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:

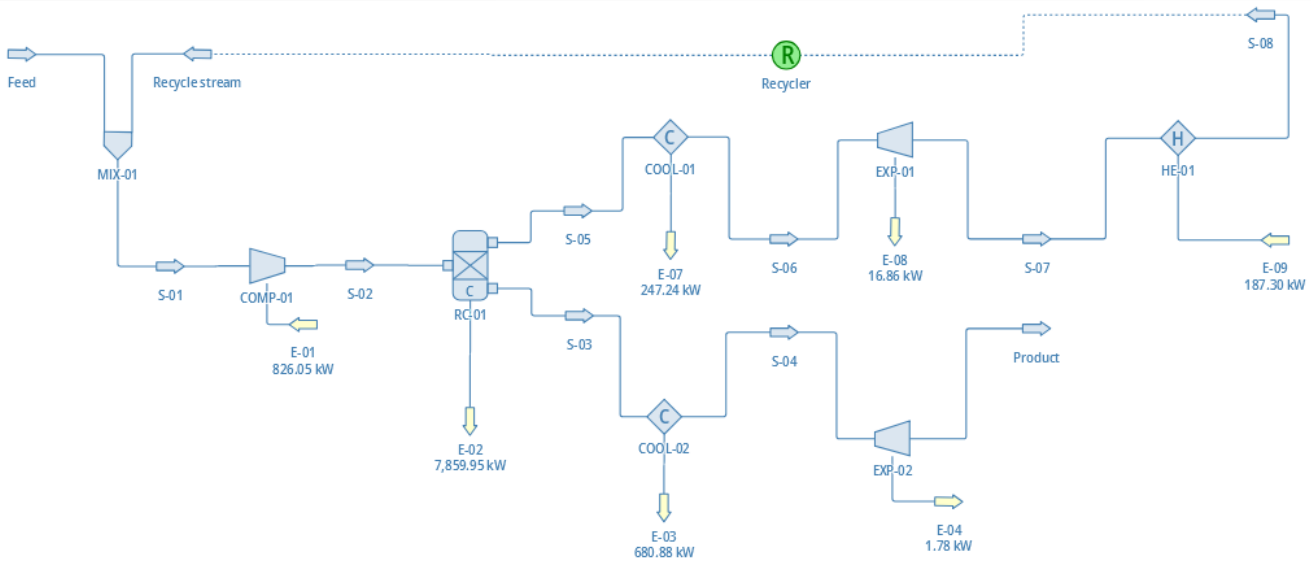
The feed comprises primarily of Ammonia and Hydrochloride gas, which is fed into a stream mixing with the recycle stream as the other input. The output mixture has the temperate of 30°C is fed into the Conversion reactor, which performs the primary reaction. For reliable results and conversion, the Peng-Robinson 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.

Since the temperature of this stream is lower than the feed, a heater is added before 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 Ammonium chloride(NH4Cl) from the bottom output of the Stream-2, which is the output from the EXP-02 and it is named as “Product” material stream.

Flowsheet:



Results:

Results				
Object	**Feed**	**Recycle stream**	**Product**	
Temperature	303.15	303.15	303.404	**K**
Pressure	100000	100000	100000	**Pa**
Mass Flow	1	0.25007	0.999995	**kg/s**
Molar Fraction (Mixture) / Ammonia	0.5	0.49987	8.80889E-06	
Molar Fraction (Mixture) / Hydrogen chloride	0.5	0.50013	1.2496E-06	
Molar Fraction (Mixture) / Ammonium Chloride	0	1.61473E-08	0.99999	
Molarity (Mixture) / Ammonia	19.9716	19.9664	0.278616	**mol/m3**
Molarity (Mixture) / Hydrogen chloride	19.9716	19.9768	0.0395237	**mol/m3**
Molarity (Mixture) / Ammonium Chloride	0	6.44976E-07	31628.7	**mol/m3**

Conclusion:

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