PRODUCTION OF AMMONIUM CHLORIDE FROM AMMONIA

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Background:

Ammonium chloride is prepared from Ammonia by the synthesis reaction of Ammonia$(NH_3)_{vap}$ and Hydrogen chloride$(HCl)_{vap}$. Both fumes react to form white Ammonium chloride smoke, which can be developed into solid crystals. This exothermic reaction produces a significant amount of heat, up to 13 times the feed input. Nowadays the consumption of Ammonium chloride has been increased as it is used in Leclanche cells in aqueous solutions, used in fertilizers as a nitrogen source and much more applications.

$NH3 + HCl \rightarrow NH4Cl$

Description of the flowsheet:

The feed comprises primarily of Ammonia and Hydrochloride gas, which is fed into a stream mixing with the recycle stream as the other input. The output mixture has the temperate of 30°C is fed into the Conversion reactor, which performs the primary reaction. For reliable results and conversion, the Peng-Robinson property approach is recommended for this synthesis. The conversion limit is set to 80%, which is the maximum practical limit for obtaining the product. As this is an exothermic reaction, the output stream carries the mixture of temperature about 410°C. This is further cooled by a Cooler, which drops the temperature to 30°C. A considerable amount of energy will be released, as expected.

The conversion reactor's top product contains the majority of the ammonia and hydrogen chloride, while the bottom product contains mostly ammonium chloride. Both have their own distinct paths, which are referred to as Stream-1 and Stream-2, respectively. Separate coolers have been implemented to lower the heat output of the conversion reactor by up to 13 times. The output of both coolers is at a high pressure of 30 bar, which should be decreased to 1 bar for the sake of the subsequent procedures. To tackle this problem, Expander-01 and Expander-02 are introduced.

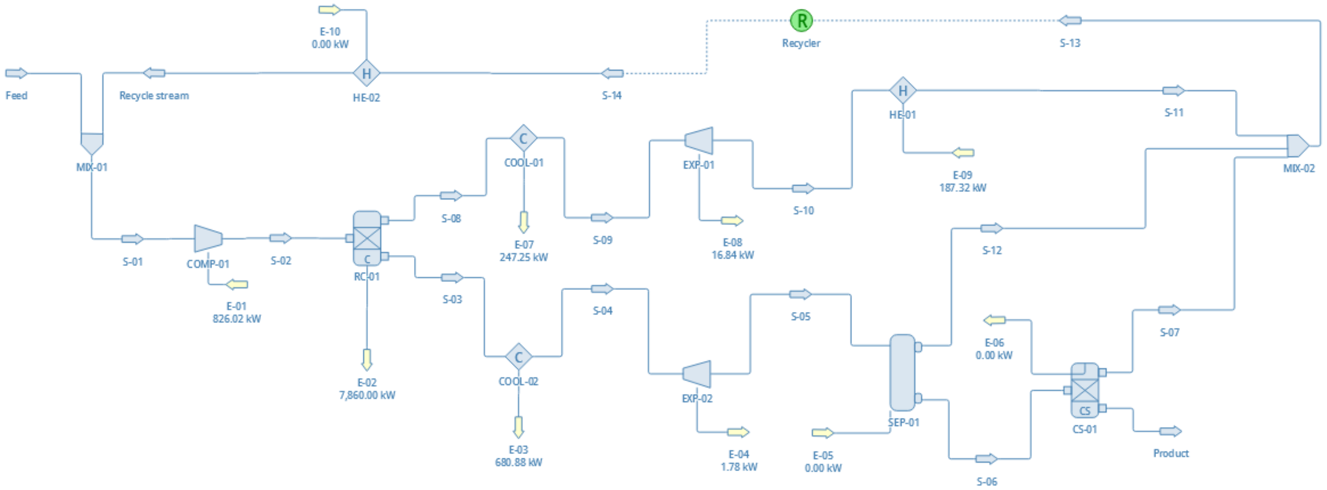
When the pressure in Stream1 is rapidly lowered, the temperature is automatically reduced to -67°C. The state of Ammonia has changed from vapor to liquid because of the temperature shift. As a result, the Expander-01's output is a heterogeneous mixture of vapor and liquid.

On the other end, stream-2 is ready for the separation of Ammonium chloride (NH4Cl), which is simple due to the liquid state of the ammonium chloride and the vapor state of the excess feed mixture. So, for the next step, I used the Gas-Liquid Separator (SEP-01) to separate the Ammonium chloride.

The top product of the Gas-Liquid separator is primarily Ammonia and Hydrogen chloride, while the bottom product is primarily Ammonium chloride with a minor quantity of feed mixtures, and these minor feed mixtures are separated using a Component separator (CS-01).

On the other end of the recycling process, the streams from Stream 1 and the top product of the Gas-Liquid separator (Sep-01) and the top product of the Sep-01 are mixed together. Since the temperature of the recycle output is lower than the feed, a heater is added after the Recycler. If this is not rectified, the temperature of the feed mix will be affected. When this cycle is repeated, we are able to retrieve our final product of pure Ammonium chloride from the bottom output of the CS-01 separator.

Flowsheet:



Results:

Results				
Object	**Feed**	**Recycle stream**	**Product**	
Temperature	30	30	30.2544	**C**
Pressure	1	1	1	**bar**
Mass Flow	3600	899.974	3600	**kg/h**
Molar Flow	134.601	33.6492	67.3023	**kmol/h**
Molar Fraction (Mixture) / Ammonia	0.5	0.499999	0	
Molar Fraction (Mixture) / Hydrogen chloride	0.5	0.500001	0	
Molar Fraction (Mixture) / Ammonium Chloride	0	1.61471E-08	1	
Phases	V	V	L	
Molarity (Mixture) / Ammonia	0.0199716	0.0199715	0	**kmol/m3**
Molarity (Mixture) / Hydrogen chloride	0.0199716	0.0199716	0	**kmol/m3**
Molarity (Mixture) / Ammonium Chloride	0	6.44966E-10	31.88	**kmol/m3**

Conclusion:

Thus, DWSIM is used to simulate the manufacturing of Ammonium Chloride.