Lecture Note
For
Chemical Process Industries - I

Course-Diploma
Stream-Chemical Engineering
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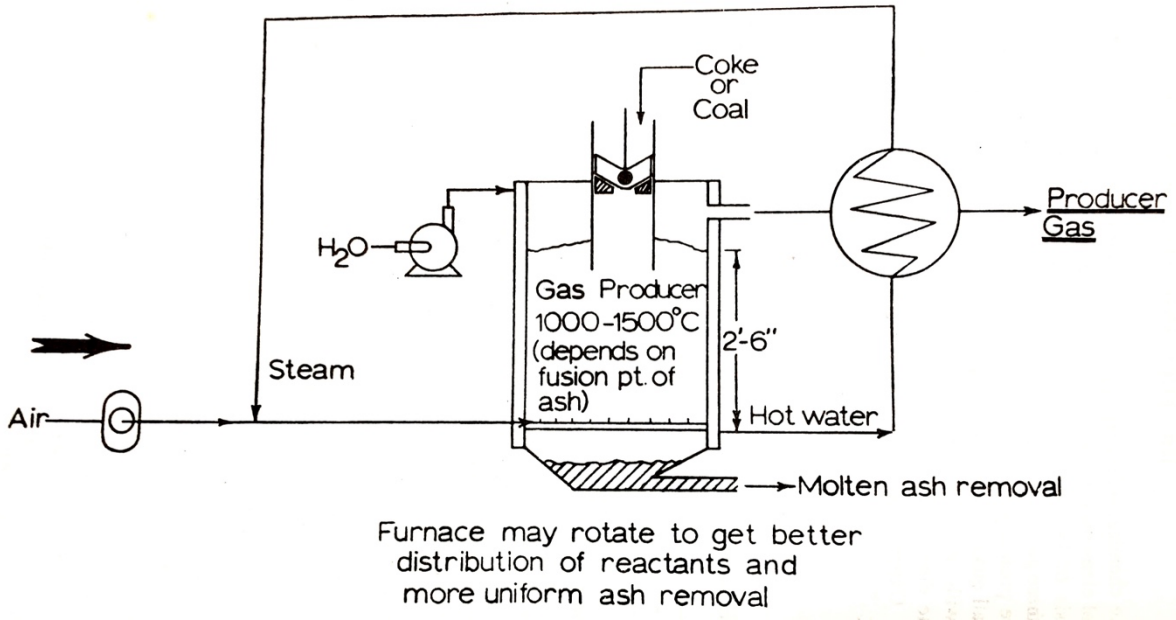
Industrial Gases

Manufacturing of producer gas



Manufacture of producer gas

Quantitative requirements

(a) Basis: 100 Nm of producer gas

Coke	20-25 kg
or Coal	25-30 kg
Air	60-80 Nm3
Steam	8-10 kg

(b) Plant capacities: 25,000-250,000 cubic meters/day

Process description:

Steam and air mixture injected in bottom of a water-cooled jacketed steel furnace equipped with a rotating grate to remove fusible ash. Solid fuel is added from hopper valve on top of furnace. Producer gas is cooled by passing through a waste heat boiler.

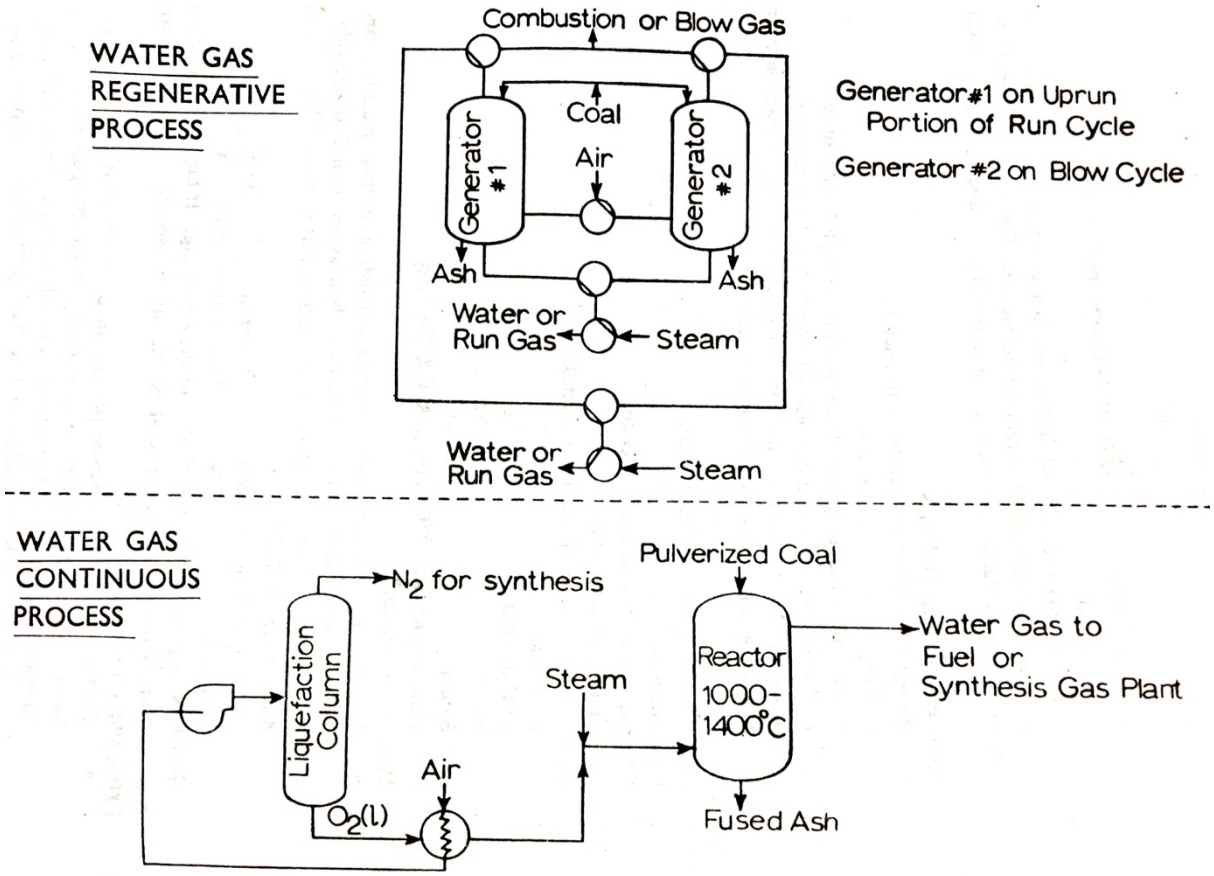
Major engineering problems:

(a) Design of suitable gas producer furnace to:

- Keep uniform fuel surface
- Provide adequate gas-fuel contact time at high temperature
- Avoid clinkering and provide for proper fused ash removal

(b) Addition of correct steam quantities to supply net heat of reaction near zero on a continuous once-through process.

Manufacturing of Water gas



Manufacture of Water gas

Raw materials: Bituminous, anthracite coal, or coke

Quantitative requirements

(a) Basis: 100 cu m of water gas from C

C as coke	55 kg
or C as coal	58 kg
Air	220 Nm
Steam	80 kg

(b) Plant capacities: 250,000-1,500,000 Nm™/day

Process description

• Regenerative process- -older process consisting of two reactors, one operates on blow period which heats carbon by reaction 2(a), the other on a run period where endothermic reaction 2(d) occurs. The cycle of
4-6 minutes is divided as:

Blow or heat-up	35%	Downrun	33%
Uprun	30%	Short purge uprun	2%

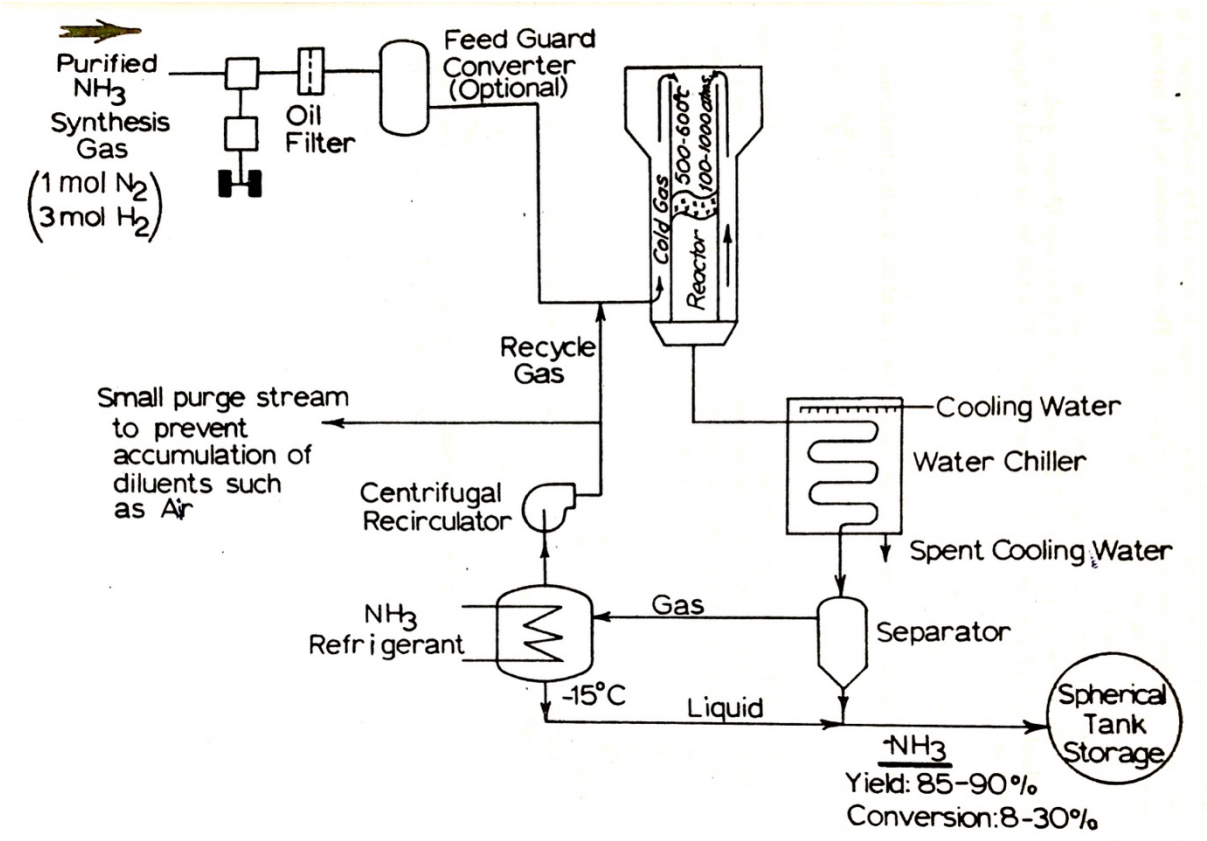
Reactors or generators are steel with refractory lining. If higher BTU gas is required, an additional high-temperature carburetor section is required for pyrolyzing oil spray and mixing.

• Continuous process--newer process invented in 1940's by Germans.Based on use of tonnage or low purity grade oxygen made by air separation procedure. The correct ratio of steam, oxygen, and coal is added to the reactor to yield a self-sustaining reaction of approximately zero heat release. Subsequent innovations allow for ash content > 30% so Indian coal can be used.

Major engineering problems

- Designing suitable ash removal systems for various grades of coal in continuous processing.
- Optimizing cycle for regenerative process.

Manufacturing of Ammonia



Pertinent Properties of Ammonia:

Mol. wt.	17.03
M.P.	-77.7°C
B.P.	-33.4°C
Solubility	Very soluble in water

Grades: Anhydrous or liquefied NH_3, stored at 80°F with a pressure of 175 psig.
Aqueous grade (28 wt. % NHs).

Consumption Pattern

End Uses

The end uses for ammonia worldwide are as follows:

Direct application as fertilizer	25%
Urea (for both fertilizers & plastics)	21%
Ammonium phosphates	16%
Nitric acid	12%
Miscellaneous	12%
Ammonium nitrate	8%
Ammonium sulfate	3%
Acrylonitrile	3%

Raw materials

- H2 from synthesis gas
- N, from air addition in synthesis gas process or from air liquefaction process

Process description:

Ammonia synthesis gas (3 moles pure H: 1 mole pure Ny) is compressed to the operating pressure (100-1,000 atms. depending on conversion required). It is sen through a filter to remove compression oil and additionally through a high temperature guard converter (converts CO and CO, to CH, and removes traces of H,O, H,S, P and As). This is done by catalyst and suitable getter materials.

The relatively cool gas is added along the outside of converter tube walls to provide cooling so that carbon steel can be used for the thick wall pressure vessel and internal tubes. The preheated gas flows next through the inside of the tube which contains promoted porous iron catalyst at 500-550°C.