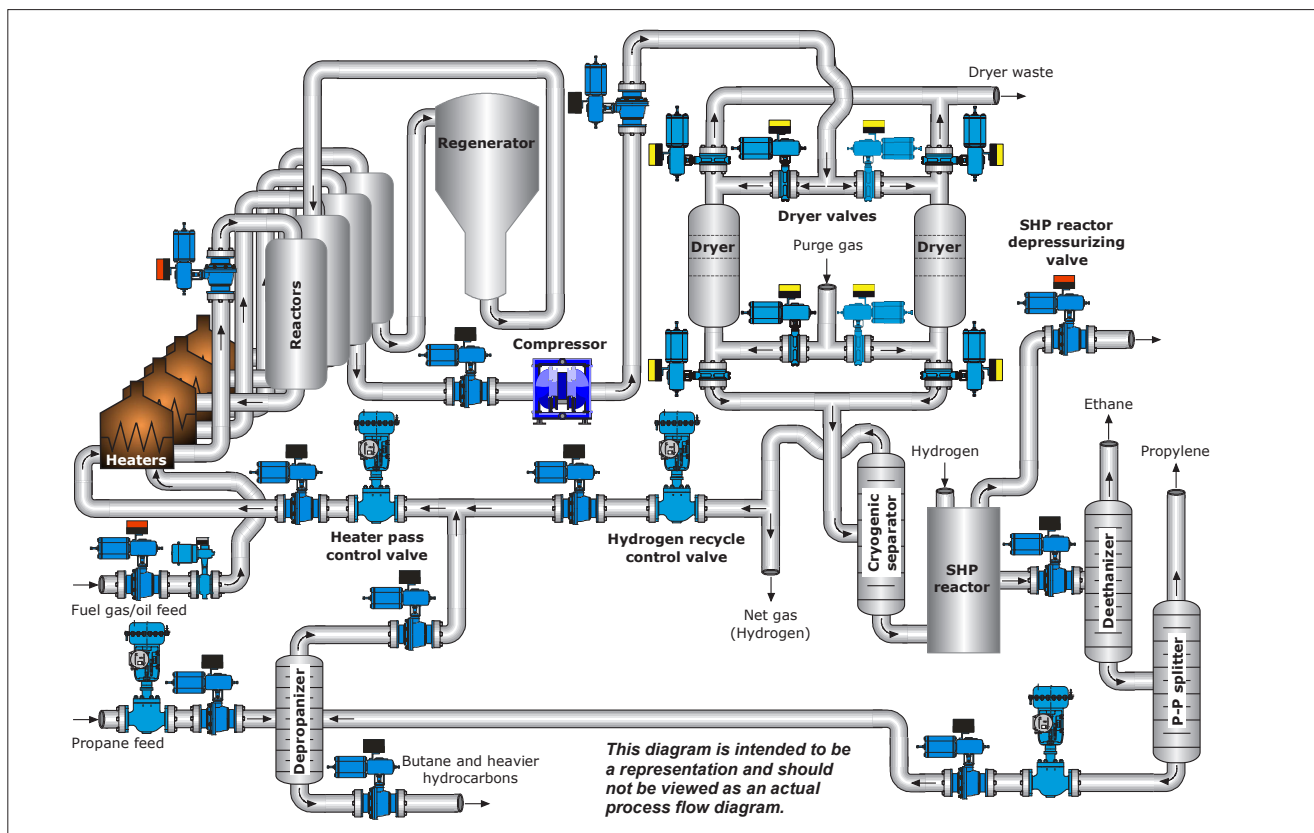


Propane dehydrogenation – Reactor and product recovery



Process overview

Propane dehydrogenation (PDH) is used to produce polymer-grade propylene from propane independent of a steam cracker or fluid catalytic cracking unit. It provides a dedicated and reliable source of propylene to meet the growing market demand for propylene and gives more control over propylene feedstock costs.

Fresh propane feed is mixed with recycled propane and optionally also with recycled hydrogen gas and is fed into a heater to be heated to over 540°C (1000°F) and then enters the reactors to be converted at high mono-olefin selectivity. Three or four reactors are usually used and they are operated either in series or in parallel. When the reactors are operated in series, interstage heaters are used to maintain the reaction through supplying heat, since the reaction is endothermic.

Catalyst activity is maintained by continuous catalyst regeneration or by utilizing regeneration air. Reactors operated in series utilize continuous catalyst regeneration, where catalyst is continuously withdrawn from the reactor, regenerated, and then fed back into the reactor bed. For reactors operating in parallel, catalyst activity is maintained by shutting down the reactors one by one and regenerating the catalyst by using heated regeneration air.

The propylene-rich reactor effluent is compressed, dried and sent to a cryogenic separator where hydrogen is recovered. The olefin product is then optionally sent to a selective hydrogenation process where dienes and acetylenes are saturated to mono-olefins.

The olefin stream then goes to an ethylene column where light-ends are removed prior to the propane-propylene splitter where propylene is recovered. Unconverted feedstock is recycled and combined with the fresh feed.

Propane dehydrogenation valves

Reliable valve performance is critical in a propane dehydrogenation process. Potential runaway situations require robust safety valve designs to provide relief systems in case of sudden pressure or temperature increases. Some media present in a propane dehydrogenation process are also highly flammable.

Valves are also responsible for ensuring efficient recovery of hydrogen sulphide through molecular sieve beds. Unsatisfactory hydrogen sulphide recovery could poison downstream catalysts or damage equipment. Thus, proper valve performance is important so that process uptime and efficiency can be maximized.

Reactor feed shut-off valves

Located following the heater, these emergency shut-off valves must promptly isolate the feed to the reactor in case of an upset scenario. There are separate isolation valves for the feed and regeneration lines.

It is imperative that these valves function correctly when needed, even after an extended period of non-operation. Quick operation and tight shut-off are essential. The temperature is extremely high, from around 400°C (750°F) up to 540°C (1000°F).

Neles solution for reactor feed shut-off

Neles trunnion mounted ball valves with a ValvGuard intelligent safety solenoid to ensure reliable operation in case of an upset.

- **High temperature compatible**, with special construction and materials making the valve applicable up to 600 °C (1100 °F)
- **Long lasting tight shut-off**, up to ANSI Class V
- **Increased availability** with advanced diagnostics and possibility for partial stroke testing
- **Quick operation** without additional instrumentation due to high pneumatics capacity
- **Simple and compact valve instrumentation** provided by ValvGuard™

Column heat and product control

Propane dehydrogenation processes usually utilize several columns including an ethylene column (or deethanizer) and a propane-propylene splitter. Column operation is a balance between energy consumption and separation efficiency. A lower reflux rate requires less heat in the reboiler, conserving energy but decreasing separation efficiency.

To ensure that the valve does not adversely affect separation efficiency, accurate and stable control is required of the valve. Flow media are also toxic and flammable, making emissions a concern. A common problem with column operations is also poor loop sensitivity caused by improperly sized (oversized) valves

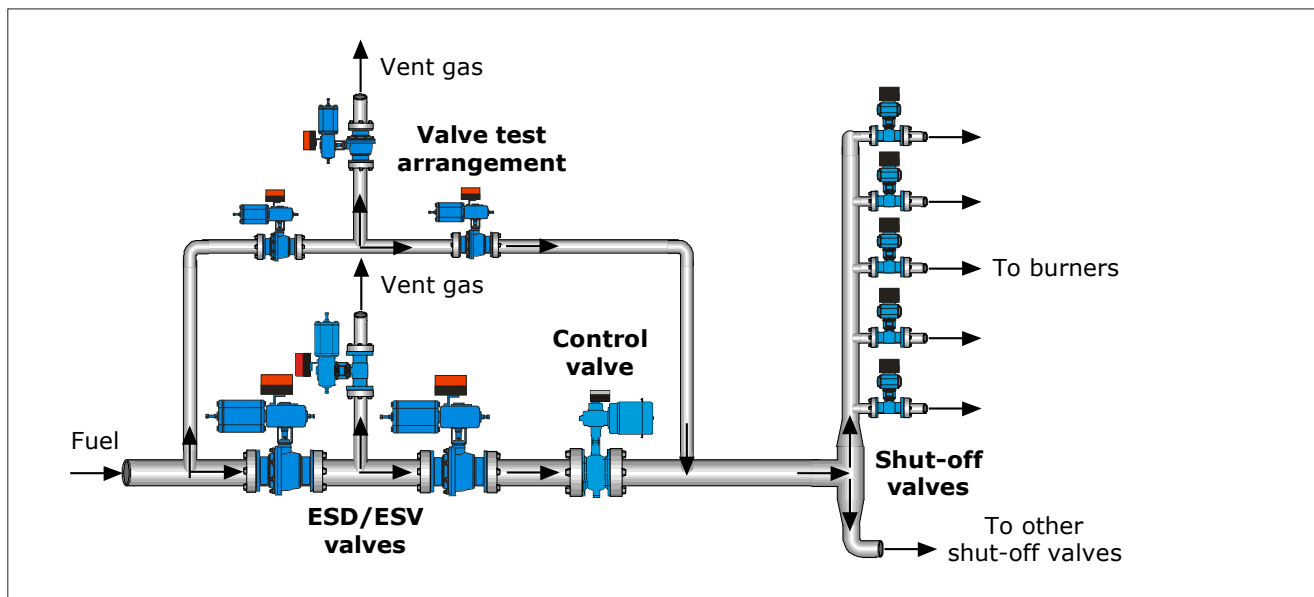
Neles™ solution for column control

Neles linear globe valves provide the foundation for stable and reliable column operations.

- **Wide range of trim designs and a wide valve size range** ensures compatibility with various column applications
- **Fugitive emission certified** according to ISO15848-1
- **Minimize process deviations** with accurate control profile calibration enabled by intelligent ND valve controller
- **Reliable valve sizing** with Neles valve sizing software since valve installed characteristics are also analysed



Neles globe valve



Simplified schematic of a typical burner valve setup

Fuel gas/oil control valve

Heaters create heat required to maintain the reaction and convert the feedstock since the dehydration reaction is endothermic.

The different heat generation properties of the fuels require a valve which can regulate the flow accordingly. 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 VD 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

- **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
- **Easy maintenance** – Top entry construction for easy access, valve assembly is simple and self-guiding
- **Low-friction actuator operation** improving efficiency and control performance

If the type of fuel being used varies and/or extremely high rangeability is required, the **Neles rotary V-port segment valve** 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
- **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, increasing reliability and reducing costs
- **Fire-safe compliant** according to API 607
- **Q-Trim™ design available**, eliminating noise and the potential for cavitation to occur



Neles segment valve

Burner shut-off and ESD valves

Gas flows into the burners through a series of two ESD valves that have a vent (ESV) between them. The vent is used to prevent pressure build up and flow through the second isolation valve when the system is isolated. The ESD valves automatically shut off the supply of fuel when de-energized by a combustion safety control, safety limit control, or loss of actuating medium. The gas then flows to burner shut-off valves before entering the burners. Proper functioning in case of an upset is imperative. Type approvals are also becoming a standard requirement by local authorities in different countries. Typical process conditions are similar to the control valve.

Neles solution for burner shut-off/ESD

Jamesbury™ soft-seated ball valves with a B1-series piston actuator and a ValvGuard safety solenoid to ensure operability in case of an upset for ESD/ESV valves. For shut-off valves, **Jamesbury ball valves** with a Valv-Power VPVL actuator provide excellent tightness during shut-off

- **Field proven Xtreme™ seat & Lip-Seal capabilities** in both continuous and on-off (switching) heating
- **Safe and reliable bubble tight shut-off** even after a million cycles and the self-relieving feature (cavity relief) provides safe operation after a long time of non-movement
- **Partial stroke testing capability** with the ValvGuard safety solenoid
- **Fire-safe design** acc. to API 607 or ISO 10497
- **Low fugitive emission approvals** by third party authorities
- **Compliance up to SIL 3** by third party certifications
- **Gas burner valve type approvals** acc. to EN161, EN264, ISO 23553-1, AGA, FM and CSA



Jamesbury ball valve

Reactor depressurizing valves

The selective hydrogenation reactor depressurizing valve is designed to open in case of over-pressurization to ensure safe operation during upset conditions. Most depressurizing systems utilize two depressurizing valves: a slow operational depressurizing valve and a fast emergency depressurizing valve. Local safety regulations may necessitate the presence of redundant valves to ensure that depressurization can occur in case one valve malfunctions.

High reliability and fast operation is required of the reactor depressurizing valves, since the valves must open immediately in case over-pressurization or other upsets occur. Tight shut-off and robust stem packing are necessary to prevent leaks, which cause loss of product and potential safety issues if volatile hydrocarbons enter the facility. Noise reduction capabilities and fire safe designs are typically also required.

Neles solution for reactor depressurizing

Neles metal seated ball valve, with a special noise reducing Q-Trim, equipped with pneumatic B1-series actuator and Neles ValvGuard intelligent safety solenoid.

- **Avoid unnecessary flaring** due to long lasting metal seated tightness and partial stroke testing with ValvGuard
- **Emission proofing** with rotary technology and standard live-loaded packing
- **Advanced online diagnostics** enabling predictive maintenance
- **Fire proofing available and fire safe certified** design as standard
- **Prevent too fast depressurizing** by utilizing special trims with capacity limitations



Neles ball valve

Dryer switching valves

The dryers are used to remove trace amounts of water formed from catalyst regeneration and to remove hydrogen sulfide. The valves play an important role in directing the inlet/outlet stream of gas between the dryer columns, switching the columns from adsorption phase into regeneration phase in a pre-set sequence. Natural gas or hydrogen at a high temperature of around 250°C (480°F) is used to regenerate the adsorption bed.

The valves should withstand fluctuations in temperature while keeping bi-directional tightness over a period of several years of operation. The seat material and construction must resist particles entering the seat cavities and adhering to sealing surfaces because the molecular sieve beds tend to release dust during the regeneration cycle.

Neles solution for dryer switching

Neles metal-seated ball valves with a B1-series actuator and an intelligent valve controller SwitchGuard™ as an option offer the optimal solution for the application.

- **Particle build-up prevention**, as the seat and ball are in continuous contact effectively wiping the seat surface with every cycle
- **Durable two-way tightness** as standard with live-loaded metal seats
- **Heavy duty valve design**, capable of withstanding the pressure differences and piping forces in the process

For larger pipe sizes, **Neles triple eccentric butterfly valves** offer an economical and high performance solution.

- **Assured tightness over long periods**, due to unique full metal seat design
- **Mechanically induced disc and seat contact**, making tightness unrelated to differential pressure
- **Thermal cycling resistant** with bi-directional tightness even in large cycling
- **Low friction operation** reducing wear and increasing operational life
- **Impurity resistant**, due to heavy duty stem and bearing arrangement

Neles valve controller SwitchGuard offers topmost reliability in severe environmental conditions and provides extensive diagnostics for high cycle on-off applications, enabling users to guarantee the availability of PDH-valves.

- **Configure to meet process demands** – SwitchGuard gives the possibility to set the on-off valve stroking times and profiles per process needs
- **Reach fast stroking times without accessories** such as volume boosters or quick exhaust valves, due its high pneumatics capacity
- **Practise predictive maintenance** with the help of the extensive diagnostics that it provides on the PDH-valve performance
- **Comprehensive hazardous area certifications** for intrinsically safe and flameproof applications are available for all valve control instruments

Benefits

- Improved process control, increasing product yield and profit
- Predictive maintenance planning and reaching plant uptime targets with on-line diagnostic capabilities
- Reliable and lasting valve operation
- Meet noise, emission and fire safety regulations set by local authorities
- Highest safety and availability for ESD/ESV applications



Neles butterfly valve

Valmet Flow Control Oy

Vanha Porvoontie 229, 01380 Vantaa, Finland.

Tel. +358 10 417 5000.

www.valmet.com/flowcontrol

Subject to change without prior notice.

Neles, Neles Easyflow, Jamesbury, Stonel, Valvcon and Flowrox, and certain other trademarks, are either registered trademarks or trademarks of Valmet Oyj or its subsidiaries in the United States and/or in other countries.

For more information www.neles.com/trademarks

