Tikrit University

College of Petroleum Processes Engineering

Department of Petroleum Refining Engineering

Specialized Petroleum Processes

Fourth Class

Lecture 6

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Crude Oil Processing from Oilfield to Refinery

4. Stabilization and Sweetening of Crude Oil

Once degassed, dehydrated, and desalted, crude oil is pumped to gathering facilities to be stored in storage tanks. However, if there are any dissolved gases that belong to the light or the intermediate hydrocarbon groups (as was explained in Chapter 3), it will be necessary to remove these gases along with hydrogen sulfide (H_2S; if present in the crude) before oil can be stored. This process is described as a dual process of both stabilizing and sweetening a crude oil. Stabilizer plants are used to reduce the volatility of stored crude oil and condensate. Process units are designed to maximize recovery of hydrocarbon liquids that might otherwise be lost to the natural gas stream. Crude oil is considered sweet if the dangerous acidic gases are removed from it. On the other hand, it is classified as sour if it contains as much as 0.05 ft^3 of dissolved H_2S in 100 gal of oil. Prior to stabilization, crude oil is usually directed to a spheroid for storage in order to reduce its pressure to very near atmospheric, as shown in Figure 1.

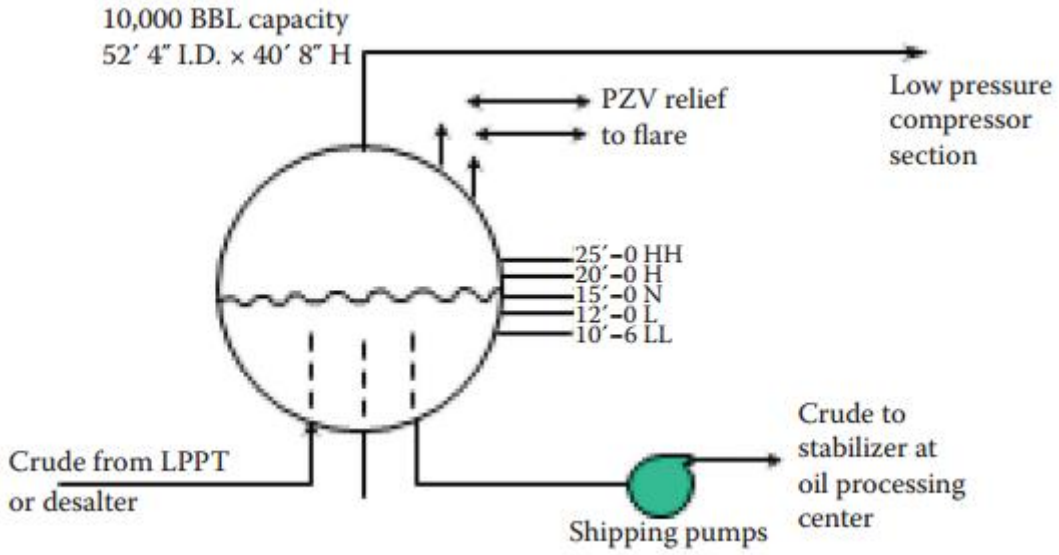

Figure 1: Typical spheroid for storage prior to stabilization.

Stabilization Processes

Stabilization is aimed for the removal of low boiling compounds without losing the more valuable components. The stabilization mechanism is based on removing the more volatile components by flashing using stage separation and stripping operations. The two major specifications set for stabilized oil are the Reid vapor pressure (RVP) and hydrogen sulfide content. Based on these specifications, different cases are encountered:

- Case 1: Sweet oil (no hydrogen sulfide); no stabilization is needed
- Case 2: Sour crude; stabilization is a must.

A. Stabilization by Flashing (Additional Gas–Oil Separator)

Stabilization by flashing utilizes an inexpensive small vessel to be located above the storage tank. The vessel is operated at atmospheric pressure. Vapors separated from the separator are collected using a VRU. This approach is recommended for small-size oil leases handling small volumes of fluids to be processed.

B. Stabilization by Stripping

The stripping operation employs a stripping agent, which could be either energy or mass, to drive the undesirable components (low boiling point hydrocarbons and hydrogen sulfide gas) out of the bulk of crude oil. This approach is economically justified when handling large quantities of fluid and in the absence of a VRU. It is also recommended for dual-purpose operations for stabilizing sour crude oil, where stripping gas is used for stabilization. Stabilizer-column installations are used for the stripping operations.

Types of Trayed Stabilizers

Two basic types of trayed stabilizer are commonly used. Conventional reflex types normally operate from 150 to 300 psia. They are not common in field installations. They are more suitable for large central field processing plants. Nonreflxed stabilizers generally operate between 55 and 85 psia. These are known as cold feed stabilizers. They have some limitations, but they are commonly used in field installations because of their simplicity in design and operation. Figure 2 is explained the typical tray-type stabilizer.

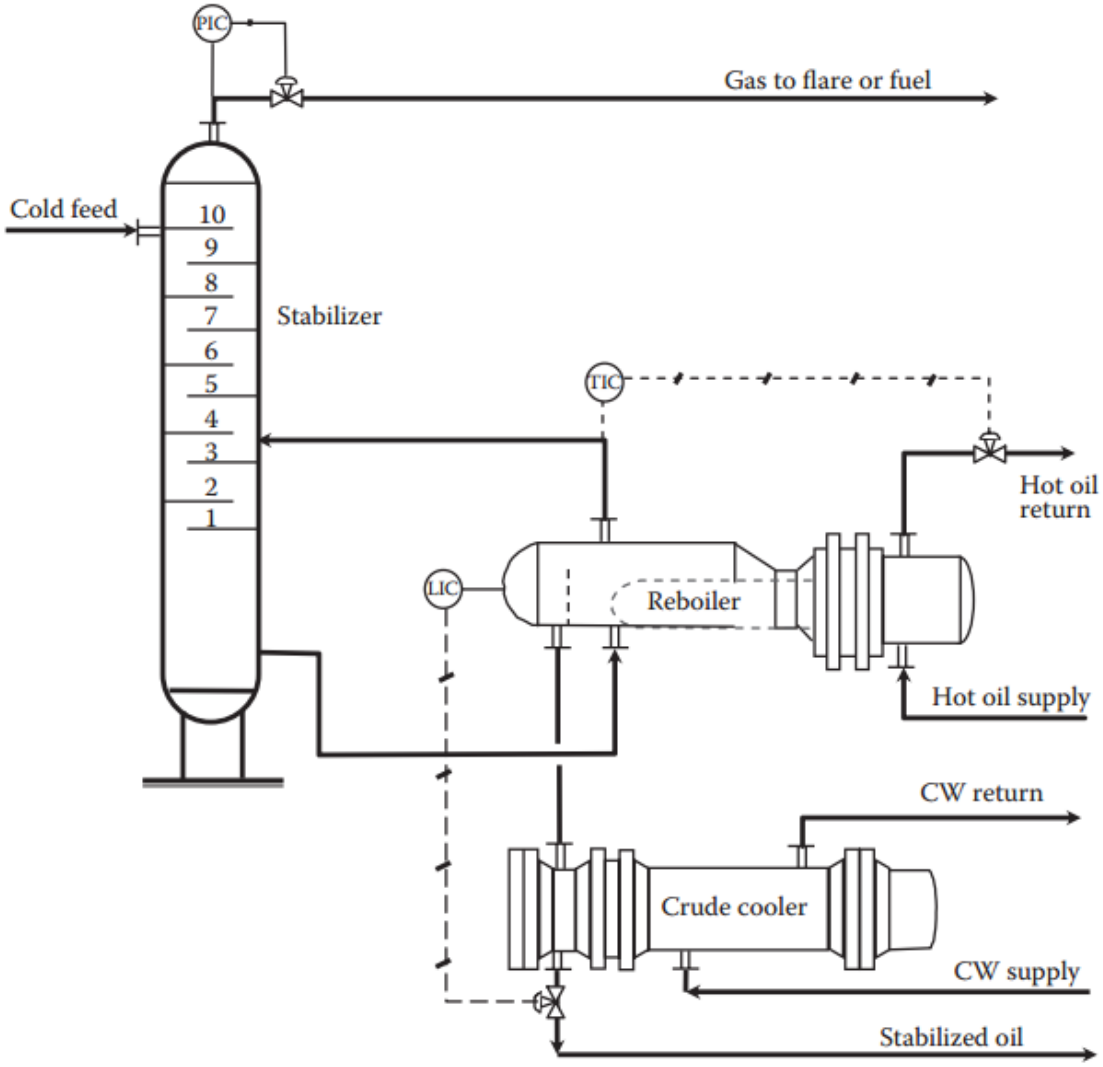

Figure 2: typical tray-type stabilizer.

Crude Oil Sweetening

Apart from stabilization problems of sweet crude oil, sour crude oils containing hydrogen sulfide, mercaptans, and other sulfur compounds present unusual processing problems in oil field production facilities. Along with stabilization, crude oil sweetening brings in what is called a dual operation, which permits easier and safe downstream handling, and improves and upgrades the crude marketability. Three general schemes (Figures 3 – 5) are used to sweeten crude oil at the production facilities as observed in Table 1.

Table 1: general schemes for sweetening crude oil

Process	Stripping Agent
Stage vaporization with stripping gas	Mass (gas)
Trayed stabilization with stripping gas	Mass (gas)
Reboiled tray stabilization	Energy (heat)

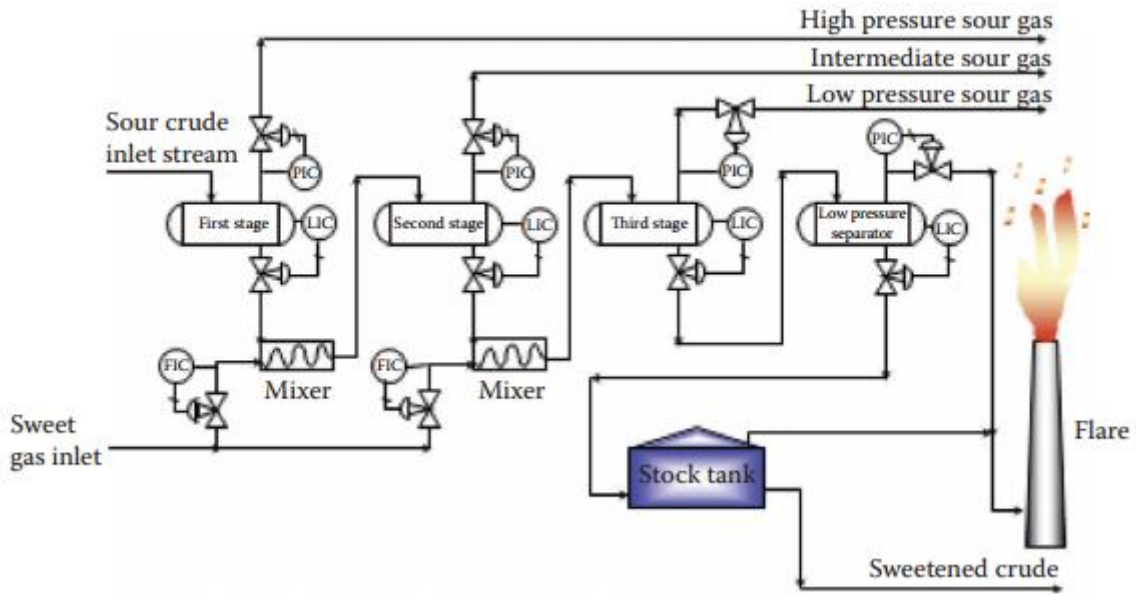

Figure 3: sweetening by stage vaporization with stripping gas

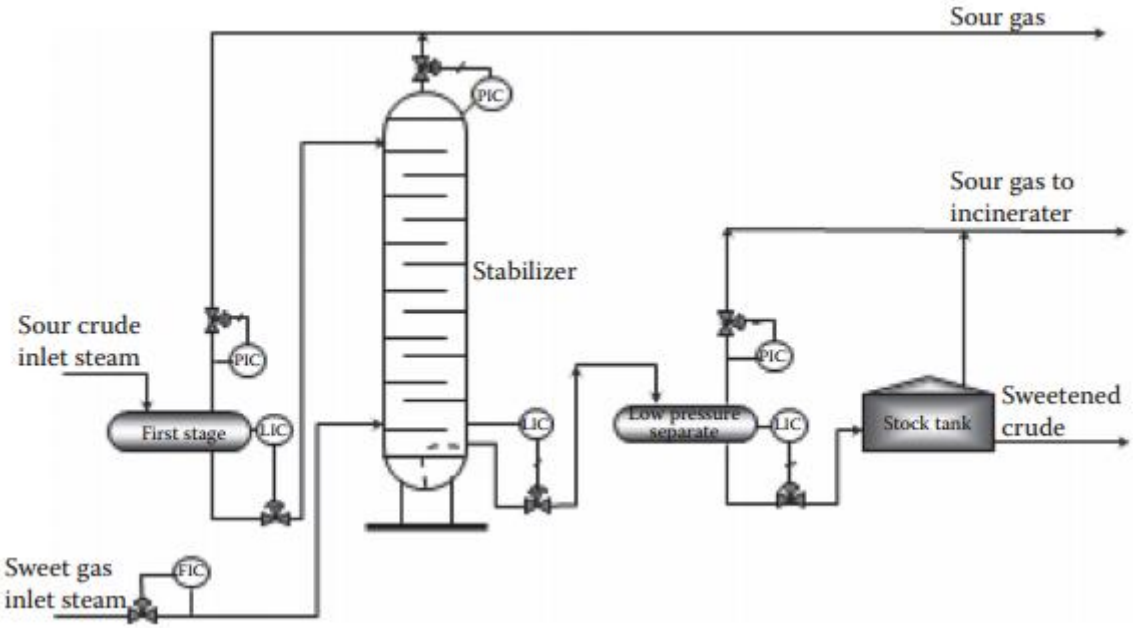

Figure 4: crude stabilization by trayed stabilization with stripping gas

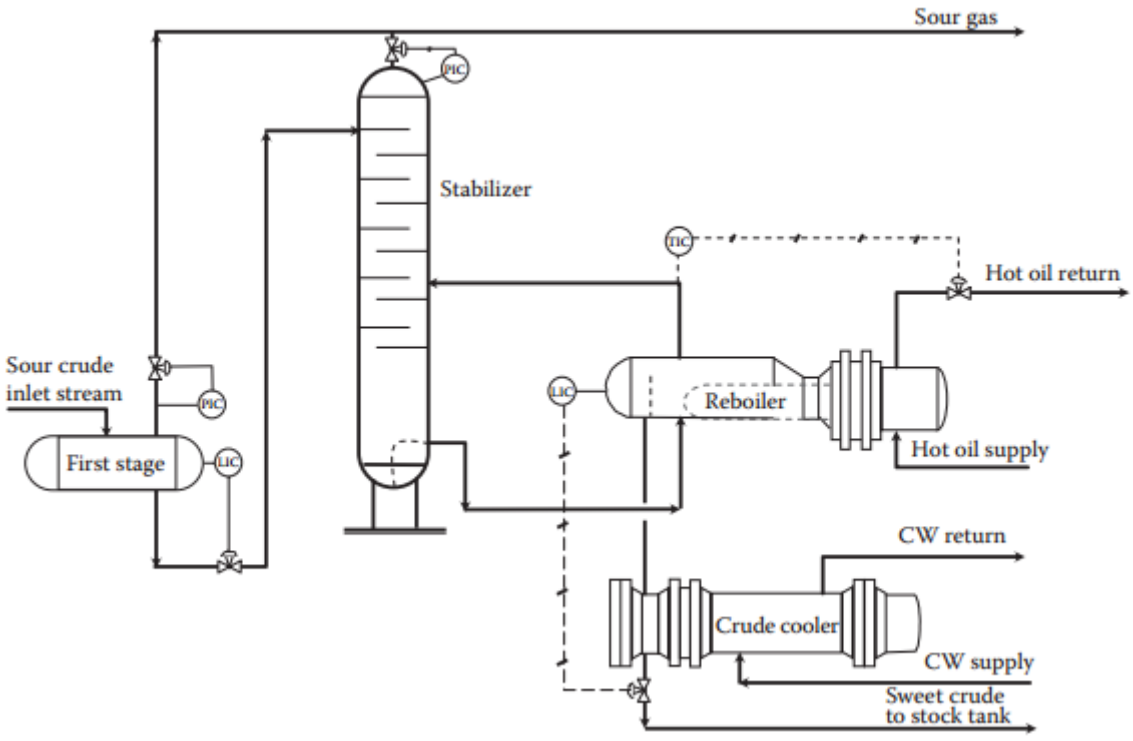

Figure 5: crude sweetening by reboiled trayed stabilization.

5. Storage Tanks

Storage tanks for crude oil are needed in order to receive and collect oil produced by wells, before pumping to the pipelines as well as to allow for measuring oil properties, sampling, and gauging (Figure 6).

Figure 6: Storage tanks.

The design of storage tanks for crude oil and petroleum products requires, in general, careful consideration of the following important factors:

- The vapor pressure of the materials to be stored.
- The storage temperature and pressure.
- Toxicity of the petroleum material.

Types of Storage Tank

The main features of some of the common types of storage tank used by the petroleum industry in general are presented in Table 2.

Table 2: Summary of Refinery Storage Tanks.

Characte-ristics	Standard Storage Tanks	Conservation-Type Storage Tanks		
		I (Floating Roofs)	II (Variable-Vapor-Space)	III (Pressure Storage)
Evaporation losses	High	Significantly reduced	Significantly reduced	Prevented or eliminated
Operating conditions	Recommended for liquids whose vapor pressure is atmospheric or below at storage conditions (vented).	Allow no vapor space above the liquid: level (no venting)	Allow the air-vapor mixture to change volume at constant or variable pressure (no venting)	Allow the pressure in the vapor space to build up. Tanks are capable of withstanding the maximum pressure without venting.
Sub-classification	1.Rectangular 2.Cylinderical: a) Horizontal b) Vertical	-	1. Lifter roof, which is a gas holder mounted on a standard storage tank. 2. Vapor-dome	1.Low-pressure storage normally designed for 2.5-5 psig and up to 15 psig (0.14 – 0.34 bar and up to 1.02 bar) 2.High pressure storage: 30-200 psig (2 – 13.5 bar)
Typical types	Cone-roof-vertical (cylinderical tanks)	Floating-roof. wiggins-Hidek type	Lifter roof tanks. wiggins dry seal type	Spheroids and hemispheroids for low pressure storage, spheres for high pressure storage
Applications	Heavy refinery-products	Sour crude oils, light crude oils, light products.	Light refinery product and distillates	Spheroids are used to store aviation, motor, jet fuels. Spheres are used to store natural gasoline and LPG.