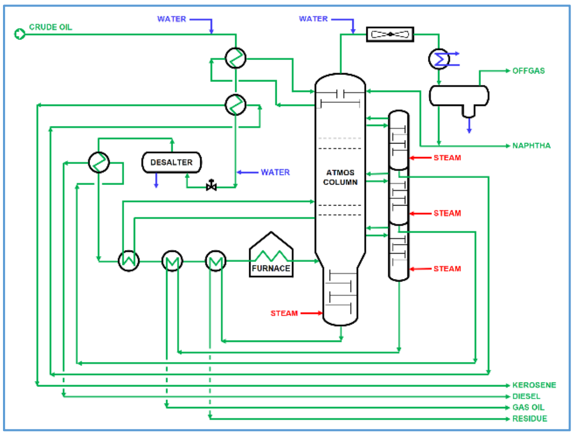
# Refining Process Overview
# Crude Oil Distillation




## Process Description

The crude distillation unit (CDU) is generally (but not always) the first processing step for crude oil entering the refinery. It uses fractional distillation to separate the crude oil into several fractions (products) with different boiling ranges; offgas, naphtha, kerosene, diesel, gas oil and atmospheric residue. The heart of the process is the atmospheric column which contains 20 - 45 trays, depending on complexity, and operates at 1.0 - 2.5 barg (14.5 - 36.3 psig).

The crude oil is preheated to a temperature of 100 - 150 ºC (212 - 302 ºF) by heat exchange with sidecut (liquid product) and pumparound (heat removal) streams in a series of shell and tube heat exchangers arranged in one or more parallel trains. Wash water is injected into the crude oil and the mixture then passes through a desalter where inorganic salts (mainly sodium chloride) are removed. The desalted crude is further heated by more sidecut and pumparound streams before passing through a fired charge heater (furnace) which raises its temperature to around 340 - 380 ºC (644 - 716 ºF), depending on crude type. The partially vapourised crude oil enters the "flash zone" near the bottom of the atmospheric column where all but the heaviest fractions flash into vapour. The remaining liquid is atmospheric residue with some gas oil. Stripping steam is injected into the base of the column to recover this gas oil. The hot vapours rise up the column, cooling as they ascend. Progressively lighter components condense out and are withdrawn as sidecuts. Side strippers are provided to help vapourise the lighter fractions in each sidecut and return them to the column. In order to distribute vapour and liquid loadings more evenly throughout the column, heat is generally removed via two or three pumparound circuits. Some CDUs have a relatively small vessel or column upstream of the charge heater and atmospheric tower. The purpose of the preflash tower is to remove light ends from the feed to the atmospheric tower which effectively debottlenecks and improves pressure control of the atmospheric tower.

## Key Variables

The key variables affecting CDU performance are charge heater coil outlet temperature (COT), tower top pressure, stripping steam ratios and product cut points. The goal is to maximise distillate recovery within tower operating limits and product quality specifications. To achieve this, the charge heater COT should be raised to the highest possible temperature short of cracking. Tower pressure should be minimised to increase vapourisation at the tower inlet and reduce the overall amount of energy required to achieve the desired product yields. However, the ability to reduce tower pressure is limited by overhead condensing capacity and ability to handle increased gas rates. Stripping steam injection rates at the atmospheric tower and side strippers should be raised to reduce the hydrocarbon partial pressure which further increases vapourisation at the tower inlet. However, the ability to increase stripping steam rates is limited by the vapour handling capacity of the tower internals, overhead condensing capacity and sour water disposal system hydraulics. Product yields are largely determined by front and back end cut points and the T95/T5 distillation point gap provides an indication of fractionation efficiency. Internal flowrates of hot vapour and cold liquid should be increased to improve fractionation efficiency between adjacent products. Note that the integrity and cleanliness of the tower internals can have a dramatic effect on the contacting efficiency between the hot vapour and cold reflux.

## Safety Issues

Loss of primary containment (LOPC) of fluids above their autoignition temperature is the single biggest safety issue for CDUs. Exposure to hydrogen sulphide ($H_2S$) is also a major safety risk on units processing high sulphur crudes.

## Availability Issues

Corrosion of the preflash and atmospheric tower overhead systems is typically the single biggest availability issue for CDUs with fouling of crude preheat exchangers following close behind. Corrosion of overhead systems is a function of desalter efficiency. Crude preheat exchanger fouling is a function of process design, exchanger construction, compatibility of crude oil mixtures and desalter efficiency. Coking of crude charge heater tubes can also be a problem if the heater fired duty limit is exceeded or flame impingement on the tubes occurs.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