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Petrochemical Industry Ammonia Plant

Process Gas Chromatograph Application Note

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Ammonia is used in a variety of applications in the petrochemical industry. It can be used as a fertilizer or it can be reacted with other compounds to form fertilizers, nitric acid, explosives and synthetic fibers. It is also used as a refrigerant in large cooling systems.

The ammonia plant starts with methane and/or other light hydrocarbons that is treated to remove any trace sulfur compounds. This treated feed stream is reacted with steam within catalyst-filled tubes of the primary reformer, according to the reaction:

$$CH_4 + H_2O \rightarrow 3H_2 + CO \quad (1)$$

The effluent stream (the desired product being hydrogen) is mixed with air and passed through the secondary reformer where unreacted natural gas is converted again by reaction (1). The nitrogen required for the ammonia synthesis is supplied by the air inlet but first, any trace CO and CO_2 must be removed.

The stream proceeds to a series of reactors that converts CO into CO_2 (convertors), removes as much CO_2 as possible (CO_2 Removal), and converts the remaining CO_2 into CH_4 (Methanator). The stream is now a synthesis gas (consisting of N_2, H_2, and inert gases) which is compressed and sent to the synthesis reactor consisting of a number of catalyst beds. In the synthesis reactor, ammonia is formed by the reaction.

$$3H_2 + N_2 \rightarrow 2NH_3 \quad (2)$$

The ammonia produced is condensed and removed as product. The unreacted gas is then recycled to the compressor with a portion of the recycle stream purged to prevent the buildup of inert gases. The purge gas is sometimes used as fuel to fire the primary reformer.

Typical GC measurements

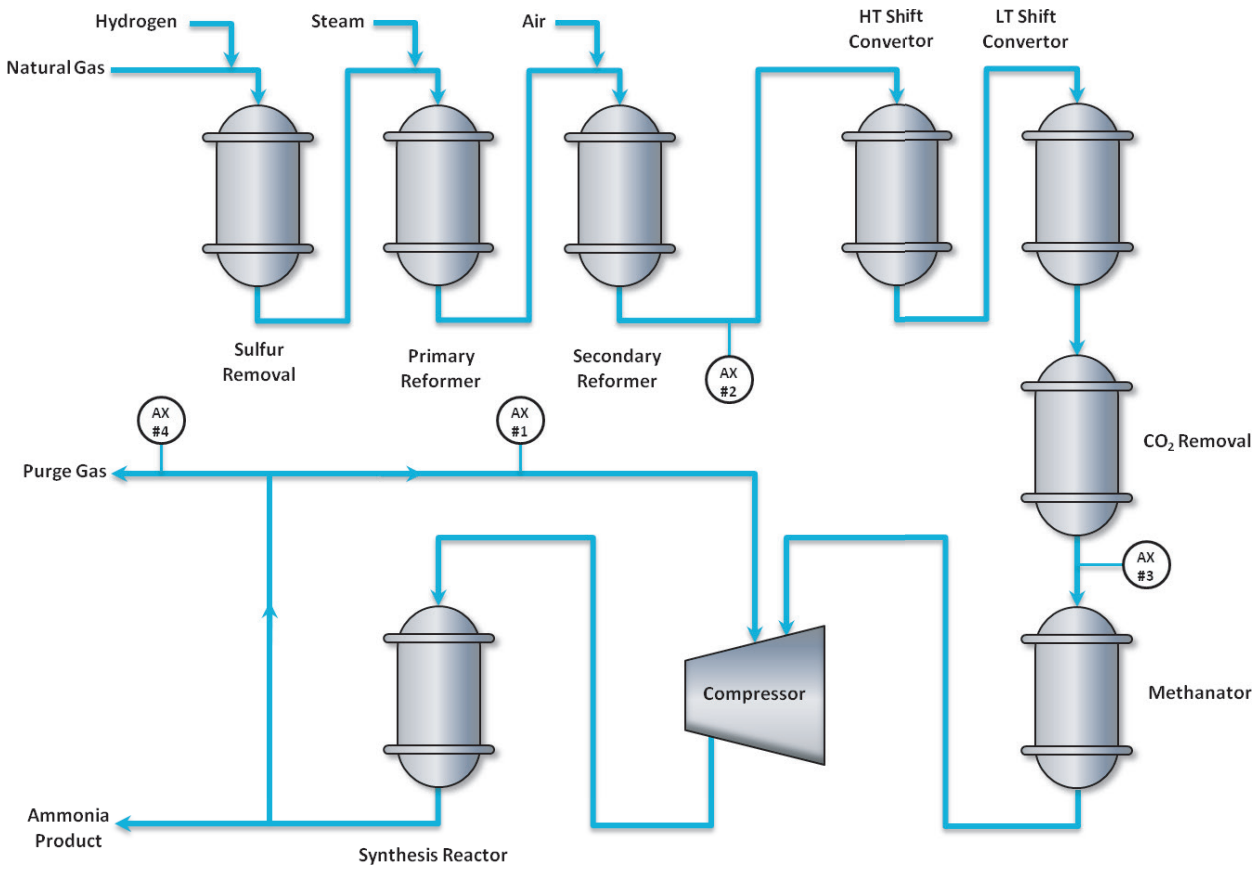
There are a few key measurements that need to be made to keep the ammonia plant operating efficiently:

1. **Synthesis Gas Recycle** – this is the most critical measurement point. It monitors the H_2 and N_2 ratio in the recycle stream. It must be kept at the proper level to produce the maximum amount of ammonia in each pass.
2. **Secondary Reformer Effluent** – measures C_1 to track the methane conversion in the secondary reformer.
3. **CO_2 Scrubber Effluent** – measures the levels of CO and CO_2 to optimize the unit's performance.
4. **Purge Gas** – monitors the inert gases to keep them at an optimum level. It can also measure the BTU content if the purge gas is being used as fuel for process heaters.

Optional

- Analyzer #1: mass spectrometers are often used for the recycle measurement due to the need for fast analysis time
- Analyzer #1: combine this analyzer. with analyzer #4 set up in a two-stream configuration.
- Analyzer #3: non-dispersive infrare (NDIR) analyzers can be used for the CO_2 effluent measurement. NDIR is often preferred because of low cost, but there have been issues with measurement errors due to cross interference.

Ammonia Plant



Analyzer No.	Stream	Components Measured	Measurement Objective
1	Synthesis Gas Recycle	H_2, N_2	Maintain H_2 to N_2 ratio for optimum synthesis conversion
2	Reformer Effluent	C_1	Monitor for unconverted C_1
3	Exit of CO_2 Scrubber	CO, CO_2	Monitor for complete removal of CO and CO_2
4	Purge Gas	Inerts & BTU	Optimize Purge Gas rates and track BTU for use as Fuel Gas

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