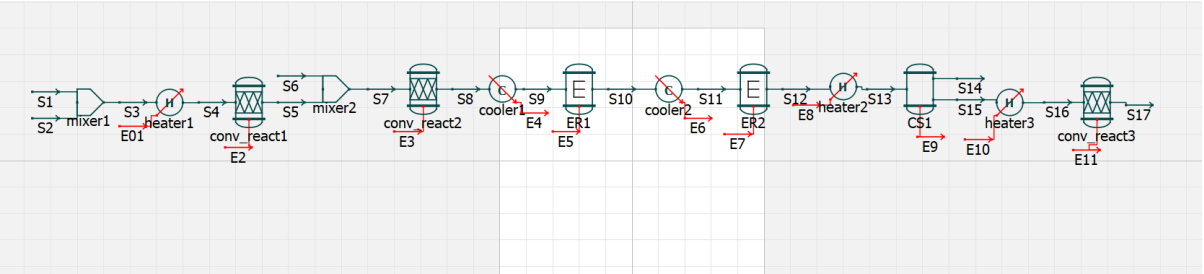
Introduction:

Ammonia is an essential chemical that can be produced from N_2 and H_2. The raw materials required for this process is air and naphtha which serves as a source for N_2 and H_2 respectively. While using naphtha as a raw material a large amount of carbon dioxide emission takes place which led the ammonia plant of Fertilizers and Chemicals Travancore Ltd (FACT) to use an alternative source of raw material which is sustainable that is liquified natural gas R-LNG. R-LNG produces less amount of carbon dioxide as it has lower carbon to hydrogen ratio and the pre desulphurisation step can be avoided which makes it a suitable raw material for the production of Ammonia. The following reactions takes place for production of syngas

1. Primary reforming :
    a. $CH_4 + H_2O \rightarrow CO + 3H_2$
    b. $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$
    c. $CO + H_2O \leftrightarrow CO_2 + H_2$
2. Secondary reforming:
    a. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
    b. $CH_4 + 1.5O_2 \rightarrow CO + 2H_2O$
3. Shift reaction:
    a. $CO + H_2O \leftrightarrow CO_2 + H_2$
4. Methanation:
    a. $CO + 3H_2 \rightarrow CH_4 + H_2O$
    b. $CO_2 + 3H_2 \rightarrow CH_4 + 2H_2O$

Flowsheet Description:



The feed consists of Steam (S1) and desulphurized R-LNG (S2) which is sent to a heater where it is heated up to 753.15 K and then fed into the conversion reactor(conv_react1) where the primary reforming takes place .The conversion reactor(conv_react1) is controlled to maintain 10.5 % of hydrocarbon as complete air reforming takes place in the secondary conversion reactor (conv_react2). Air (S6) is mixed along with the material stream (S5) before introducing it into the second conversion

reactor(conv_react2) where secondary reforming reactions takes place .During this process sufficient amount of nitrogen is produced for the production of ammonia. Then it is introduced into the equilibrium reactor (ER1 and ER2) where the carbon monoxides are removed by converting it to H_2 and CO_2. The leaving stream is then subjected to a compound seperator(CS1) where water and carbon dioxide is removed. The leaving stream(S15) is heated and subjected to another conversion reactor where the methanation reaction takes place where the trace amount of carbon oxides are used to obtain methane (S17) thereby reducing the emmission of carbon dioxide. Further processing can be used for the production of ammonia.

Results :

Stream	S1	S2	S5	S6	S8	S10	S12	S17
Temperature(K)	653.15	613.15	1050.15	1038.15	1235.15	675.829	494.286	604.15
Pressure (Pa)	3040000	3.73E+06	3.04E+06	3.11E+06	3.04E+06	3.04E+06	3.04E+06	3.04E+06
Mole Flows(mol/s)	388.883	138.912	719.393	507.196	1227.79	1227.79	1227.79	812.887
Molar Composition								
Hydrogen	0	0	0.456571	0	0.267517	0.299485	0.312529	0.46513
Water	1	0	0.350333	0	0.272135	0.240166	0.227122	0.005736
Carbon dioxide	0	0.00080016	0.057226	0	0.06501	0.096979	0.110023	0
Carbon monoxide	0	0	0.076095	0	0.046539	0.01457	0.001526	0
Methane	0	0.98519704	0.057071	0	6.96E-06	6.96E-06	6.96E-06	0.002316
Oxygen	0	0	0	0.21	0.020862	0.020862	0.020862	0.03151
Nitrogen	0	0.0140028	0.002704	0.79	0.327931	0.327931	0.327931	0.495309

Conclusion:

A flowsheet is built to produce syngas from R-LNG, steam and air. The syngas thus obtained can be used for further processing for the production of ammonia.

References:

1. Sunny, A., Solomon, P. A., & Aparna, K. (2016). Syngas production from regasified liquefied natural gas and its simulation using Aspen HYSYS. Journal of Natural Gas Science and Engineering, 30, 176-181.