Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering

Department

Petroleum Refining Processes

Fourth Class

Lecture 5

By

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Introduction

- Petroleum refining is a unique and critical link in the petroleum supply chain, from the wellhead to the pump. The other links add value to petroleum mainly by moving and storing it (e.g., lifting crude oil to the surface; moving crude oil from oil fields to storage facilities and then to refineries; moving refined products from refinery to terminals and end-use locations, etc.).
- Refining adds value by converting crude oil (which in itself has little end-use value) into a range of refined products, including transportation fuels. The primary economic objective in refining is to maximize the value added in converting crude oil into finished products.
- Petroleum refineries are large, capital-intensive manufacturing facilities with extremely complex processing schemes. They convert crude oils and other input streams into dozens of refined (co-)products, including:
  - ♦ Liquefied petroleum gases (LPG)
  - ♦ Gasoline
  - ♦ Jet fuel
  - ♦ Kerosene (for lighting and heating)
  - ♦ Diesel fuel
  - ♦ Petrochemical feed stocks
  - ♦ Lubricating oils and waxes
  - ♦ Home heating oil
  - ♦ Fuel oil (for power generation, marine fuel, industrial and district heating)
  - ♦ Asphalt (for paving and roofing uses).
- The transportation fuels have the highest value; fuel oils and asphalt the lowest value. Many refined products, such as gasoline, are produced in multiple grades, to meet different specifications and standards (e.g., octane levels, sulfur content).
- More than 660 refineries, in 116 countries, are currently in operation, producing more than 85 million barrels of refined products per day. Each refinery has a unique

physical configuration, as well as unique operating characteristics and economics. A refinery's configuration and performance characteristics are determined primarily by the refinery's location, vintage, availability of funds for capital investment, available crude oils, product demand (from local and/or export markets), product quality requirements, environmental regulations and standards, and market specifications and requirements for refined products.

- Most refineries in North America are configured to maximize gasoline production, at the expense of the other refined products. Elsewhere, most of the existing refining capacity and virtually all new capacity is configured to maximize distillate (diesel and jet fuel) production and, in some areas, petrochemical feedstock production, because these products are enjoying the fastest demand growth in most regions of the world.

Crude Oil Processing from Oilfield to Refinery

Crude oil collected from the wells contains sand, mud, and water as impurities which may vary from 20% to 30% by volume. Hence, raw crude is collected in a battery of treatment tanks where both treatment and storage of crude oil are carried out. Treatment steps involve:

- Removal of sand and water by gravity settling
- Chemical treatment to remove emulsified water
- Crude conditioning or stabilizing

- Well fluids are complex mixtures of different compounds of carbon and hydrogen with different densities, vapor pressure and physical characteristics.
- As the well fluids travel from the reservoir to the production facility, it experiences pressure and temperature reduction.
- The characteristics of the well stream continuously changes with the evolving gas from the liquid as the pressure reduces.

- The separation of these phases is one of the basic operations in production, processing and treatment.

Wellhead and Manifold

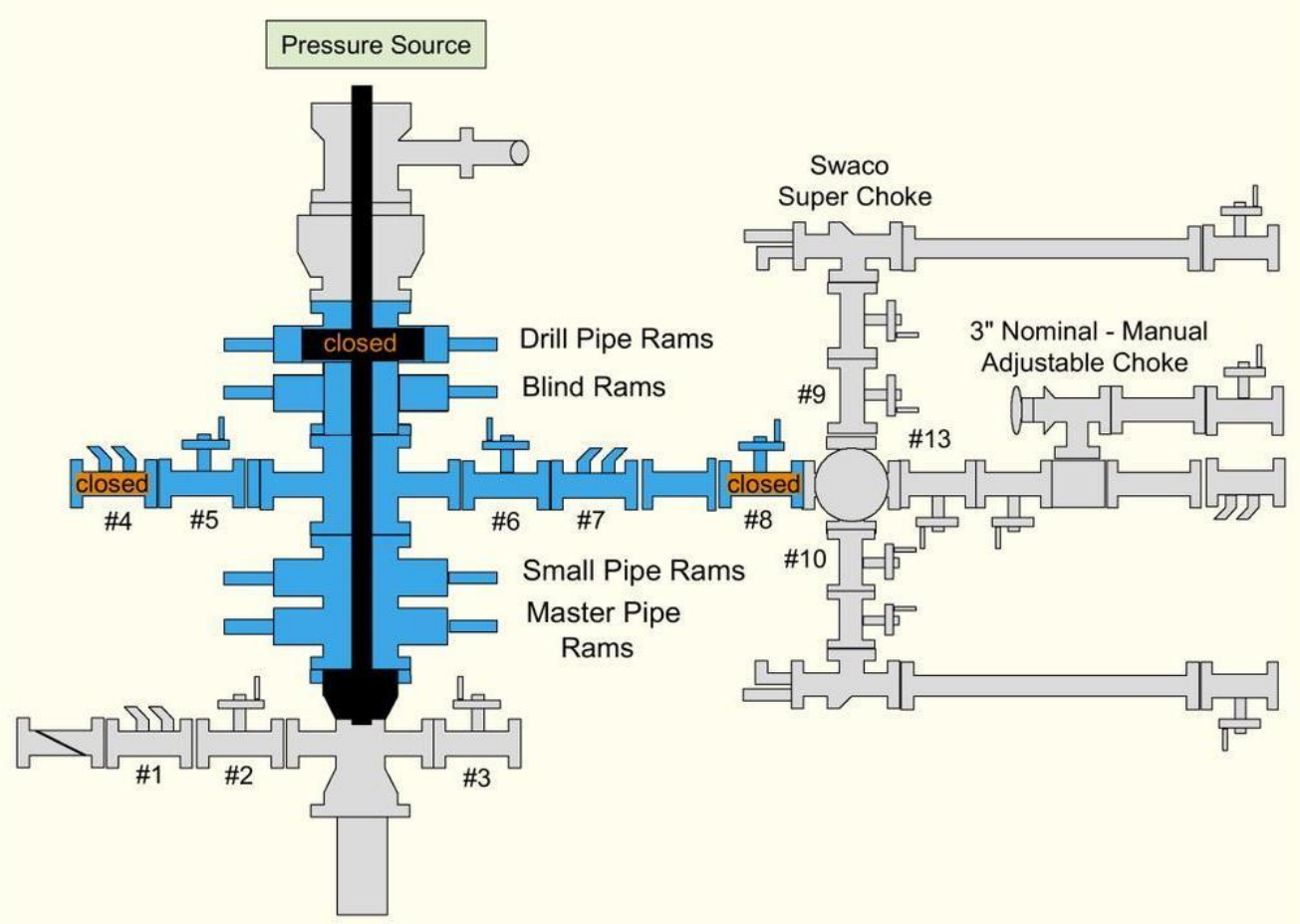

Figure 1: Wellhead Manifold.

- The oil production system begins at the wellhead, which includes at the least one choke valve, whose percentage opening determines the flowrate from the wells.
- Most of the pressure drop between the well flowing tubing head pressure (FTHP) and the separator operating pressure occur across the choke valve.

- Whenever two or more wells are installed on a wellhead platform, a production manifold as well as test manifold should be installed to gather fluid from the wells prior to be processed in separator or exported via pipeline.
- The test manifold is provided to allow an individual well to be tested either via a Test Separator or Multiphase Flow Meter (MPFM).

Separation Gas & Liquid

- The well-stream may consist of crude oil, gas, condensates, water and various contaminants.
- The purpose of a separator is to split the flow into desirable fractions.
- Primary separation of produced water from gas and oil is carried out in production separator.
- Separators work on the principle of gravity separation.

The following are the types of separators generally used in the oil industry:

- Two Phase Separator; A two phase separator is used to separate well fluids into gas and liquid mixtures.
- Three Phase Separator; This type of separator is used when the expected outlet streams are gas, oil/condensate, and water.

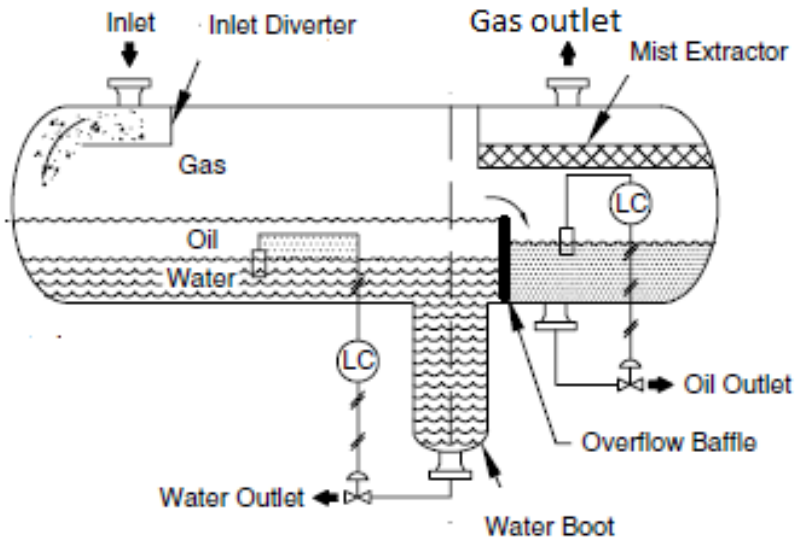

Figure 2: Typical Three Phase Separator (horizontal).

A separator can be either horizontal or vertical configuration

Horizontal separator

Horizontal separator is preferred for low GOR well fluids and three phase separation.

Table below shows the advantages and disadvantages of horizontal separators:

Advantages	Disadvantages
Provide sufficient residence time for liquid-liquid separation	Only part of shell available for passage of gas
Large liquid surface area for foam dispersion generally reduces turbulence	Larger foot print / plot area
Large surge volume capacity	Liquid level control is more critical
Lend themselves to skid mounting and shipping	More difficult to clean produced sand, mud, wax, paraffin. etc.

Vertical separator

Vertical separator is preferred for high GOR well fluids and two phase separation

Table below shows the advantages and disadvantages of vertical separators:

Advantages	Disadvantages
Have full diameter for gas flow at top and oil flow at bottom	Not suitable for bulk liquid-liquid separation
Occupy smaller plot area	Occupy more vertical spacing between decks in offshore
Liquid level control is not so critical	More difficult to skid mount and ship
Have good bottom drain and clean out facilities. Can handle more sand, mud, paraffin, wax, etc.	More difficult to reach and service top-mounted instruments and safety devices

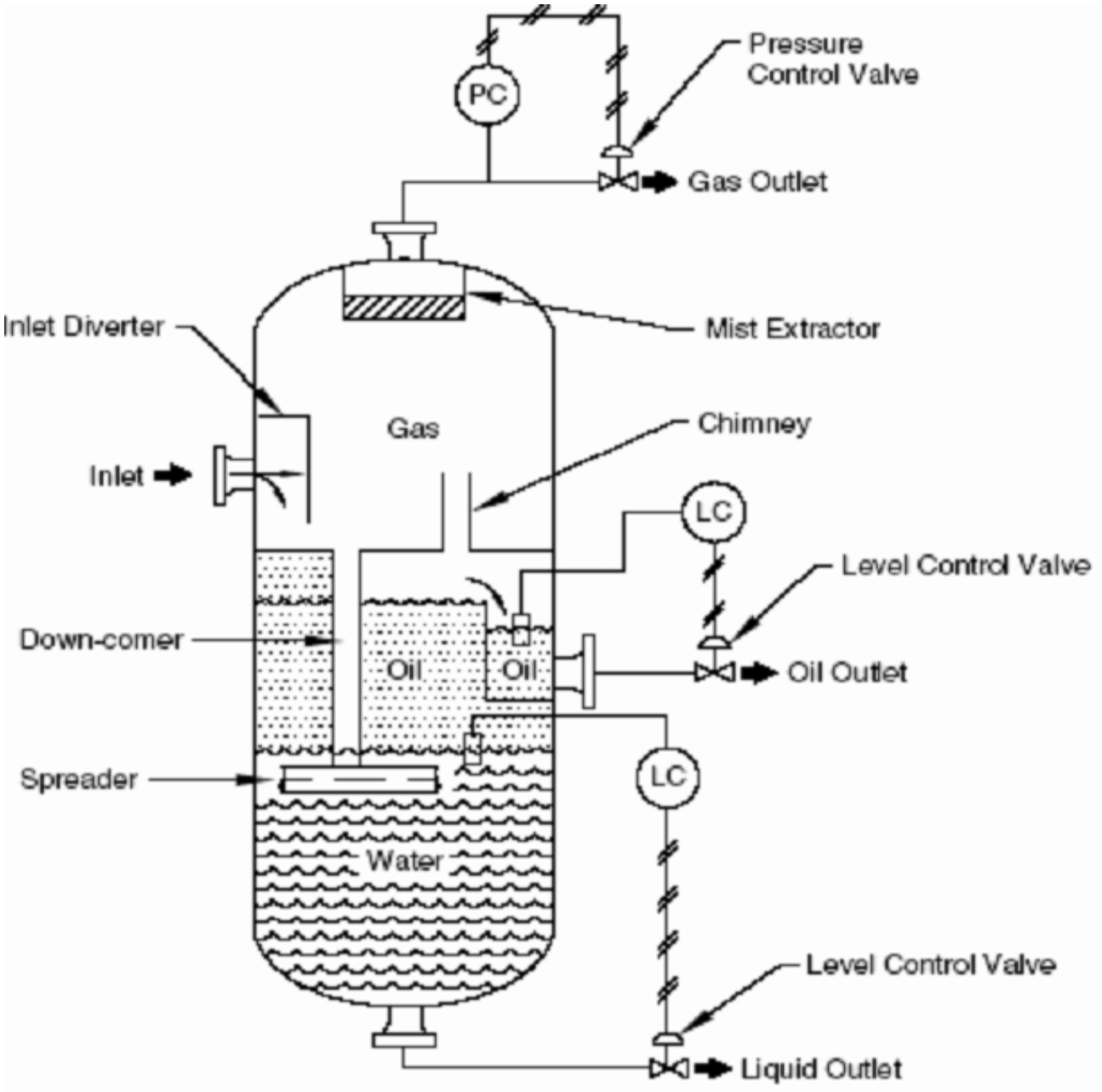

Figure 3: Typical Three Phase Separator (vertical).

Crude Oil Stabilization

- Dissolved gas in the crude oil must be removed to meet pipeline, storage, or tanker RVP specification.
- Removal of the dissolved natural gas components is called oil stabilization.
- Crude oil can be stabilized by passing it through multiple separators in series where the volatile components will vaporize.
- A stabilization column might replace the simple flash-separation stages to achieve the required RVP, but these columns are rarely found offshore.

Stabilization of the crude oil often requires:

Heat to be added or removed at certain points in the processing train. Crude heating may be required for:

- Emulsion breaking and improved separation of oil and produced water.
- Adjustments of final product vapour pressure and H2S content.