The Recovery of Ammonia from Purge Gas
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During production of ammonia, a portion of gas, which is a mixture of hydrogen, nitrogen and some inert gases, must be vented to increase synthesis rate of ammonia. This part of gas is called emission gas. After depressurizing the synthesis ammonia enters ammonia tank system, where the gases dissolved in ammonia under high pressure such as hydrogen, methane, nitrogen and a small amount of argon will evaporate, as well as a certain amount of ammonia. This part of gas is called storage tank gas. The combination of emission gas and storage tank gas is considered purge gas.

There are about 180~240m³ purge gas for one ton of ammonia produced. The compositions of the purge gas are: 20~70% hydrogen, 7~25% nitrogen, 7~18% methane, 3~8% Argon, 1~55% ammonia, and small percentage of krypton and xenon. Within storage tank gas, ammonia content may be up to 40~55%. Due to the pollution of ammonia, purge gas cannot be directly emitted into atmosphere. It should be recovered. The common processes are water wash and cryogenic separation. The recovery of the hydrogen, nitrogen or argon is sometimes required as well. The recovery of those gases will increase ammonia’s production rate, reduce the energy consumption. At mean time it will benefit environment pollution control as well.

Nowadays, most fertilizer manufactures in China use water wash and high temperature steam to recover the ammonia from storage tank gas. The recovery rate is low and energy consumption is high. The cryogenic process is a better way to perform the recovery job. According to the evaporating points, the components of the purge gas will be separated at low temperature. Our turbo expander has found its wide use in this area. The expander can be designed based on the working conditions. It works with high efficiency heat exchangers to recover the gases effectively.

We have designed and manufactured several units of the equipment and located them in the production fields. The equipment uses the pressure of purge gas to produce cold and recover ammonia. It does not need additional power. The purity of the recovered ammonia is greater than 99% and the ammonia vestiges of the emission less than 1%. If hydrogen and nitrogen content in the purge gas is high, they can be recovered and merged into the ammonia synthesis system as needed, or used as fuel gas into the boiler.

Advanced membrane separation equipment is wildly used now to extract the hydrogen from the emission gas and then sends it to the system. The gas goes to the boiler after adsorption and decompression. It is better for this adsorbed gas to enter the ammonia recovery system so that its pressure of 3.0 Mpa can be used effectively to produce cold. After cold recovery, it is sent to boiler with the ammonia-free tank gas.

The equipment designed by us for Sichuan Meifeng Company uses above process. The pressure of their storage tank gas is 2.2 MPa , ammonia content greater than 45%, about 1000M³/hr of process gas. After separation the residual ammonia content of the purge gas is less than 0.5%, the emission pressure is about 0.3 Mpa. The recovered ammonia product is high purity of 99% with pressure of 0.25~0.3MPa.

Another unit designed for Shandong Haihua Venus Company has been running for a while. Its recover capacity is more than 13 ton/day. It turned profit in three months. The specifications are followings: Process gas 1600Nm³/h, Gas pressure 22bar, Gas temperature 15 °C to 30 °C, gas components with 54% NH₄, 16% CH₄, 20% H₂, 7% N₂,
3% Ar. The gas after ammonia removal is sent boiler, with residual ammonia content less than 0.5%.

The profit from the recovery process depends on the conditions of ammonia production. Every plant has its specific situation. The recovery system uses purge gas pressure, no need of additional power, the operation is reliable and simple, and the cost of both the equipment and the operation are very low.

The entire sets of the equipment we made recently for Hebei Jinan Chemical Plant, Sichuan Meifeng Company and other clients are the improved, second-generation products. They look like a cold box. The installation of the equipment in the field is very simple. Locating and fixing it on the ground and then connecting the corresponding pipelines are the only installation work. The operation can be either automatically or manually, depending on the users needs.