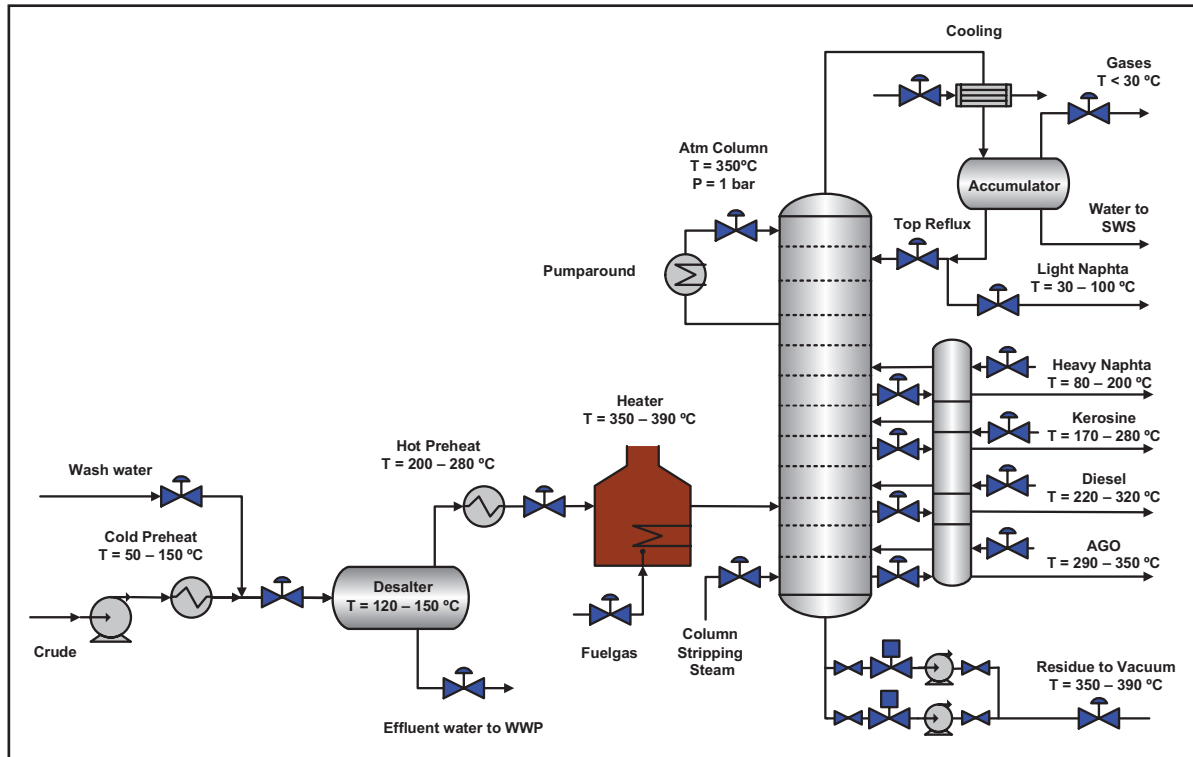


# Crude distillation



## Process overview

**Crude distillation is the first major process in a refinery. All crude oil entering the refinery passes through the atmospheric distillation on the way to be further processed in downstream process units to improve fuel properties, increase the yields of the distillate products and meet environmental specifications. Any process upset situation have an effect on the downstream processes, serious upsets may shutdown the entire refinery.**

Crude oil is first washed in desalting to remove salts, metals and other impurities that would cause corrosion in atmospheric distillation and catalyst deactivation in downstream catalytic process units. After desalting the feed is preheated in a series of heat exchangers and heated to the process temperature

in a heater. Feed enters to the distillation column at 2 - 5 bars and about 380 °C. Light vapors rise to the top of the column and heavier liquid hydrocarbons fall to the bottom. Hydrocarbon fractions are drawn from the tower according to the specific boiling temperatures. Stripping steam at the column bottom improves the separation of lighter boiling components. The vapors are condensed at the overhead cooling and recycled back to the column as reflux. Circulating reflux (pumparound) and side stripping with steam improve the separation of different fractions. Column bottom heavy residue is sent to vacuum unit to recover more distillates.

The capacity of the presented crude distillation is 200 000 bbl/day (~10 million tons/year) with fuel consumption of about 10 000 MMBtu/day.

## Crude distillation challenges

Refineries today are facing new challenges in order to meet the requirements with respect to environment, health and safety of the plant personnel and the quality of the finished products. With increasing crude oil prices, refineries are processing heavier, lower quality crudes that set new challenges to further develop the processes and maximize the yield of valuable distillates in an energy efficient way. Plant run-time targets are increasing which sets more challenges for equipment reliability and process control.

**Health, Safety, Environment** – For any refinery HSE-issues are important aspect since plants are working around the clock under severe temperature and pressure conditions. Valve leaking poses both an environmental and safety issue due to risk of fire and oil spills, as the sticky residue accumulates on the valve bonnet and refinery ground. ESD and on/off valves must be able to perform their action in a process or equipment failure.

**Top-class products at maximum yield** – Minimizing process variability reduces production losses, upsets and fuel consumption. At the same time it is also important to maximize process unit flexibility in changes related to feedstock, downstream units or process revamp. The market calls for clean products and high quality. Since atmospheric distillation is the first refining process, it is important that the process is stable, flexible and under control. Sticking and leaking of control valves reduces the accuracy of throughput control and adversely affects also the downstream processes.

**Maintenance costs** – Poorly performing valves in the process must be serviced because they will have a direct impact on the efficiency of the process. The cost of unscheduled maintenance will be quite high, up to 70 % of the cost of a new valve in some applications. Add this to the cost of removing the valve from the line and disruption of the process and the total cost will be much higher.

**Plant run-time** – Refineries are increasing process unit and plant run-time targets since downtime means production losses and is a remarkable cost including maintenance costs. This requires reliable equipment in terms of materials and process control.



## Metso solutions

**Metal and soft seated rotary control, on-off and ESD-valves together with application specific intelligent valve controllers and Neles FieldCare valve condition monitoring can answer all these challenges with wide margins of assurance.**

**Safety** – Metso Automation rotary stem operation reduces fugitive emissions and protects from leaking. Packing construction meets the latest emission standards. Our products are fire tested and approved to meet the standards. Neles ValvGuard™ partial stroking will ensure that plant emergency shutdown valves will always perform properly when needed.

**Efficiency** - Throughput losses due to sticking and poor control performance will be avoided with high performance rotary control valves. Flow through the process unit may be changed as the need arises with range ability of 150:1 and further with full bore ball valves. These valves may be equipped with Metso Automation's advanced Neles ND9000 digital valve controller that ensures higher positioning accuracy and faster response to reduce process variability. Correct valve selection and sizing with Metso Automation Nelprof-program we can assure the best valve performance and process control.

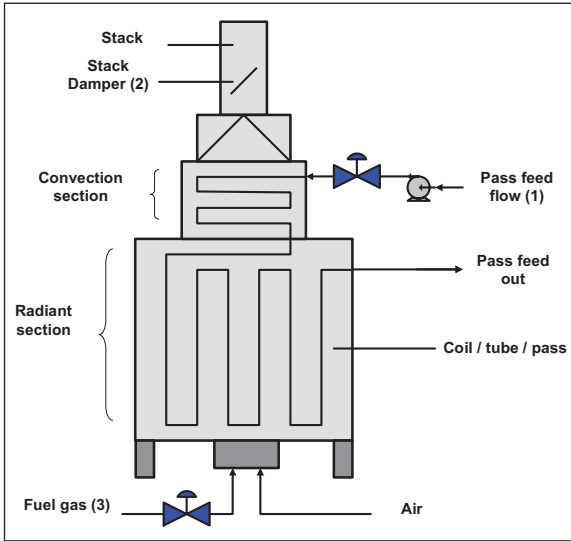
**Availability** – Simple rotary designs offer non-clogging flowports and rugged hard-faced trims. Costly service work involving the removal of the valve from the line and replacement parts is eliminated. Same face-to-face dimensions as globe valves, upgrading linear valve technology to rotary designs eliminates the need for changes to pipework configurations. Rotary valves have been in service for several years without requiring maintenance and show no sign of leakage. Our global service network and inventory management will help you to complete your maintenance activities.

**Reliability** – Trend data collected by Metso Automation smart valve controllers and analyzed by Neles FieldCare configuration and condition monitoring software based on open FDT/DTM technology makes it possible to predict and respond to maintenance requirements and avoid unscheduled downtime. This gives full transparency to the valve performance in process control.



### Heater applications

Energy-efficient heater operations involve proper control, maintenance and monitoring of process fluid outlet temperature, draft, excess air and fuel-firing rate. In multipass heaters it is important to control the flowrates for optimum residence time. Leaking valves will result in valve sticking and poor control behaviour. 1 % fuel savings in a 10 000 MMBtu/day heater saves approximately 200 000 USD/year in fuel cost.



#### 1. Heater pass flow control

**Challenge** – Before Metso, some customers had to maintenance their valves every 2 - 6 months because of gland leaks and valve sticking. This reduced heater performance and throughput control, increased risks for health, environment and safety and in some cases caused unscheduled shutdowns, when valve by-pass was not available.

**Metso Solution** – Finetrol eccentric plug rotary valve for mild temperature service (< +425 °C) and Top 5 rotary ball valve for high temperature service (> +425 °C).

**Benefits** – Our customers report remarkable savings in maintenance costs after installing Metso Automation control valves. Oil leaking through gland packing has been avoided, and this improved operator safety in the plant and reduced emissions to environment. Heater efficiency was improved by reducing the tube fouling and fuel consumption. Average saving in maintenance costs on a 4-year process cycle is approximately 38 000 USD/valve.



Metso Finetrol valves at customer heater pass flow control

#### 2. Heater dampers automation

**Challenge** – Heater efficiency is measured in accordance of excess O<sub>2</sub> in flue gases. In a customer heater the excess O<sub>2</sub> was 4.5 %, which resulted in poor heater performance in the use of fuel gas. Damper actuation had control problems, like hysteresis, overshooting and response time. The dampers were mostly operated manually.

**Metso Solution** – Pneumatic B-series actuator with ND9106HNT positioner.

**Benefits** – The heater efficiency was improved thanks to Metso’s reliable full automation solution and services for damper performance. The system was fully automated and it is possible to predict the maintenance needs. The residual O<sub>2</sub> decreased from 4.5 % to 2.5 % (manual operation) and 1.5 % (automatic operation). This equals to yearly fuel gas savings of 200 000 USD in a 200 000 bbl/day crude distillation.



Metso B-series actuator at customer heater damper control

### 3. Heater fuel gas control

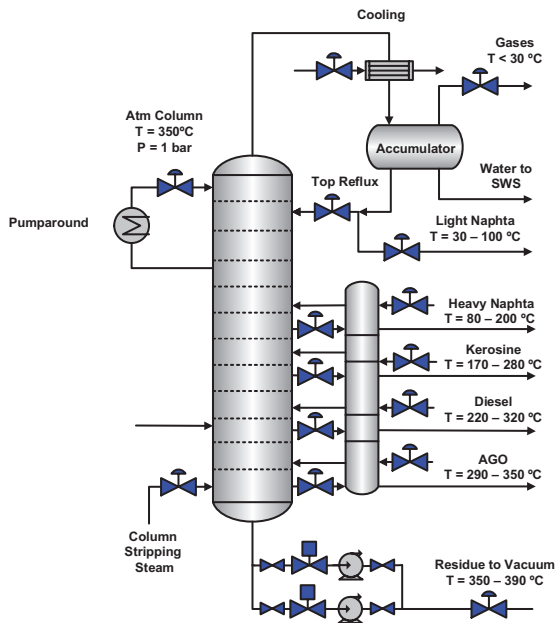
**Challenge** – Reliability and accuracy is required from heater fuel gas control. It has a direct impact on the process performance, since the crude oil heater outlet temperature is controlled by fuel gas to the burners. Variations in the fuel gas composition have an affect on the heating value and fuel-gas pressure at burner. A failure in the system may shutdown the whole crude distillation process.

**Metso Solution** – RE-series segment valve / Finetrol eccentric plug valve.

**Benefits** – Single valve solution due to wide range ability – no need for split range control. Reliable control and reduced variability improves heater energy efficiency and crude oil temperature control.

### Distillation column applications

Crude oil enters the distillation column in a liquid-vapor 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. Column control parameters, such as stripping steam, pressure control and circulating reflux depend on each other and the changes to the feed quality entering the column.



### 4. Overhead vapour – flare valves

**Challenge** – Plant upset or emergency shutdowns require that pressures can be vented safely. This is done by flare valve to flare header. No unnecessary leakage is allowed for safety reasons and to avoid product losses. The valve operation must be fast and reliable. There is a risk of noise at high pressure drops and large sizes.

**Metso Solution** – Neldisc® butterfly valves for low pressure drop and Neles ball valves for high pressure drop applications.

**Benefits** – Metso Automation unique Neldisc® butterfly valves ensure fast and reliable valve operation. HSE-risks including noise are reduced with flow balancing trim. Unique triple offset metal seat design provides tight shut-off over long time periods up to class VI tightness. Comparing to class IV tightness in 10" valve product losses due leaking customers can save approximately 40 000 USD/year.



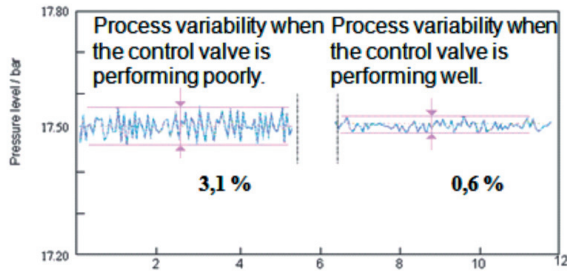


**5. Distillate products – stripping and reflux control**

**Challenge** – The purpose of distillation is to separate the different boiling fractions, obtain final or 95 % boiling point purity of the product streams at minimum required energy and maximum product yield.

**Metso Solution** – Finetrol eccentric plug valve.

**Benefits** – With Metso Automation Finetrol control valve the product variability is reduced. This provides optimum product quality and yield with no additional energy requirements. Valve plays a significant role in control loop, especially when high loop performance is targeted. 1 % increase of total distillate yield means increased production about 40 000 USD/day in an average size (200 000 bbl) crude distillation. Even a part of this increase with better valve performance means increased profit to the refinery.



**6. Column bottom ESD and on-off valves**

**Challenge** – These valves must be able to perform their action in a process upset situation. The most part of the time these valves are either open or closed. There is a risk of coke particles accumulation and valve sticking at column bottom. The process run-length is long, usually 4 - 5 years, so extreme reliability is required. In case of failure with these valves, there is a risk of shutdown the entire process. ESD valves are also important for the safety of the people operating the plant.

**Metso Solution** – Seat supported X-series ball valves for demanding low pressure service; trunnion mounted D-series ball valves for high pressure service, and Neldisc butterfly valves for large sizes with Neles ValvGuard partial stroking test for valve performance monitoring.

**Benefits** – Crude distillation up-time can be maximized and process safety improved with simple and compact solutions that are ideal for sticky and coking fluids in the crude distillation column bottoms.



ESD-valve with ValveGuard ensuring customer process safety

## Summary

Optimize your plant safety and crude distillation performance, reduce energy and maintenance costs and produce top-class products with Metso Automation intelligent rotary control, on-off and ESD-valves.



*Finetrol eccentric rotary plug valve for general and demanding control applications.*



*Neldisc, high performance butterfly valve for large size applications.*



*T5 top entry control valve for demanding applications.*



*RE-series v-shape segment valve for general purpose control applications.*

The information provided in this bulletin is advisory in nature, and is intended as a guideline only. For specific circumstances and more detailed information, please consult with your local automation expert at Metso.

### Metso Automation Inc.

**Europe**, Vanha Porvoontie 229, P.O. Box 304, FI-01301 VANTAA, Finland.  
Tel. +358 20 483 150. Fax +358 20 483 151

**North America**, 44 Bowditch Drive, P.O. Box 8044, Shrewsbury, MA 01545, USA.  
Tel. +1 508 852 0200. Fax +1 508 852 8172

**South America**, Av. Independência, 2500- Iporanga, 18087-101, Sorocaba-São Paulo  
Brazil. Tel. +55 15 2102 9700. Fax +55 15 2102 9748/49

**Asia Pacific**, 20 Kallang Avenue, Lobby B, #06-00, PICO Creative Centre, Singapore 339411, Singapore.  
Tel. +65 6511 1011. Fax +65 6250 0830

**China**, 19/F, the Exchange Beijing, No. 118, Jianguo Lu Yi, Chaoyang Dist, 100022 Beijing, China.  
Tel. +86-10-6566-6600. Fax +86-10-6566-2575

**Middle East**, Roundabout 8, Unit AB-07, P.O. Box 17175, Jebel Ali Freezone, Dubai,  
United Arab Emirates. Tel. +971 4 883 6974. Fax +971 4 883 6836

[www.metso.com/valves](http://www.metso.com/valves)