

CH1019 Chemical Process Technology

Lecture 3

Chapter 2 Sulfur and Silicate Industries

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Overview of topics

Chapter 2 SHULFUR AND INDUSTRIES

- 1 Sources of Sulfur
- 2 Mining of Sulfur
- 3 Manufacture of sulfuric acid
- 4 Silicate Industries – Alum, and Ceramics
- 5 Glass and Cement



Overview of topics

Chapter 2 SHULFUR AND INDUSTRIES

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Sulfur industries – Sulfur

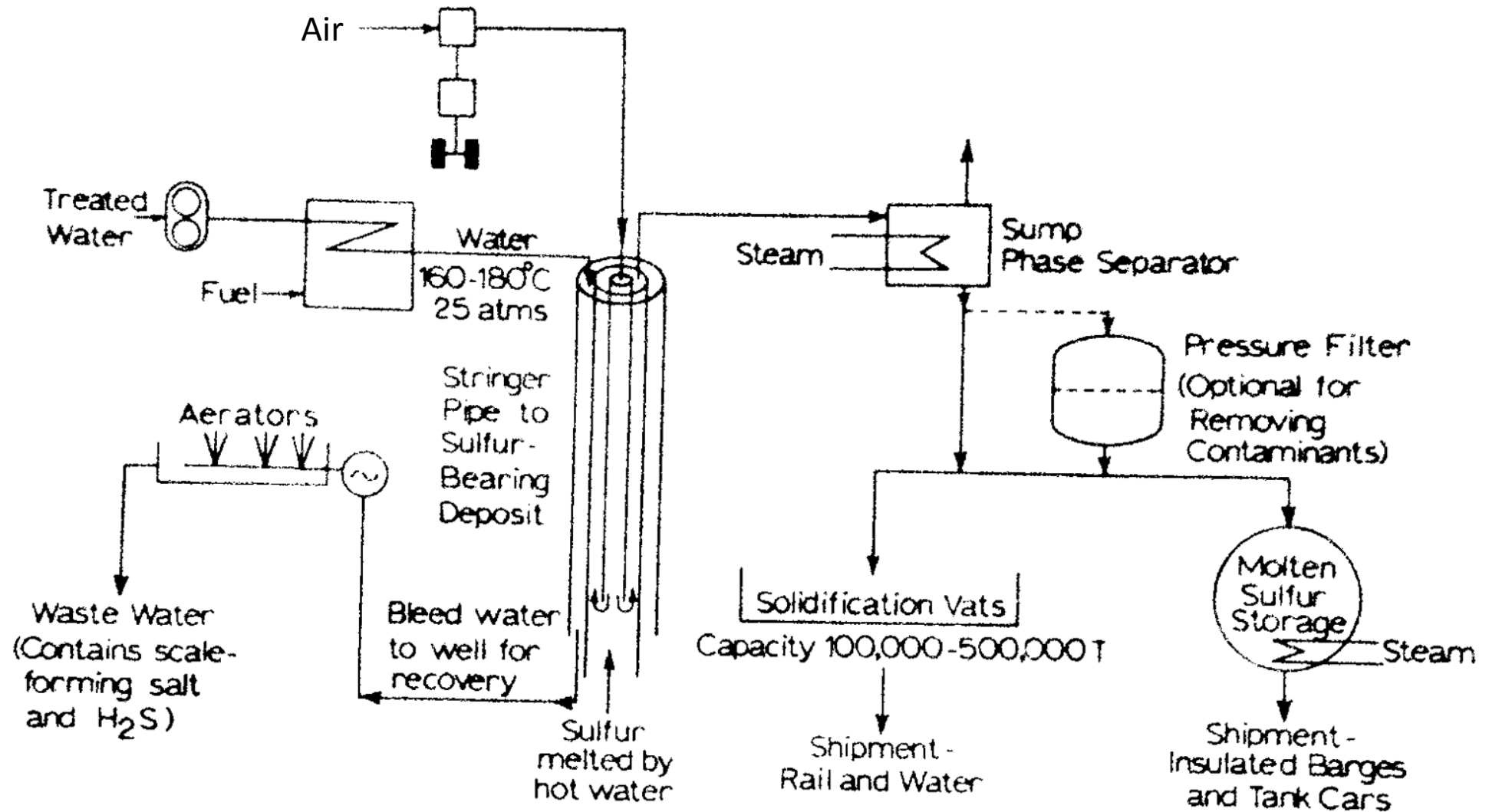
- Sulfur is the basic raw material for the manufacture of sulfuric acid
- Sulfur has the chemical formula S
- It exists in rhombic crystals and as monoclinic crystals
- It is insoluble in water but soluble in organic solvents and liquid ammonia

Sources of sulfur:

- Sulfur bearing salt domes
- Recovery of elemental sulfur from petroleum refinery (sour crude oil)
- Hydrogen sulfide in sour crude oil

Sulfur industries – Sulfur

- Elemental sulfur mining from salt domes





Sulfur industries – Sulfur

Elemental sulfur mining from salt domes

- Wells drilled into free sulfur-bearing salt domes.
- Treated hot water is pumped into deposit melt sulfur; water moves upward and outward to bleeder of casing and is jet pumped with compressed air to sump-separation units and shipment or storage.
- Filtration is used to remove carbonaceous and mineral matter.



Sulfur industries – Sulfur

Application of Sulfur

- 80-90% of sulfur-containing materials are converted into commercial oxidized forms:
- Sulfur dioxide, Sulfur trioxide, Sulfuric acid, Oleum ($\text{H}_2\text{SO}_4 + \text{SO}_3$)
- 85-90% for sulfuric acid manufacture
- Rubber vulcanization agents
- Sulfur dyes
- Gun powder, phosphate fertilizers, copper leaching
- Pigments



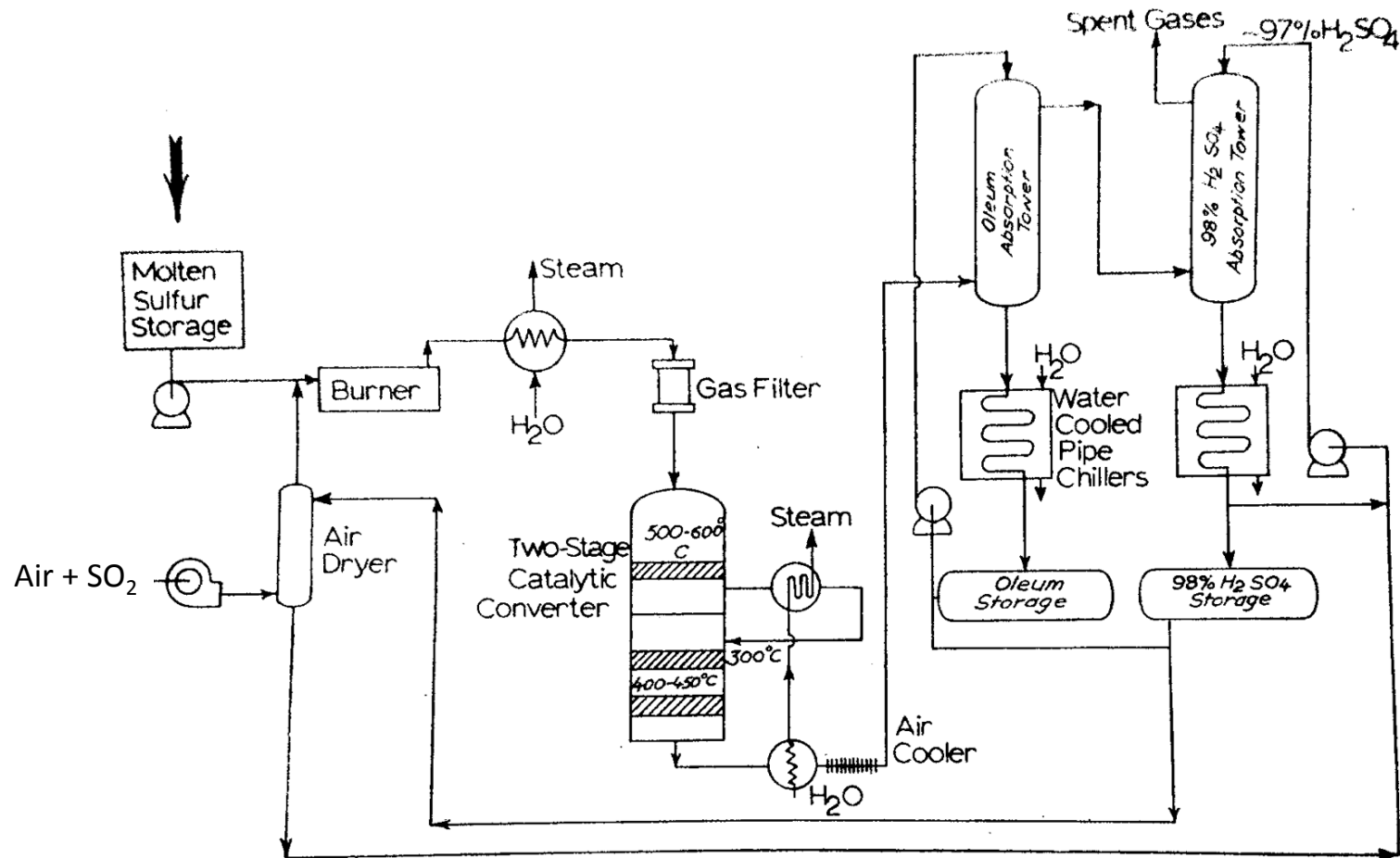
Sulfur industries – Sulfuric acid

Manufacture of Sulfuric acid

- Methods employed in the manufacture of H_2SO_4 includes
 1. Contact process
 2. Chamber process
- Both the process are based on SO_2 .
- Chamber process was developed first 1746 but produced acid of concentration less than 80%
- Contact process yields 98% H_2SO_4
- Chamber process is virtually obsolete now

Sulfur industries – Sulfuric acid

Manufacture of Sulfuric acid – Contact process



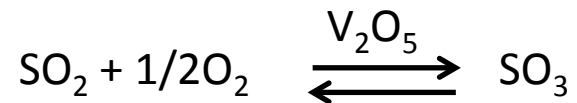
Sulfur industries – Sulfuric acid

Manufacture of Sulfuric acid – Major steps



Sulfur is oxidized to SO_2 $\Delta H = -70.9$ Kcal

This reaction is accomplished in the burner



Conversion of SO_2 into SO_3 in presence of vanadium pentoxide catalyst. This reaction occurs in two stage catalytic reactor. $\Delta H = -23.0$ Kcal

The resulting reactor effluent is cooled, absorbed to get Oleum and Sulfuric acid



Sulfur industries – Sulfuric acid

Manufacture of Sulfuric acid – Catalyst

Advantages of V_2O_5

- Relatively immune to poisons
- Low initial investment

Disadvantages of V_2O_5

- Requires high O_2/SO_2 conversion for economic operations
- Large converters and initial investment on reactors are high



Silicate industries

Silicate Industries – Ceramic, Glass and Cement Industries

The traditional ceramic industries, referred to as the [clay industries or silicate industries](#) , have as their finished products that are essentially silicates.

Some of the properties of ceramic products are:

1. White wares – China, earthen ware, pottery, porcelain, stoneware and vitreous ware.
2. Refractories – Firebricks, silica, chromite, magnesite, aluminum silicate and alumina products
3. Structural clay products – Building bricks, sewer pipe and drain tile.
4. Enamel and enameled metal



Silicate industries

Silicate Industries – Ceramic

Some of the properties of ceramic products are:

1. Withstand higher temperature
2. Resist greater pressure
3. Superior mechanical properties
4. Posses special electrical characteristics
5. Protect against corrosive chemicals



Silicate industries

Silicate Industries – Ceramic

- Alum is a double sulfate of aluminium.
- Aluminium sulfate is very important industrially and, although it is not a double sulfate, it is often called either alum or paper makers alum.
- Alums are used in water treatment and sometimes in dyeing.



Silicate industries

Silicate Industries – Glass

Glass

- Glass may be defined, physically, as a rigid, having no definite melting point and sufficiently high viscosity
- Glass is completely vitrified product.
- Glass has the following properties:
 - I. Posses high transparency
 - II. good resistance to chemical attack
 - III. Effective electrical insulator
 - IV. Brittle and has greater tensile strength



Silicate industries

Silicate Industries – Glass

Glass

- In general, commercial glasses falls into the following class:
 - ① Fused silica
 - ② Alkali silicates
 - ③ Soda-lime glass
 - ④ Lead glass
 - ⑤ Borosilicate glass
 - ⑥ Glass fiber
 - ⑦ Window glass and plate glass.



Silicate industries

Silicate Industries – Glass

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Silicate industries

Silicate Industries – Cement

Cement is the generic name for powdered materials which initially have a plastic flow when mixed with water or other liquid, but form solid structure in several hours with varying degree of strength and bonding properties which continue to improve with age.



Silicate industries

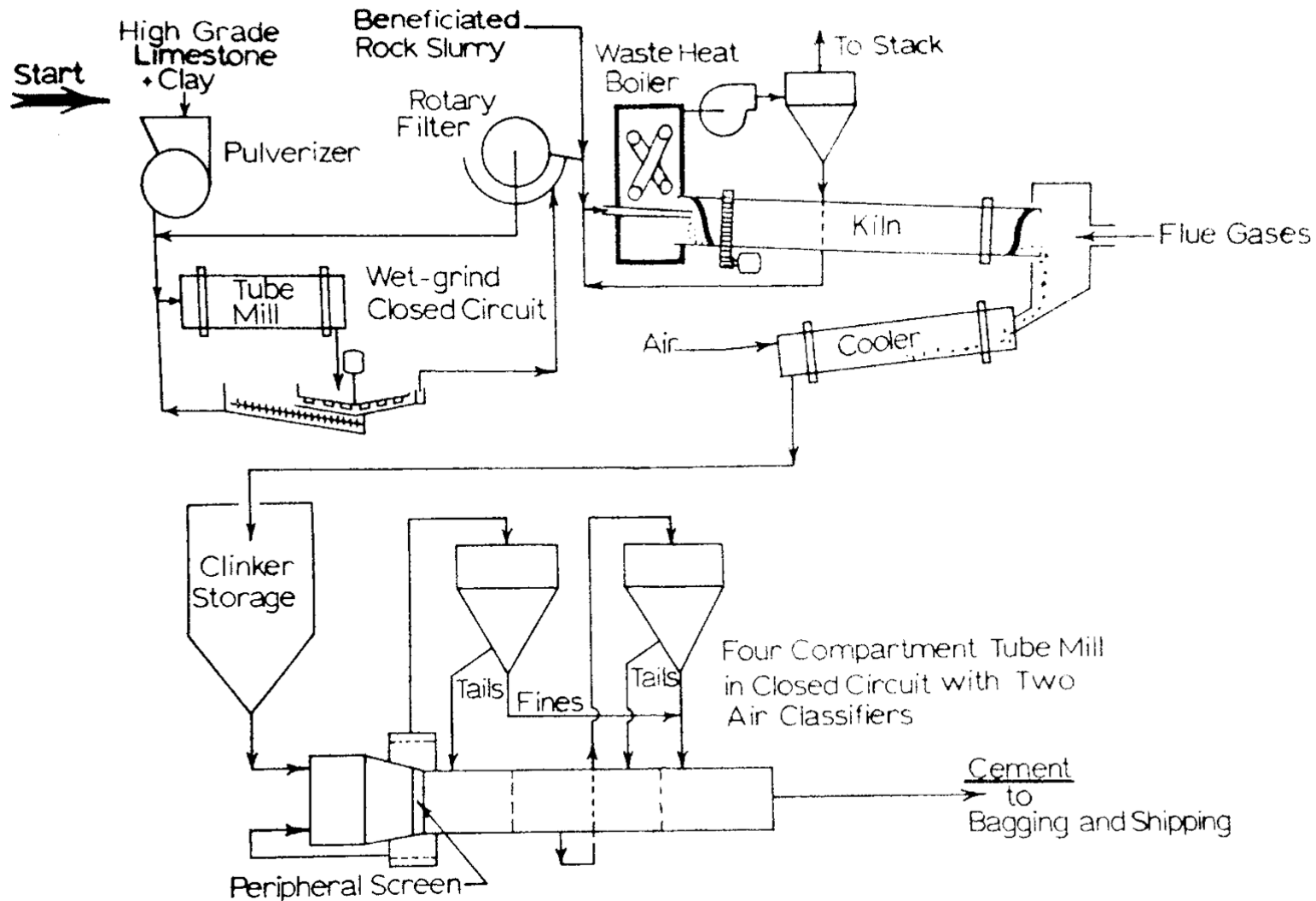
Silicate Industries – Cement

General types of cement

- I. Portland cement
- II. High alumina
- III. Hydraulic hydrated lime

Silicate industries

Silicate Industries – Cement





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)