Haber Process (Ammonia Cryogenics)

- Flowsheeting - Add Table of Results
- Physical Property Environment
- Analysis - Optimization + Constraint
- Units - R-Equilibrium//Gibbs

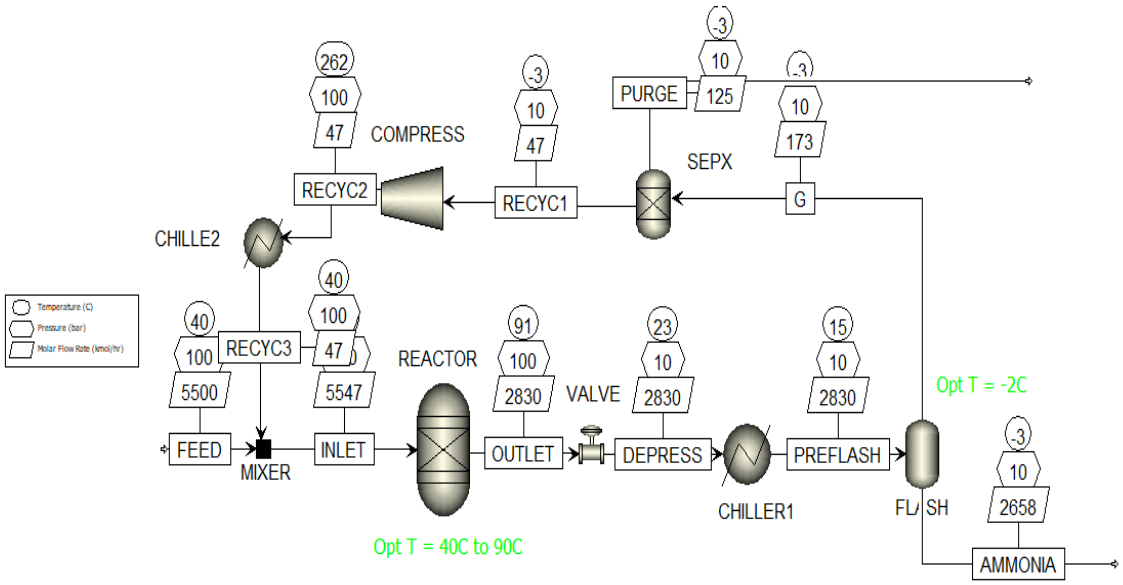
Problem Statement :

- Ammonia gas is to be produced from a mixture of cryogenic gases, H2, N2,CH4, Ar and some H2 (74.2, 24.7, 0.8, 0.3%)
- T feed = 40°C, P = 100 bar, F = 5500 kmol/h
- There is a reactor which converts Nitrogen gas and Hydrogen gas to Ammonia, as given in the Haber Process as: N2 + 3H2 → 2NH3
- Use Gibbs Free Energy Reactor 40°C to verify the % composition of the outlet of the reactor
- The mixture is then separated from Ammonia via flashing at low T… pre-specified T is -10°C, but the process engineer must verify/optimize the Temperature to maximize gains.
- Min. Purity is to be 99.5% Molar in the product of NH3
- Purge system has a 90% recovery of reactants, N2, H3 only. All other is purged

Design Methodology :

- (A) Run the reactor, verify the composition in the outlet given T-Reactor = 40°C
  - (Ai) Verify for IDEAL
  - (Aii) Verify for NRTL
  - (Aiii) Verify for Peng Robinson (recommended)
- (B) Cool down, then flash mixture → Verify Mole flow of Ammonia and purity
- (C) Recycle gases, recall that 90% of N2, H2 is recovered, all other is sent to stack & Verify Composition of Reactor
- (D) Optimize temperature of Flash. Maximize NH3 flow rate with at least 99.5% purity
- (E) Optimize temperature of Reactor. Maximize NH3 flow rate with at least 99.5 % purity

Model Simulation :



Results Summary :

	Units	AMMONIA	DEPRESS	FEED	G	INLET	OUTLET	PREFLASH	PURGE	RECYC1	RECYC2	RECYC3
− MIXED Substream												
Temperature	C	-2.68196	23.4564	40	-2.68196	39.9921	91.024	15	-2.68196	-2.68196	262.4	40
Pressure	bar	10	10	100	10	100	100	10	10	10	100	100
Molar Vapor Fraction		0	0.845263	1	1	1	1	0.14772	0.744804	1	1	1
Molar Liquid Fraction		1	0.154737	0	0	0	0	0.85228	0.255196	0	0	0
Molar Solid Fraction		0	0	0	0	0	0	0	0	0	0	0
+ Mole Flows	**kmol/hr**	**2657.68**	**2830.46**	**5500**	**172.788**	**5547.36**	**2830.46**	**2830.46**	**125.424**	**47.3635**	**47.3635**	**47.3636**
− Mole Fractions												
H2		0.000162795	0.0185866	0.742	0.301966	0.74413	0.0185866	0.0185866	0.0415996	0.991445	0.991445	0.991445
N2		1.89898e-06	0.000160846	0.247	0.00260564	0.244964	0.000160846	0.000160846	0.000358961	0.00855512	0.00855512	0.00855509
CH4		0.00252232	0.0155452	0.008	0.215852	0.0079317	0.0155452	0.0155452	0.297363	0	0	0
ARGON		0.00131327	0.00582943	0.003	0.0752934	0.00297439	0.00582943	0.00582943	0.103726	0	0	0
NH3		0.996	0.959878	0	0.404284	0	0.959878	0.959878	0.556952	0	0	0