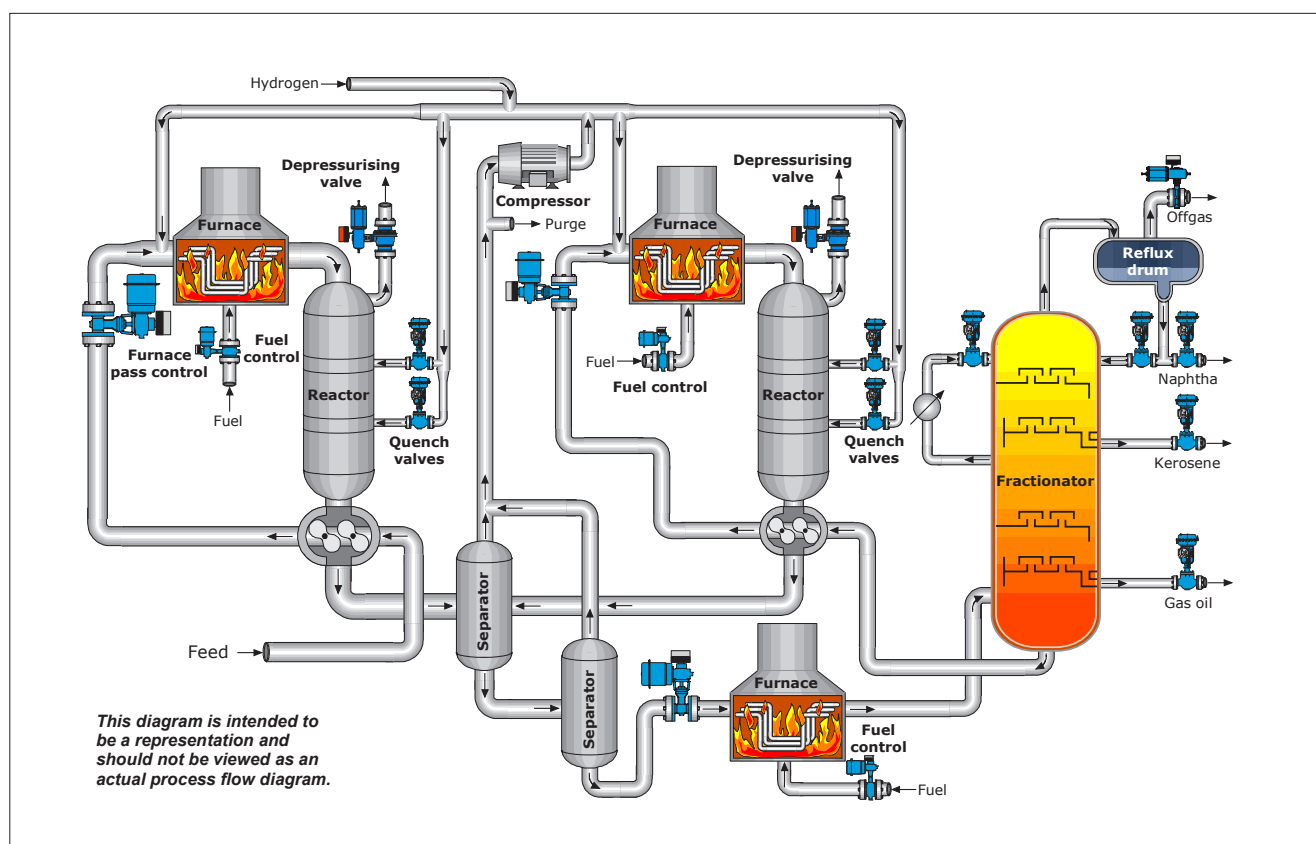


Hydrocracking



Process overview

Demand for gasoline and diesel is increasing, while the demand for heavy oils, such as fuel oil, is declining. Refiners are therefore taking more steps to convert heavy oils into lighter distillates. Hydrocracking can significantly improve refining margins by upgrading low-value products into higher-value, high-demand products.

Typical hydrocracking feedstocks include heavy atmospheric and vacuum gas oils, and catalytically or thermally cracked gas oils. These products are converted to lower molecular weight products, primarily naphtha or distillates. Sulphur, nitrogen and oxygen removal and olefin saturation occur simultaneously with the hydrocracking reaction. Typical reactor operating conditions require temperatures of 280-475 °C (540-890 °F) and reactor circuit pressures of 35-215 barG (510-3100 psig) depending on the feedstock and final products desired.

The reactions consume hydrogen and are highly exothermic. The key to hydrotreating and hydrocracking reactions is applying bi-functional catalysts that contain an acid function and a metal function.

Various process configurations have been developed, which can be classified as single-stage, two-stage and series-flow hydrocracking. The differences between these configurations are partial or complete conversion of feed to lighter products, type of catalyst and process selectivity towards contaminants and final product types. The above process flow diagram describes a two-stage full conversion process, through recycling of unconverted product, and it is widely used because of its efficient design resulting in minimal cost for full-conversion operations.

Hydrocracking applications

Valves play an important role in the hydrocracking process, ensuring that reactors are kept at their optimal temperature. They are also of importance in providing emergency depressurising possibilities and in ensuring an optimal flow of raw materials to maximise product yield.

Furnace pass flow control

The furnace pass control valve controls the flow of feed into the furnaces which heat the feed before entering the reactor. The feed may be dirty causing problems with valves sticking. Valves should also be able to resist gland leaks. The operating temperature is usually around 280-350 °C (530-660 °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 O₂ in the flue gas. Poor control of the damper leads to poor utilisation of fuel gas in the furnace. Proper control can lead to a decrease of up to 3 % of excess O₂, equaling yearly fuel savings of 200 000 USD in a 200 000 bbl/day process 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 heat the feedstock into the temperature producing optimal yield of desired products in the reactor. 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 furnace outlet temperature and for 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.

- **Minimise 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 characterised 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 utilises 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

Reactor bed quench

The hydrogen quenches are controlled to obtain equal bed inlet and outlet temperatures. This minimises the catalyst deactivation rate and maximises product selectivity. The bed inlet temperatures are typically controlled within $\pm 0.5\text{ }^{\circ}\text{C}$ ($\pm 1.0\text{ }^{\circ}\text{F}$) of the desired temperature. As the catalyst activity declines during the run, this decline must be compensated by raising the average temperature.

This requires a valve with good control accuracy and minimised variability to optimise hydrogen consumption. Rangeability is also needed to compensate for catalyst activity loss.

Neles solution for reactor bed quench

Neles globe valves with an ND intelligent valve controller to minimise variability.

- **Wide rangeability** allowing the same valves and piping to be used with rising reactor temperatures
- **Optimised hydrogen consumption** as the ND controller can reduce temperature variability
- **Easy maintenance** – Top entry construction for easy access, valve assembly is simple and self-guiding
- **A variety of trims available**, including the Tendril design, reducing noise and eliminating cavitation
- **Improved process safety** with the online diagnostics provided by the ND controller



Neles globe valve

Reactor depressurising

In case a thermal runaway in the reactor, a safety function is needed to stabilise the conditions. Hydrocracking reactors are usually equipped with a slow and a fast depressurising system. During an emergency the slow system is always considered first to minimise damage to process equipment. If the slow emergency system fails to contain the situation, the fast system is taken into use.

Depressurising valves are typically required to reduce the vessel pressure to a certain value (e.g. 50 %) of the design level within a set amount of time (which can range from several minutes to almost an hour). As the depressurised gas is usually lead to a disposal system, such as a flare, the capacity of this system usually limits the outlet velocity of the depressurising valves. Noise reduction capabilities may also be needed.

Neles solution for reactor depressurising

Neles ball valves with the intelligent safety solenoid ValvGuard™ as an option provide a reliable and safe solution for reactor depressurising.

- **Fire-safe construction**, ensuring availability in fire emergency conditions
- **Reduce emissions and product losses** due to long lasting metal seated tightness, rotary stem and live-loaded packing
- **Patented Q-trim™ design available**, providing up to 18 dB(A) noise attenuation where noise levels are to be reduced during depressurising
- **On-line valve diagnostics with ValvGuard**, ensuring reliable and safe valve operations so that the process can be brought back to safe conditions



Neles ball valve

Fractionator control valves

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

Neles solution for fractionator valves

Neles globe valves for general control applications or **segment valves** for high capacity applications.

- **Reliable and accurate control**, allowing the process parameters to be optimised giving optimal efficiency
- **Wide rangeability**, allowing the flows to be adjusted to account for changes in feed quality
- **Predictive maintenance** is made possible with the online diagnostics provided by the ND valve controller

For large sizes, **Neldisc™ butterfly valves** provide a reliable, compact and economical solution.

- **Mechanically induced disc and seat contact**, making tightness unrelated to differential pressure
- **Assured tightness over long periods**, due to unique full metal seat design
- **Impurity resistant**, due to heavy duty stem and bearing arrangement

Benefits

- Reduced process variability, ensuring product yield and productivity targets are attained
- Meet strict reliability, safety and environmental requirements
- High pressure gases vented safely to the flare
- Save piping and valve costs with compact and lightweight valve solutions
- Meet process run-time targets



Neles globe valve

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