

CH1019 Chemical Process Technology

Lecture 4

Chapter 3 Fertilizer Industries

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Overview of topics

Chapter 3 FERTILIZER INDUSTRIES

- 1 Nitrogen industries
- 2 Phosphorous industries
- 3 Potassium industries



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Fertilizer industries

- Fertilizer industry is the major component of the agricultural chemicals industry which in turn a major chemical engineering contribution to agro-business.
- Three major components are necessary in fertilizers:
 - (a) **Nitrogen (N)** – required during early stages of plant growth to promote development of stems and leaves.
 - (b) **Phosphorus (P)** – which stimulates early growth and accelerates seeding or fruit formation in later stages of growth.
 - (c) **Potassium (K)** – essential to the development of the starches of potatoes and grains, the sugar of fruits and vegetables and the fibrous materials of the plant; an ample supply of potassium in the soil sometimes helps to prevent disease and to lessen the effects of excessive nitrogen application.



Fertilizer industries – Nitrogen

- Fertilizers supplying nitrogen are prepared in two basic types:
 - i. **Mixed fertilizers** – these contain three principal elements (nitrogen, phosphorous, and potassium).
These are generally granular solids.
 - ii. **Chemical nitrogen fertilizers** – chemical compounds used separately where direct application is required.



Fertilizer industries – Nitrogen

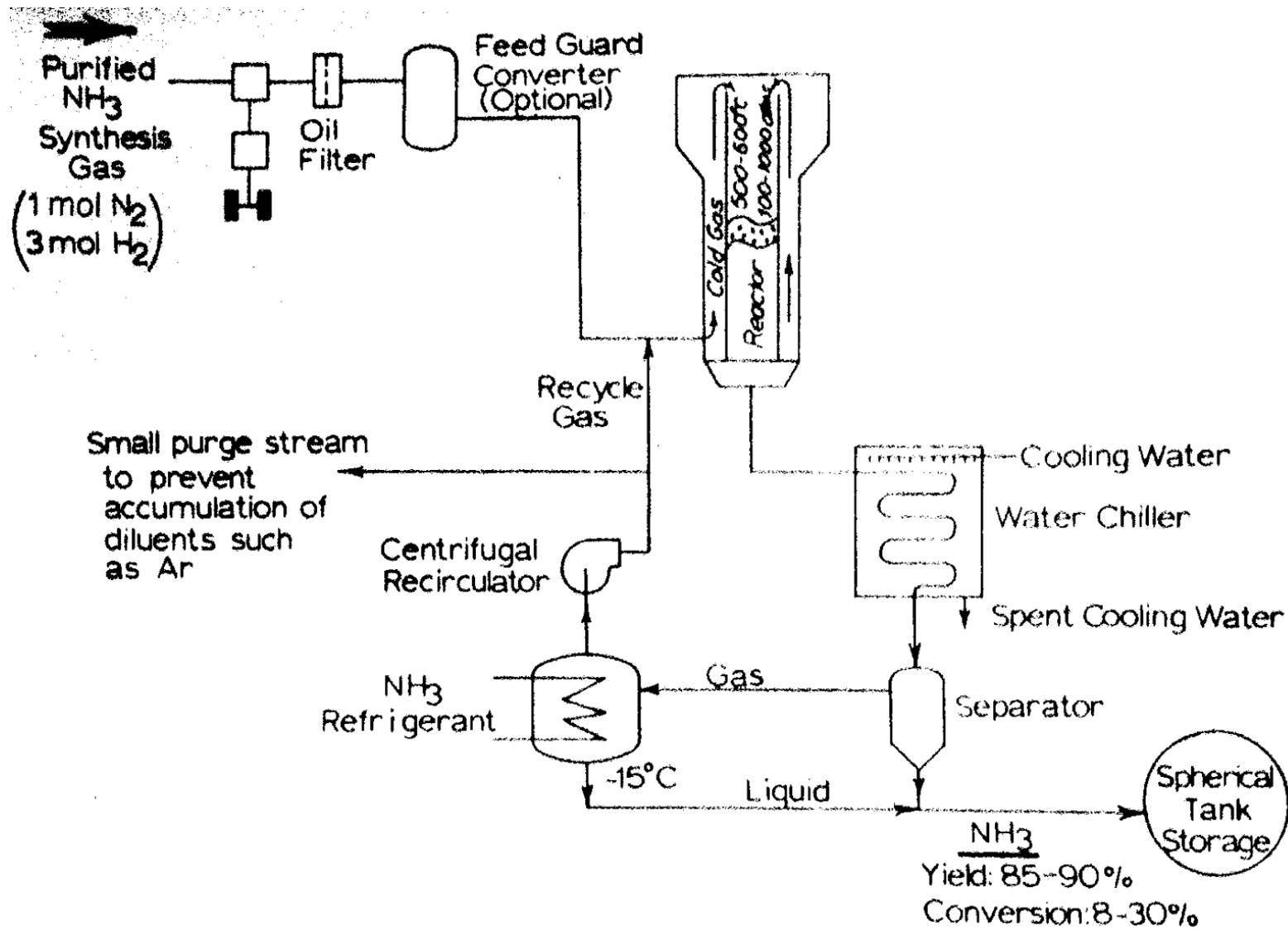
- Abundant nitrogen in the air is commercially fixed by reaction with low-cost hydrogen to give **ammonia**.
- This low –cost chemical is used for supplying:
 - (a) Nitrogen fertilizers in the form of liquid and aqueous NH_3 solutions, ammonium salts and **urea**.
 - (b) **Nitric acid**



Fertilizer industries – Ammonia

- End uses of Ammonia
 - a) Direct application as fertilizer
 - b) In the **urea**
 - c) **Ammonium phosphates**
 - d) In the manufacture of **nitric acid**

Fertilizer industries – Ammonia



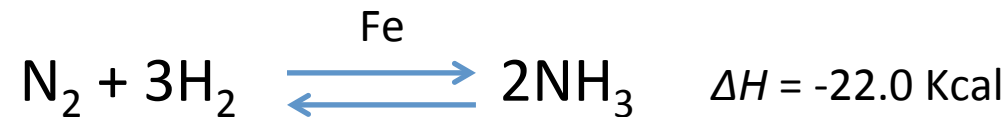
Fertilizer industries – Ammonia

Major steps involved in the manufacture of Ammonia (NH_3)

- Ammonia synthesis gas (3 moles of pure H_2 :1 moles of pure N_2) is compressed to the operating pressure (100 – 1,000).
- Filter is used to remove the compression oil and additionally through a high temperature converter. (converts CO and CO_2 to CH_4 and removes traces of H_2O , H_2S and P).
- This is done by catalyst (Fe).

Fertilizer industries – Ammonia

The reaction is



Relatively cool gas (NH_3) is added along the outside of converter tube walls to provide cooling.

- The porous iron catalyst is used in the converter and the temperature maintained at $500 - 550^\circ\text{C}$.
- The ammonia conversion achieved is about 30% depending on the process conditions.



Fertilizer industries – Ammonia

- The product ammonia is separated by separated by condensation with water cooling and then by refrigeration.
- The unconverted N_2 - H_2 mixture is recirculated to obtain 85 – 90% of Ammonia yield.



Sulfur Industries

References

1. Dryden C. E, *Outlines of Chemical technology – for the 21st Century*, 3rd edition, East-West Press (2004)
2. Austin G. T, *Shreve's Chemical Process Industries*, 5th edition, Mc Graw Hill International editions (1984)