# Standard Operating Procedure(SOP) – AVU

**Atmospheric and Vacuum Distillation Units**

Distillation of crude oil is carried out in two units, first in an Atmospheric Distillation Unit (also known as Crude Distillation Unit, CDU), with further processing of the residue from atmospheric distillation in the Vacuum Distillation Unit (VDU), as illustrated in Figure 4.2. For sake of simplicity, Figure 4.2 does not include the network of heat exchangers and pump around loops to pre-heat the desalted crude before it is fed into the fired furnace. In the furnace, the crude is heated to the desired temperatures (700-750° F) such that all the distillate fraction and roughly 10-20% of the bottom product are evaporated, depending on the volatility of crude oil. The two-phase mixture is then introduced into the CDU flash zone for separation of vapor and liquid streams, where the vapor fraction rises toward the top of the column and the liquid fraction is subjected to stripping with steam to recover the low-boiling distillate components dissolved in heavier liquid before sending the bottom product (i.e., atmospheric distillation residue) to the vacuum distillation unit.

A temperature gradient is established in the column by removing heat from the overhead vapor. The column condenses the naphtha fraction and sends a portion of the liquid naphtha, as reflux, to the column to achieve a good separation of the distillate products drawn from the side of the distillation column, such as kerosene, LGO, and HGO, as seen in the diagram. Steam strippers on the side of the column also provide reflux to the main column to help with clean separation of the distillate products. Additional reflux is provided to the main column by pump around loops associated with heat exchangers for preheating the crude. Counter-current flow of vapor and liquid streams through the contact stages (e.g., trays) in the main column, enabling good separation of the distillate fractions. The temperature at the bottom of CDU is limited to 700-750° F to prevent cracking – breaking of the chemical bonds between carbon atoms in the aliphatic hydrocarbons constituting the crude oil. Cracking would cause coking (accumulation of carbonaceous solids) on the metal surfaces in the column and interferes with fractionation in distillation. Vacuum distillation is necessary to fractionate the heavy distillates because further increase in temperature would cause thermal cracking of the feed components. In ***HYSYS Project 1*** assignment, you will learn how to introduce crude assay data to a distillation simulator and calculate the yields of naphtha, kerosene, diesel, atmospheric gas oil, and residue for different crudes.

the atmospheric residue is reheated in a fired furnace to 730-850° F before introduction into the vacuum distillation unit (VDU). The furnace outlet temperature is selected depending on the thermal reactivity (or coking propensity of crude oil, as will be discussed further) and the desired level of separation in the column. Steam ejectors, or, more recently, vacuum pumps, are used to create a vacuum for evaporation of the light vacuum gas oil and heavy vacuum gas oil fractions. The temperature and pressure in VDU also depend on whether steam is introduced, or the separation is carried out without the steam addition in “dry” towers, varying between 10 to 30 mmHg at the bottom of the tower. Lower pressures and higher temperatures are used in dry towers. To minimize the pressure difference between the bottom and top of the column, some special packing materials are used (see, for example, Figure 4.5) instead of trays for providing contact between liquid and vapor streams to improve fractionation.

The heavy distillates (light vacuum gas oil and heavy vacuum gas oil) separated in VDU are further processed in downstream separation and conversion units to produce lubricating oil base stocks, or as feedstock for hydrocracking to produce light and middle distillates. The residue from vacuum distillation (VDR) can be upgraded into marketable products and fuels using processes such as visbreaking, deasphalting, and coking,