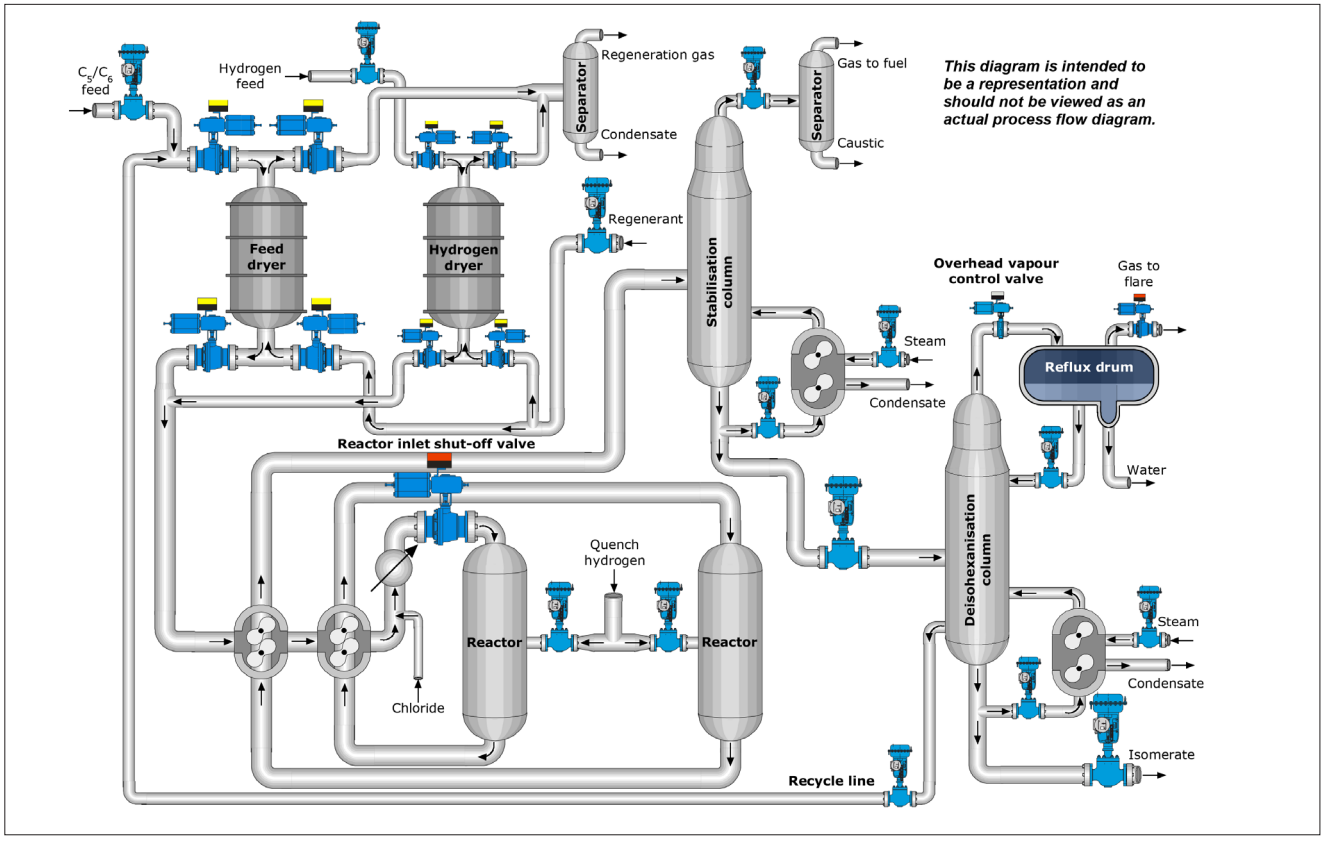
Isomerisation



Process overview

An isomerisation process can be used to improve the octane numbers of light straight-run naphtha. In isomerisation, the atoms of a molecule remain the same but are rearranged producing an isomer. Isomerisation processes also saturate benzene into cyclohexane by hydrogenation as benzene concentration in gasoline is legislated due to environmental concerns.

Using a simpler once-through process, research octane numbers (RON) can be improved from 70 to about 80-84. When also utilising recycling of the unconverted hexane, octane numbers can further be improved to around 87-93.

The pentane/hexane and hydrogen feed usually enter the process through dryers which are used to ensure that the feed is free of oxygen sources that could decrease catalyst activity. If a catalyst type is used that can tolerate water, dryers may not be necessary.

After mixing with make-up hydrogen, the feed is heat-exchanged against the reactor effluent. It then enters a charge heater (or heat exchanger) before entering the reactors. The reactors are kept at a temperature of about 100-200 °C (200-400 °F) as the equilibrium of the isomerisation reaction is pushed towards the isomers at lower temperatures. The relatively low temperature slows down the reaction rate, requiring the use of a catalyst to make the reaction proceed at a reasonable rate. In order to maintain high catalyst activity, some catalysts require the addition of small amounts of organic chlorides. Hydrogen quenches are used to maintain reactor temperature and catalyst activity.

Some cracking also occurs in the reactors, and the light gas formed is removed in the stabilisation column. The remaining part exits the stabiliser through the bottom. This stream then enters a deisohexaniser where the unconverted hexane is separated and recycled.

Isomerisation applications

Efficient and reliable valve operations provide the means for significant yield improvements and energy savings in an isomerisation process. Product yield can be optimised with efficient reactor quench control. Energy efficiency is improved by substantially minimizing the amount of heating fluid utilised to preheat the feed to the isomerisation process.

Feed and regenerant control

Light naphtha feed and make-up hydrogen are both charged to separate dryer vessels. The hydrogen amount is kept just slightly above the amount needed to saturate benzene in the hydrocarbon feed. The hydrogen to hydrocarbon ratio is kept at the minimum level required to prevent excessive catalyst coking in the reactors. The dryers must be regenerated properly and frequently to remove adsorbed water and other impurities from the molecular sieve beds.

Reliable and accurate control is required to keep the hydrogen to hydrocarbon ratio at an optimal level. Seat leakage required for these control valves is typically class IV or class V.

Neles™ solution for feed control

Neles globe valve with an intelligent ND valve controller provide excellent control reliability and accuracy for the application.

- **Best possible control accuracy,** ensuring that the feed ratio is kept at the right amount
- **Long lasting tightness,** as the valve utilises metal seats
- **Minimise leaks,** as the rugged one piece body structure eliminates potential leak paths
- **Different inherently characterised trims,** available as equal percentage, linear and quick open
- **Process variability reduced** with the intelligent ND valve controller

Dryer switching valves

Adsorptive dryers normally include three beds, two in drying stage and the third in regeneration with hot gas or in reactivation with cool gas. Switching from bed to bed takes place in 2-6 hours, a minimum of 4 to 6 switching valves are required for each bed. The switching valves play an important role of directing the inlet/outlet gas streams into the adsorption bed columns, switching the columns from adsorption phase to regeneration phase (and cooling phase) in a pre-set sequence. These valves are also called dryer sequencing valves.

The valves should be able to resist hot regeneration gas (200-350 °C/400-660 °F) and temperature swings (25-350 °C/45-630 °F). They should maintain operability in spite of some particulates (molecular dust) with an operating pressure up to 50-60 bar (730-870 psi). Tight shut-off is required, typically class V for feed dryer valves and class V or VI for hydrogen dryer valves.

Neles solution for dryer switching

Neles ball valves with a SwitchGuard™ (SG) intelligent on/off valve controller.

- **Particle build-up prevention**, as the seat and ball are in continuous contact effectively wiping the seat surface with every cycle
- **A high cycle design,** which makes it perfect for high cycling applications such as dryer switching
- **Durable two-way tightness** as standard with live-loaded metal seats
- **Field proven design,** as the Neles ball valves have been widely used in drying applications
- **Configure to meet process demands** – SG gives the possibility to set the on-off valve stroking times and profiles according to the process needs

Neles ball valve

Hydrogen quench control

Hydrogen quenches are used to control the reactor temperature and to protect the catalyst beds from possible coke build-up. While the isomerisation reactions are only mildly exothermic, benzene saturation releases significant heat that must be controlled to ensure a favourable equilibrium. Increased temperatures also promote catalyst deactivation.

As the composition of the feed may vary, rangeability is required of the valve to adjust for the changing amount of heat released. Active catalysts are sensitive to temperature changes, making quick response a necessity for the valves.

Neles solution for hydrogen quench

Neles globe valves ensure efficient and reliable reactor quenching.

- **Optimise hydrogen consumption,** as reliable control reduces variability
- **Use more efficient catalysts,** as more active catalysts require control that is quick to respond
- **Wide rangeability,** ensuring that the reactor temperature can be kept constant with varying feed composition
- **Interchangeable trim parts** making it possible to easily change flow characteristics
- **Detect problems in advance** with the ND intelligent valve controller

Neles globe valve

Reactor inlet shut-off

This safety valve is needed in order to isolate and protect the reactors and the catalyst in a case of a process upset. The ESD valves are normally open and they are closed in case of an upset.

These valves are expected to be available and function reliably throughout the process runs when needed, even after longer periods of non-operation.

Neles solution for reactor inlet shut-off

Neles ball valve with a ValvGuard™ (VG) intelligent safety solenoid ensures that the valve will be operational when needed.

- **Long life time,** due to robust design
- **Anti-blowout valve shaft,** ensuring the safety of personnel and equipment
- **High torque piston actuator,** designed to overcome static friction
- **Partial stroke test,** which can be performed by the VG9000 either automatically or manually to ensure that the valve is working properly
- **Compliance up to SIL 3** by third party certifications
- **HART & FOUNDATION fieldbus** communication compatibility
- **Advanced diagnostics** capability of the VG9000, increasing safety and allowing plant safety targets to be reached more economically

Neles ball valve with an intelligent safety solenoid

Column heat and product control

The reactor effluent is cooled before entering the product stabiliser. The stabiliser overhead vapours are caustic scrubbed in order to remove the hydrogen chloride (HCl) that has formed in the reactor. The stabiliser bottoms are separated into normal and isoparaffin components by fractionation in a deisohexanisation column that concentrates low-octane methylpentanes into the sidecut stream which is recycled back to the reactor feed. The reboilers control the heat input to the stabiliser/ deisohexaniser and therefore the efficiency of gas stripping from the isomerate. Reflux control is a balance between the gasoline separation and reboiler energy consumption. The lower the reflux rate the more gasoline is lost with the gases, but less heat is required in reboiler.

Reliable and accurate control performance is required of the valves to ensure efficient gas separation. If refinery process streams are being used in the reboilers, the medium may be dirty and/or pose an environmental concern.

Neles solution for column control

Neles globe valve provides a robust and economical solution for these applications.

- **Reliable control,** ensuring that the temperature remains stable ensuring efficient gas stripping
- **Fugitive emission certified** according to ISO 15848
- **Reduce reboiler energy consumption,** as accurate control ensures efficient reboiler operations
- **Tendril™ trim design option,** excelling at low noise and anti-cavitation applications

In case extreme rangeability is required, **Neles segment valves** are the valve of choice for the application.

- **Widest possible rangeability,** ensuring that the same valve and piping can be used with varying flow amounts
- **Low fugitive emissions,** due to rotary operation which is inherently less prone to leaks
- **Q-Trim™ design available,** eliminating noise and the potential for cavitation to occur

To ensure the best possible control accuracy and reliability, these valves may be equipped with the ND intelligent valve controller.

- **Benchmark control performance,** with the advanced data the controller provides on valve operation
- **Low power and air consumption,** making installation possible in all common control systems
- **Performance view with report,** giving guidelines for recommended actions
- **Reliable and robust design,** capable of withstanding harsh environments, humidity, vibrations and more

Neles segment valve

Column overhead vapour control

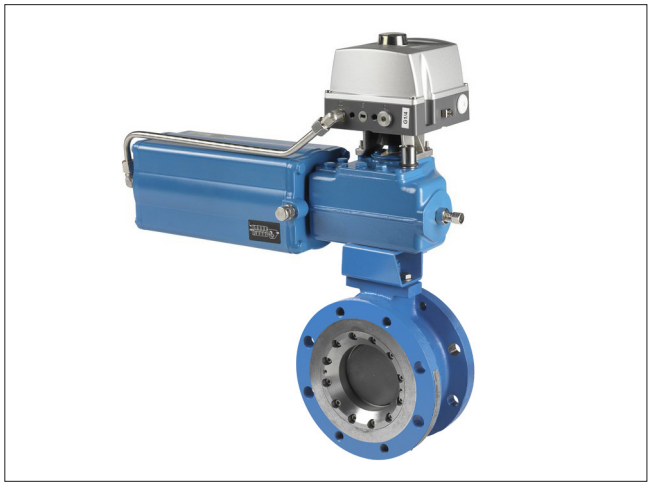
Product separation column pressures are typically kept at a minimum in order to minimise the energy consumption at the column reboiler.

Reliability is required in order to keep the column at a stable pressure. Fugitive emission control is important for gas service.

Neles solution for overhead vapour

With close to equal percentage characteristics and superior tightness, **Neles triple eccentric disc valve** is an economical and reliable choice for large size control applications

- **Triple eccentric design,** reducing wear and producing tight shut-off
- **No resilient parts exposed to the medium,** extending the life time of the valve
- **Mechanically induced disc to seat contact,** meaning that the seal does not rely on assistance from differential pressure
- **Easy and stable column operation,** since free movement of the disc ensures minimal seat friction
- **Low emissions** as a result of utilising rotary design and a reliable stem packing



Neles triple eccentric disc valve

Benefits

- Reliable and field-proven dryer performance
- Use more active isomerisation catalysts
- Improve yield with stable reactor temperature control
- Meet noise, emission and fire safety regulations set by local authorities
- Reach plant uptime targets with on-line diagnostic capabilities
- High pressure gases vented safely to the flare

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