Synthesis of Ammonia in Cryogenic Process

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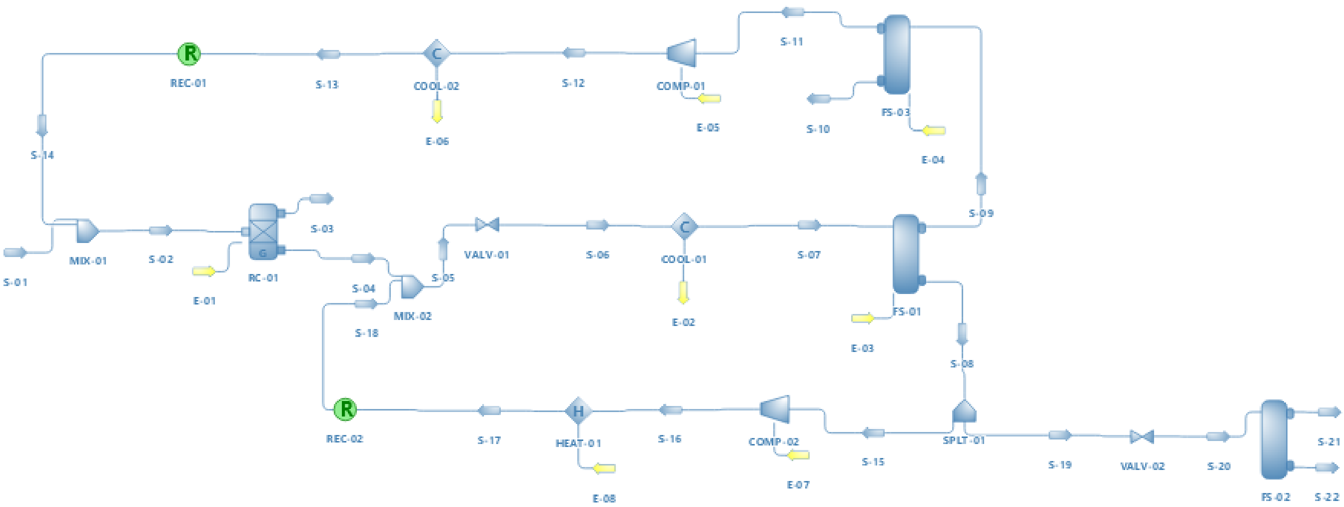
Background:

Some of the common synthesis of production of ammonia is by Haber Bosch process where H_2 is one the major component in synthesis of NH_3. The role of H2 in later stages increase following a higher complexity of energy systems due to the increase of renewable energy share, more wider and open energy market, and smarter energy management. H2 is very potential and appropriate to be used as both energy carrier and storage, also hydrogen can store the energy effectively, can be produced and utilized with several established technoloies, and has very low environmental impacts during its utilization. H_2 is import in sector of fuel as liquid hydrogen and as storage , NH_3 has one of the major role in the future H_2 economy. Ammonia also has all right characteristics of H_2 . In addition, compared to H2, it has very less flammability limit by volume in air and lower burning velocity . As another option, if if want to extract more H_2, H_2 can be released from NH_3 through several methods including thermal decomposition and electrochemical process.

Description:

This flowsheet contains single Gibbs reactor RC-1 , the reactor is used to form ammonia by having input of mixture of N_2,H_2,CH_4,Ar and recycled stream of hydrogen and nitrogen from compound separator CS-01, the outlet pressure of liquid stream S-04 is 90bar which is reduced to 15bar using adiabatic valve VALV-01 the mixture is cooled with cooler since the boiling point of ammonia is -32ºC the mixture is sent to Flash separator FS-01. the lower the operating temperature of Flash the more purity of ammonia is produced but with the cost of reduction of molar flow rate. the remaining vapour outlet of flash is passed through compound separator to separate 90% of the mixture of H_2 and N_2 for recycling back to the feed line after appropriate pressure and temperature correction. with The purity of FS-01 is 98.8%. FS-02 is joined to liquid output of FS-01 to get the purity of 99.8%. The remaining stream is recycled into output of RC-01 to get the efficiency high. the product is obtained at bottom FS-02 separator(S-21 and S-22) in vapour and liquid sections.

Flowsheet:



Results:

Master Property Table											
Object	**S-22**	**S-21**	**S-17**	**S-14**	**S-09**	**S-08**	**S-05**	**S-04**	**S-02**	**S-01**	
Temperature	-37.4254	-37.4254	50	50	-35	-35	50.0044	50	49.8466	50	**C**
Pressure	2	2	90	90	15	15	90	90	90	90	**bar**
Mass Flow	39240.1	1160.26	24761.5	1739.7	1739.71	65161.8	66901.5	42139.8	45613.9	43874.4	**kg/h**
Molar Flow	2299.98	47.5523	1438.81	92.7027	92.7034	3786.35	3879.05	2440.23	5092.7	5000	**kmol/h**
Volumetric Flow	0.0158479	0.127513	0.0119875	0.00731809	0.0328287	0.0261033	0.0316713	0.0196841	0.434319	0.426975	**m3/s**
Molar Fraction (Mixture) / Argon	0.00135183	0.338791	0.00818722	0.282438	0.282436	0.00818722	0.0147415	0.0186063	0.0149586	0.01	
Molar Fraction (Mixture) / Methane	0.000481305	0.237347	0.00527943	0.353227	0.353225	0.00527943	0.0135949	0.0184981	0.0162472	0.01	
Molar Fraction (Mixture) / Hydrogen	9.4841E-07	0.0106964	0.000217602	0.292237	0.292235	0.000217602	0.00719647	0.0113114	0.73185	0.74	
Molar Fraction (Mixture) / Nitrogen	4.95199E-15	7.72956E-11	1.57061E-12	2.95591E-09	2.95589E-09	1.57061E-12	7.21754E-11	1.13809E-10	0.235632	0.24	
Molar Fraction (Mixture) / Ammonia	0.998166	0.413166	0.986316	0.0720969	0.0721037	0.986316	0.964467	0.951584	0.00131229	0	
Molar Flow (Mixture) / Ammonia	2295.77	19.647	1419.12	6.68358	6.68426	3734.54	3741.22	2322.08	6.6831	0	**kmol/h**

Reference: https://doi.org/10.1016/j.egypro.2017.12.745