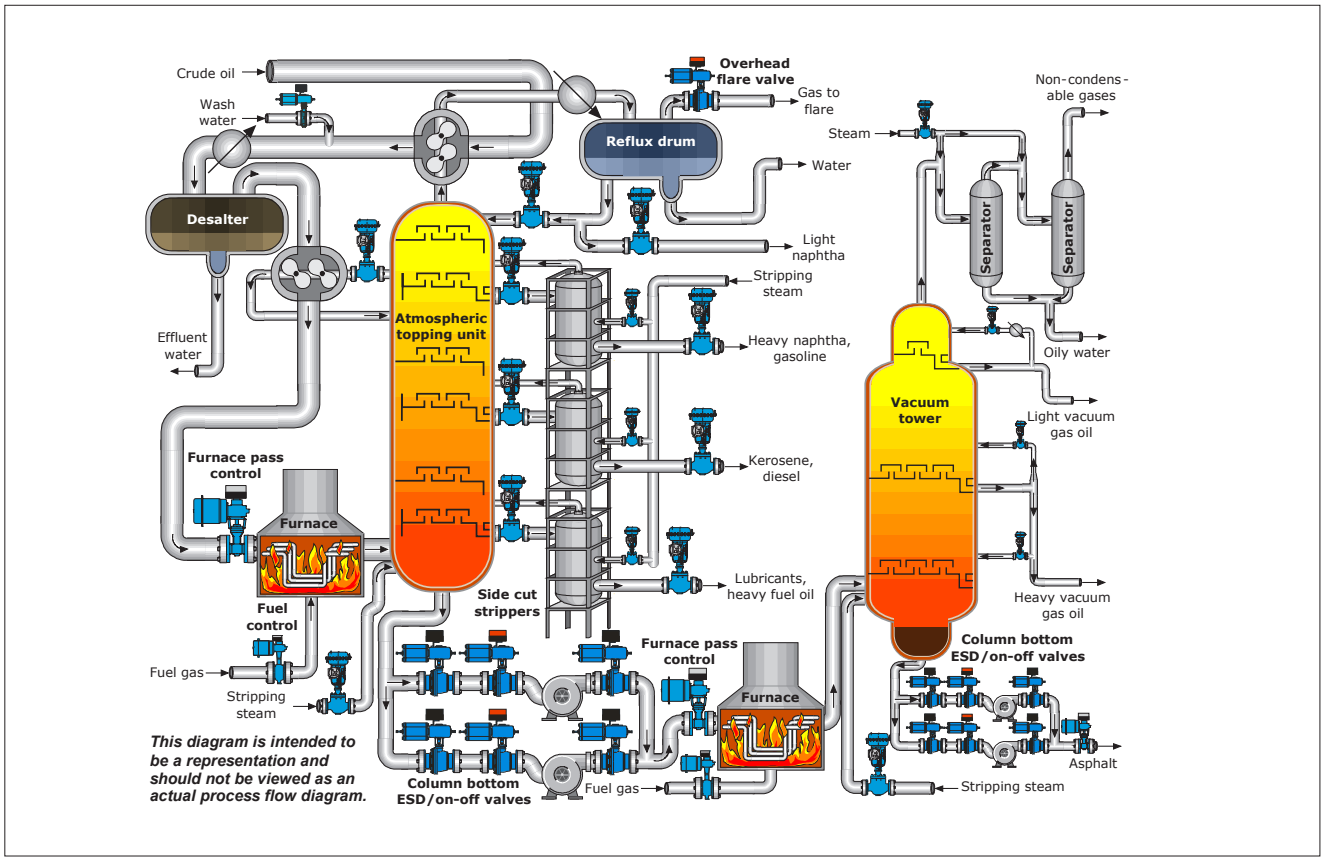
# Crude and vacuum distillation




## Process overview

Crude distillation is the first major process in a refinery. All crude oil entering the refinery passes through the atmospheric topping unit on the way to be further processed in downstream units.

Crude oil is first washed in desalting to remove salts and metals that could cause corrosive damage or catalyst deactivation in downstream units. After desalting the feed is preheated in a series of heat exchangers and then heated to the process temperature in a furnace.

Feed enters the distillation column at 2-5 barG (29-73 psig) and around 350-390 °C (660-730 °F). Light vapours rise to the top of the column and heavier liquid hydrocarbons fall to the bottom. Hydrocarbon fractions are withdrawn from the tower according to their specific boiling temperatures.

Stripping steam at the column bottom improves the separation of lighter boiling components. The vapours are condensed at the overhead cooling and recycled back to the column as reflux. Circulating reflux (pumparound) and side stripping with steam improves the separation of different fractions.

Heavy residue with boiling points exceeding 400 °C (750 °F) are sent to a vacuum tower to allow further recovery without cracking the feed. Three types of vacuum towers are used: dry (no steam), wet without stripping and wet with stripping.

Vacuum distillation is carried out with an absolute pressure of around 25-40 mmHg and a temperature of around 380-420 °C (720-790 °F). The operating pressure is maintained by using steam ejectors and condensers.

## Distillation valves

In a crude distillation process, there are valves controlling the flow of the feed into the furnaces. The fuel input is also on flow control.

The distillation towers have valves controlling the flow of product, reflux and stripping steam.

Finally the bottoms of the towers have valves ensuring safe operation of the pump.

## Furnace pass flow control

The furnace pass control valve controls the flow of feed into the furnaces which heat the feed before entering the atmospheric topping unit or the vacuum tower.

The feed may be dirty causing problems with valves sticking. Gland leaks have also usually been a problem with these valves. The operating temperature is usually around 270-290 °C (520-550 °F).

## Neles™ solution for furnace pass control

**Neles Finetrol™ eccentric rotary plug valves** for mild design temperature service (< +425 °C/797 °F) and **Neles top entry rotary ball valves** for higher design temperatures.

- **Reduced emissions,** due to rotary operation which is inherently less prone to leaks
- **Improved energy efficiency,** as reliable control reduces process variability
- **Insensitive to pipe stress,** due to rugged one-piece body construction
- **Fire-safe approved,** ensuring secure operation
- **Impurity and cavitation resistant,** with the patented Q-Trim™ design

Neles Finetrol eccentric rotary plug valve

## Furnace damper automation

The damper regulates the flow of air into the furnace. Traditionally these have mostly been operated manually.

Furnace efficiency can be determined by measuring the amount of excess $O_2$ in the flue gas. Poor control of the damper leads to poor utilization of fuel gas in the furnace. Proper control can lead to a decrease of up to 3 % of excess $O_2$, equaling yearly fuel savings of 200 000 USD in a 200 000 bbl/day crude distillation unit.

## Neles solution for furnace dampers

**Neles pneumatic B1-series actuator with an intelligent ND controller** to ensure proper damper control.

- **High torque actuator,** as the bearings support the lever arm reducing friction
- **Fast response to control signals,** ensuring that the damper is quickly adjusted to account for changes in fuel usage
- **Benchmark control performance,** with the advanced information provided by the valve controller
- **Wear resistant,** as high quality components are used

B1-series actuator with ND controller at a customer site

## Fuel gas/oil control

The furnaces create the heat required to cause vaporisation of most of the feed entering the atmospheric topping unit. For the vacuum tower, the heat level is kept just below the cracking level of the feed so that the fractions can be separated under low pressure. A variety of fuels can be used to feed the burners, depending on the most economical or practical fuel available at the time, and can range from natural gas to crude oil.

The different heat generation properties of the fuels require a valve which can regulate the flow accordingly. In addition, the difference in the amount of fuel required during start-up and actual process conditions requires a valve with good rangeability. To ensure a more reliable operation, fast reaction to signal changes is required to quickly adjust temperature to account for fouling and switching to decoking. Noise reduction capabilities may also be necessary, especially if fuel gas is being used. Typically the temperature is 40-200 °C (100-400 °F) and the pressure 2 10 barG (30-150 psig).

## Neles solution for fuel gas/oil control

We offer two types of valves which are well-suited for fuel gas/oil control. The selection of valve type depends on the type of fuel and rangeability requirements.

**Neles balanced cage guided globe valve** with a spring diaphragm actuator and an ND valve controller is well suited for the application if there is limited variety in the type of fuel used and good rangeability is required.

- **Minimize leaks,** as the rugged one piece body structure eliminates potential leak paths ensuring that volatile fuel doesn't leave the piping
- **Fugitive emission certified** according to ISO 15848
- **Different inherently characterized trims,** available as equal percentage, linear and quick open
- **Interchangeable trim parts** making it possible to easily change flow characteristics
- **Accurate and sensitive actuator** ensuring fast and proper operation of the valve

If the type of fuel being used varies and/or extremely high rangeability is required, the **Neles V-port segment valve** together with a spring-return diaphragm actuator and an ND valve controller is the optimal solution.

- **Best possible rangeability,** ensuring that the same valve can be used for various types of fuel and during start-up and full capacity conditions
- **No potential leak paths** even if subjected to pipe bending forces, as the valve features a one piece body construction
- **Reduced fugitive emissions by design,** as the valve utilizes rotary operation which is inherently less prone to leaks
- **Economical** – Low torque requirements reduce wear and reduces actuator size, resulting in better reliability and a lower cost unit
- **Fire-safe compliant** according to API 607
- **Q-Trim design available,** eliminating noise and the potential for cavitation to occur

Neles segment valve

## Overhead flare valve

Plant upset or emergency shutdowns require that the process pressure can be vented safely. This is done via a flare valve to the flare header.

No unnecessary leakage is allowed for safety reasons and to avoid product loss. Valve operation must be fast and reliable. There is a potential for high noise levels at high pressure drops and large pipe sizes.

## Neles solution for overhead flare valve

For applications with low pressure drop, **Neles triple eccentric disc valves** are well suited for the application.

- **Fast and reliable valve operation**
- **HSE-risks reduced,** including noise level, with the flow balancing S-DISC design
- **Tight and lasting shut-off up to class VI,** due to the unique triple offset metal seat design

In case of a more demanding application with high pressure drops, **Neles modular ball valves** are the optimal solution for the application.

- **Heavy duty valve design,** capable of withstanding the pressure differences and piping forces in the process
- **Live-loaded packing,** ensuring a lasting and tight shut-off
- **Noise reducing Q-Trim option available,** ensuring that noise requirements are met

**Intelligent safety solenoid ValvGuard**™ (VG9000) helps ensure that the valve is operable in case of an emergency.

- **Partial stroke test,** which can be performed either automatically or manually to ensure that the valve is working properly
- **Certified up to SIL 3** by third parties

Neles triple eccentric disc valve

## Stripping steam and reflux control

The feed enters the distillation column/vacuum tower in a liquid-vapour equilibrium. The efficiency of the distillation depends on the contact between the rising vapour and the liquid falling down through the column. The operation is a balance between product purity and energy use.

The optimal amount of stripping steam and circulating reflux depend on each other and changes in the feed quality, making accurate control a necessity for the regulating valves. A one percent increase of total distillate yield means an increased profit of about 40 000 USD/day in an average size (200 000 bbl) crude distillation unit.

## Neles solution for stripping steam and reflux

**Neles globe valves** with a spring diaphragm actuator and an ND intelligent valve controller are well suited for the application.

- **Reliable and accurate control,** allowing the process parameters to be optimized giving optimal efficiency
- **Wide rangeability,** allowing the flows to be adjusted to account for changes in feed quality
- **A variety of trims available,** including the Tendril design, reducing noise and eliminating cavitation
- **Easy maintenance** – Top entry construction for easy access, valve assembly is simple and self-guiding
- **Predictive maintenance** is made possible with the online diagnostics provided by the ND valve controller

Neles globe valve

## Column bottom ESD/on-off valves

At the column bottom(s) the piping is typically split into two lines, one of which is isolated and used as a reserve and the other line is open. Each line has two on-off valves to isolate the pump and an ESD valve which shuts the line in case of an emergency. If one pump is taken out of order e.g. due to fouling, the line is isolated and the other line is put into operation.

These valves must be able to perform their action in a process upset situation. Coke particles may also be present which may clog the valve. As the process is usually run for up to 4-5 years, these valves may be operated very seldom making reliability an important factor. Tight shut-off is also required. The medium can be very hot, up to 360 °C (680 °F) with a pressure of around 6 barG (87 psig).

## Neles solution for column bottom valves

**Neles modular trunnion mounted ball valves** for demanding high pressure service.

- **Particle build-up resistant,** by having continuous contact between the seat and the ball effectively wiping the seat surfaces
- **Spiral wound body joint gasket,** ensuring leak free operation
- **Cavitation and noise reduction option,** with the Q-Trim
- **Anti-blowout valve shaft,** ensuring the safety of personnel and equipment
- **High temperature options available**

For large pipe sizes, Neles triple eccentric disc valves offer an excellent an economical and compact solution for the application.

- **Triple eccentric design,** reducing wear and producing tight shut-off
- **No resilient parts exposed to the medium,** extending the life time of the valve
- **Rugged single piece body** eliminating potential leak paths
- **Wide temperature range,** as the standard construction performs equally well from -200 °C to 600°C (-328 °F to 1110 °F)
- **Fire-tested** acc. to API 607 (6th ed.) and BS 6755 part 2

Ensure the operability of ESD-valves with **intelligent safety solenoid ValvGuard** (VG9000) with partial stroke testing capability.

- **Advanced diagnostics capability,** increasing safety and allowing plant safety targets to be reached more economically
- **Emergency trip test** simulating an emergency condition, reducing the work needed for proof of compliance with safety regulations
- **Reach fast stroking times without accessories** such as volume boosters or quick exhaust valves, due its high pneumatics capacity
- **HART & FOUNDATION fieldbus** communication compatibility

## Benefits

- Optimize plant safety and distillation performance
- Reduce energy and maintenance costs
- Better utilization of raw materials as leaks are minimized
- Save piping and valve costs with compact and lightweight valve solutions
- Reach plant uptime targets
- Meet noise, emission and fire safety regulations set by local authorities
- Highest safety and availability for ESD applications

Neles ball valve

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