Implementation of a Reduction Scheme for Reduction in Ammonia content up to 50ppm from a Process Stream containing Hydrogen, Methane, and Ammonia

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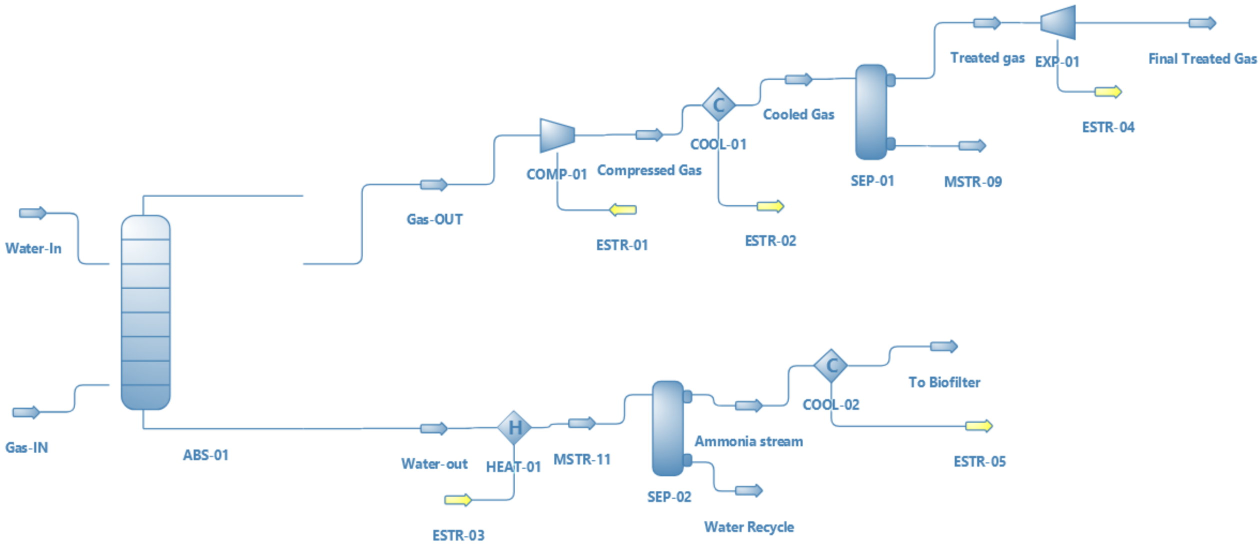
Background & Description:
This method utilizes the ability of ammonia to get readily dissolved in water to separate ammonia from the process stream. The water-ammonia mixture can then be sent to the biofilter for decomposition of ammonia.

1. Process Gas



The process gas is fed to the absorption column (ABS-01) from the bottom. The properties of the stream are:

Property	Gas-in
Temperature (°C)	40
Pressure (bar abs)	1.05
Molar flow rate (kmoles/hr)	47
Volumetric flow rate (m^3/s)	0.3237
Vapour fraction	1

2. Absorption Column (ABS-01)

The absorption column (ABS-01) is used to separate ammonia from the process stream by counter current absorption using a solvent. The solvent used is Water which is fed at a flow rate of 1243.05 kg/hr from the top of the column (water-in). The gases leaving from the top of the column (Gas-out) with reduced ammonia content are sent for further treatment to the overhead section whereas, the bottom stream (Water-out), rich in Ammonia is conditioned and sent for degradation to the biofilter. Absorber column is packed column with assumed to be operating at equilibrium, thus leaving streams are assumed to be in equilibrium.

Property	Water-in	Gas-out	Water-out
Temperature (°C)	25	24.95	20.93
Pressure (bar abs)	1.01	1.01	1.05
Molar flow rate (kmoles/hr)	69	47.27	68.72
Volumetric flow rate (m^3/s)	1.24	1156.4	1.25
Vapour fraction	0	1	0
Mole fraction Ammonia	0	6.7910-5	0.014
Mole fraction Water	1	0.026	0.985

3. Compressor (COMP-01)

The overhead gases are compressed from pressure of 1.01 bar abs to 10 bar abs with the help of a compressor (COMP-01). The gas coming out of the compressor is named compressed gas. The energy required by the compressor is given by the energy stream ESTR-01 which has a power requirement of 122.75 kW.

4. Cooler (COOL-01)

Compression of the gas leads to a significant increase in temperature to 332.8°C. This increased temperature will not prove to be helpful for further removal purification and hence, requirement of cooling of the gas to 13°C using a cooler (COOL-01). This requires cold duty equivalent to 150.87kW

5. Separator (SEP-01)

A gas-liquid separator is then used to separate the vapour stream and the liquid condensed during cooling. The outlet gas stream named, 'Final treated gas' is a mixture of Hydrogen, Methane, Ammonia and Water at temperature of 13°C and 10 bar pressure. This pressure is further reduced using an expander. The composition and properties of the stream are as follows:

Property		Final Treated gas
Temperature *(°C)*		6.08
Pressure *(bar abs)*		1.01325
Molar flow rate *(kmoles/hr)*		46.075
Volumetric flow rate *(m^3/s)*		1055.86
Vapour fraction		1
Mole fraction	Ammonia	4.9010-5
	Water	0.0013
	Hydrogen	0.9333
	Methane	0.0653

6. Heater (HEAT-01)

After water in contact with flue gas, it gets rich in ammonia (approximately 12.23 mol%). In order to make it more concentrated, the 'Water-Out' stream is heated below boiling point of water to release ammonia as gas. This heating enhances the escaping tendency of ammonia in the stream and thus can easily be stripped in the following steps of separation.

7. Separator (SEP-02)

Next, the heated stream is sent to a vapour-liquid separator. This encourages ammonia and other gases less soluble, get separated into two streams, vapour and liquid. This generates a relatively concentrated stream of ammonia in vapour form and the leaving liquid stream has very low concentration of ammonia (approximately water 99.9 mol%).