Tikrit University

College of Petroleum Processes Engineering

Department of Petroleum and Gas Refining Engineering

Gas Technology

Forth Class

Lectures 10

By

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Condensate Stabilization

- Hydrocarbon condensate recovered from natural gas may be shipped without further processing but is stabilized often for blending into the crude oil stream and thereby sold as crude oil.
- The process of increasing the amount of intermediates (C3 to C5) and heavy (C6+) components in the condensate is called ***"*****condensate stabilization*****."*** In other word, the scope of this process is to separate the very light hydrocarbon gases, methane and ethane in particular, from the heavier hydrocarbon components (C3+).
- This process is performed primarily in order to reduce the vapor pressure of the condensate liquids so that a vapor phase is not produced upon flashing the liquid to atmospheric storage tanks.
- **Stabilization Processes** Stabilization of condensate streams can be accomplished through either flash vaporization or fractionation.

Flash Vaporization

- Stabilization by flash vaporization is a simple operation employing only two or three flash tanks. This process is similar to stage separation utilizing the equilibrium principles between vapor and condensate phases.
- Equilibrium vaporization occurs when the vapor and condensate phases are in equilibrium at the temperature and pressure of separation. Figure 1 shows a typical scheme of condensate stabilization through the flash vaporization process.
- Condensate from the inlet separator after passing through the exchanger enters to the high-pressure flash tank, where the pressure is maintained at 600 psia. A pressure drop of 300 psia is obtained here, which assists flashing of large amounts of lighter ends, which join the sour vapor stream after recompression. The vapor can either be

processed further and put into the sales gas or be recycled into the reservoir and used as gas lift to produce more crude oils.

- The bottom liquid from the high-pressure tank flows to the middle pressure flash tank operated at 300 psia. Additional methane and ethane are released in this tank.
- The bottom product is withdrawn again to the low-pressure tank operated at 65 psia. To ensure efficient separation, condensate is degassed in the stripper vessel at the lowest possible pressure prior to storage. This reduces excess flashing of condensate in the storage tank and reduces the inert gas blanket pressure required in it.

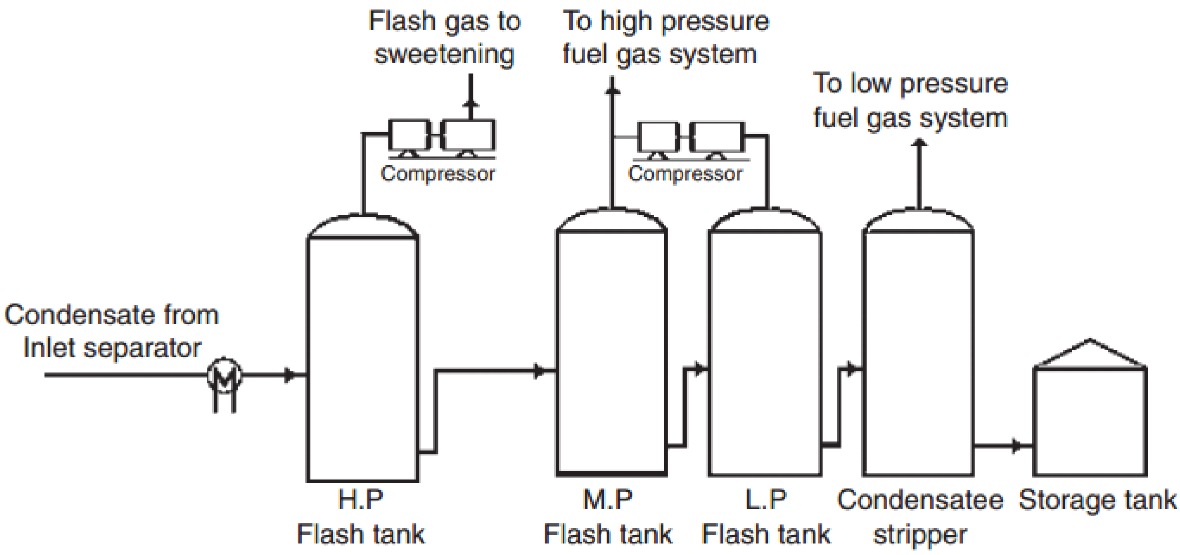

Figure 1: Condensate Stabilization through Flash Vaporization Process H.P: high pressure; M.P: middle pressure; L.P: low pressure

Stabilization by Fractionation

- Stabilization by fractionation is a detailed process, very popular in the industry and
- During the operation, light fractions such as methane–ethane–propane and most of the butanes are removed and recovered. The finished product from

the bottom of the column is composed mainly of pentanes and heavier hydrocarbons, with small amounts of butane.

- The process actually makes a cut between the lightest liquid component (pentane) and the heaviest gas (butane). The bottom product is thus a liquid free of all gaseous components able to be stored safely at atmospheric pressure.

Process Description

- Figure 2 shows a schematic condensate stabilization process. The liquid hydrocarbon (condensate) is brought into the system from the inlet separator and preheated in the stabilizer feed/bottoms exchanger before entering the stabilizer feed drum.
- Liquid from the feed drum is fed to the stabilization tower at approximately 50 to 200 psi depending on whether they are sour (sour stabilization is carried out at the low end of the range and sweet stabilization at the high end of the range).
- The condensate stabilizer reduces vapor pressure of the condensate by removing the lighter components. The stabilization is typically carried out in a reboiled absorber, with tray type internals. However, if a better separation is required, typically the column is changed from a top feed reboiled absorber to a refluxed distillation tower. As the liquid falls into the column, it becomes leaner in light ends and richer in heavy ends.
- At the bottom of the tower some of the liquid is circulated through a reboiler to add heat to the tower. As the gas goes up from tray to tray, more and more of the heavy ends get stripped out of the gas at each tray and the gas becomes richer in the light ends and leaner in the heavy ends.
- Overhead gas from the stabilizer, which would seldom meet market specifications for the natural gas market, is then sent to the low-pressure fuel

gas system through a back-pressure control valve that maintains the tower pressure to set point.

- Liquids leaving the bottom of the tower have undergone a series of stage flashes at ever-increasing temperatures, driving off the light components, which exit the top of the tower. These liquids must be cooled to a sufficiently low temperature to keep vapors from flashing to atmosphere in the condensate storage tank.

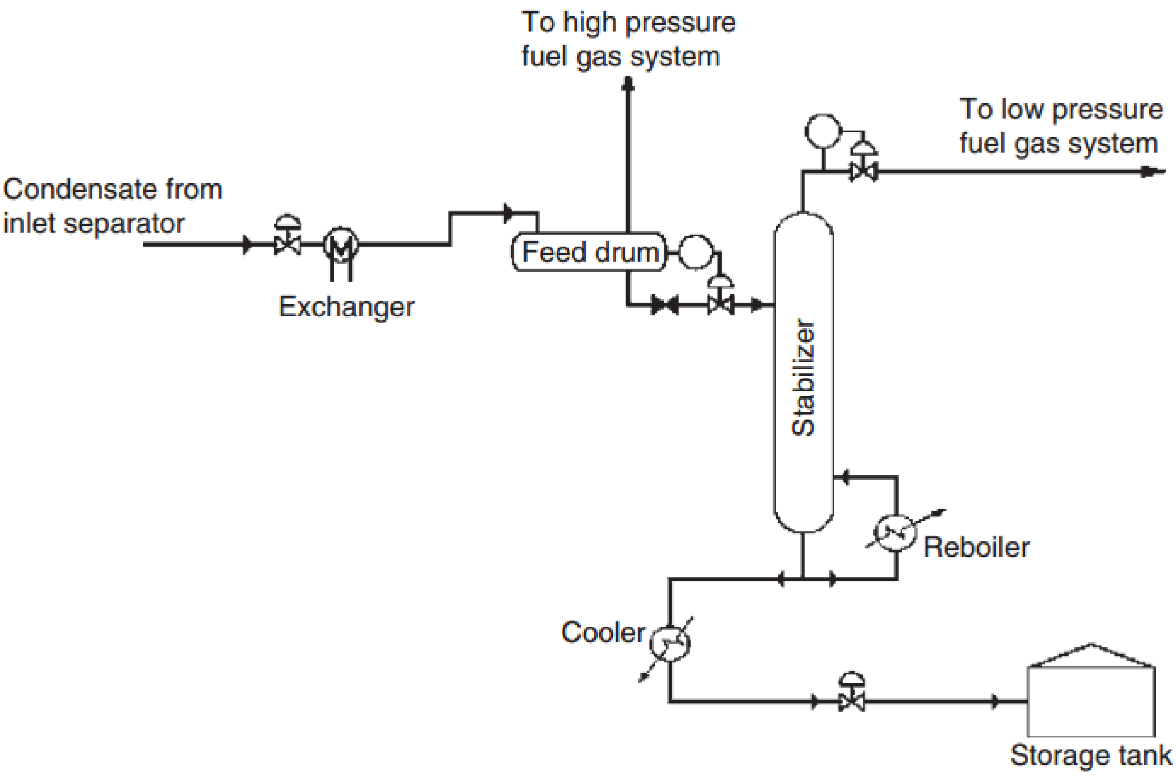

Figure 2: Condensate Stabilization System by Fractionation

Design Considerations of Stabilization Column

- In most cases of lease operation, the stabilization column will operate as anonrefluxed tower. This type of operation is simpler but less efficient than the refluxed tower operation. Because the nonrefluxed tower requires no external cooling source, it is particularly applicable to remote locations.

- A condensate stabilization column with reflux will recover more intermediate components from the gas than a cold-feed stabilizer. However, it requires more equipment to purchase, install, and operate. This additional cost must be justified by the net benefit of the incremental liquid recovery, less the cost of natural gas shrinkage and loss of heating value, over that obtained from a cold-feed stabilizer.
- When a condenser is used in a stabilization column, it will always be a partial condenser because of the quantities of methane and ethane that must be removed from the tower feed.
- The stabilization tower pressure depends on the amount of liquid to be stabilized and whether it is sweet or sour. For sweet stabilization, the pressure should be as high as possible to minimize overhead vapor recompression, as this gas is remixed with the separator vapor. This also tends to decrease the cost of reflux cooling, if it is used. However, relative volatility of the components also decreases with pressure and, as stated previously, driving H_2S overhead requires a relatively low pressure. Figure 3 shows the maximum recommended feed temperature to a stabilizer as a function of operating pressure of the stabilizer.
- Figure 4 shows suggested bottom (reboiler) temperatures for producing a specified Reid vapor pressure product. The temperature used on the bottom is limited by the thermal breakdown characteristics of the condensate and, of course,
  product specs.
- Table 1shows RVP and Relative Volatility of Various Components

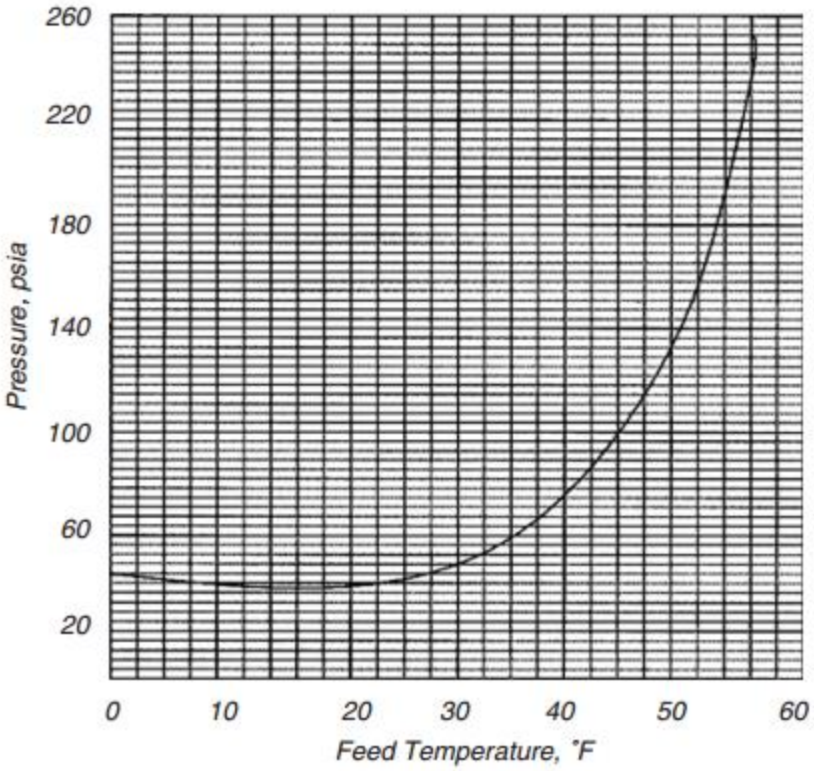

Figure 3: Maximum recommended feed temperature to a cold-feed stabilizer

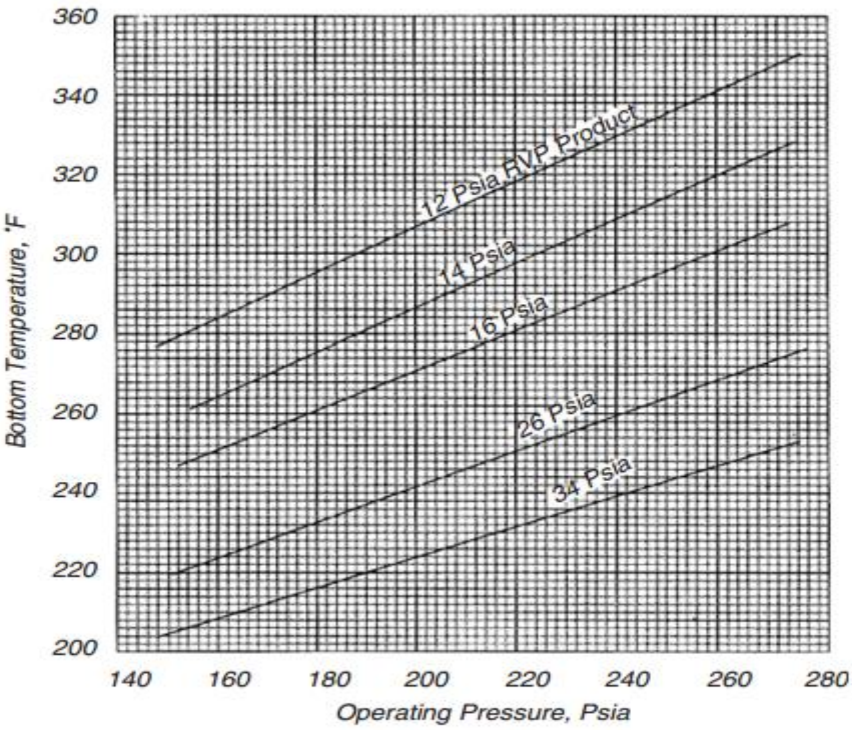

Figure 4: Maximum recommended feed temperature to a cold-feed stabilizer

Table 1: RVP and Relative Volatility of Various Components

Component	RVP psia	Relative volatility
C_1	5000	96.9
C_2	800	15.5
C_3	190	3.68
i-C_4	72.2	1.40
n-C_4	51.6	1.00
i-C_5	20.4	0.40
n-C_5	15.6	0.30
C_6	5.0	0.10
C_7^+	≈0.1	0.00
CO_2	—	Infinite
N_2	—	Infinite
H_2S	394	7.64