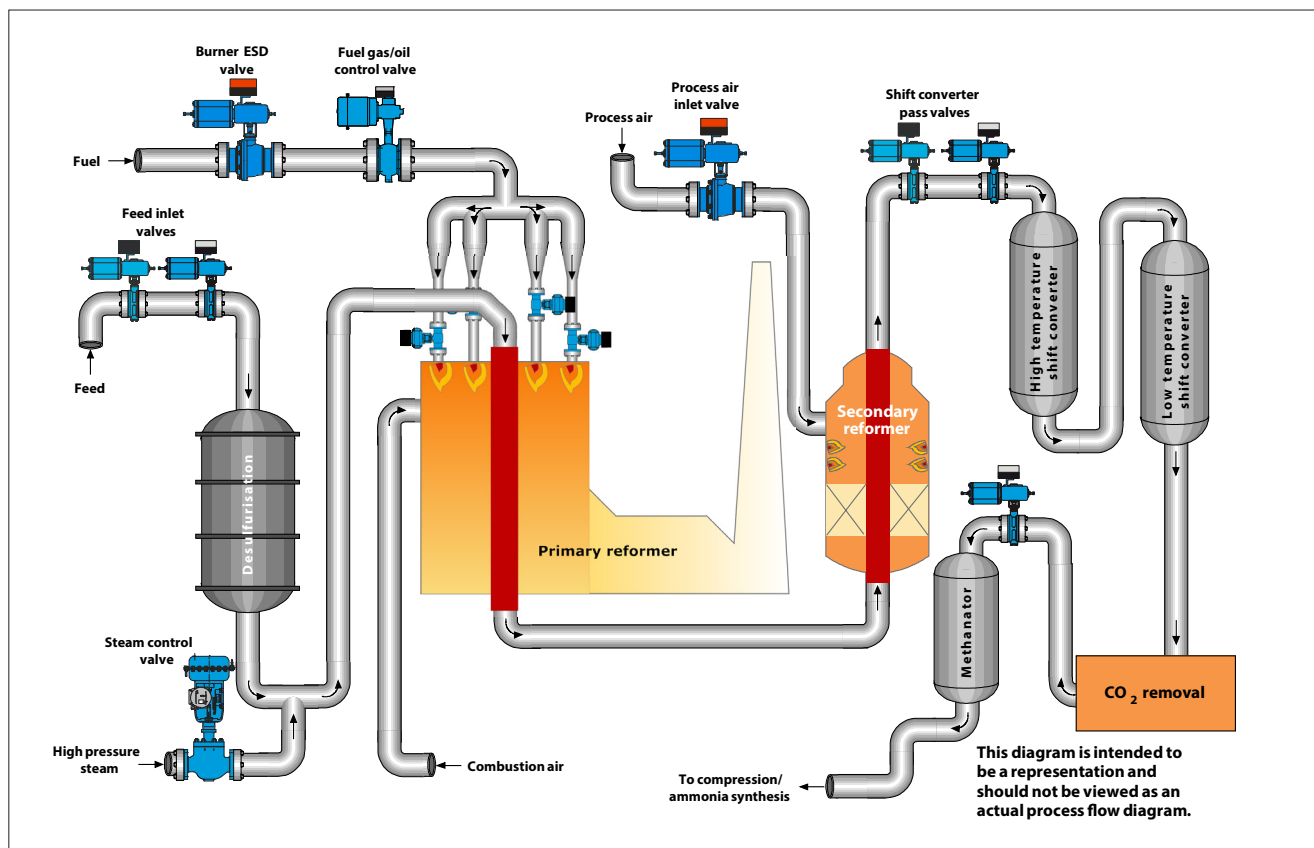


Steam reforming



Process overview

Steam reforming, or steam methane reforming, is used to convert hydrocarbon feedstocks such as natural gas, LNG, LPG or naphtha into hydrogen or syngas. The produced gas is then usually used for refinery applications (hydrotreating, hydrocracking) or petrochemical applications (ammonia, methanol).

The feed is desulfurized and then mixed with steam before entering the primary reformer. In the reformer, the feed is converted over a nickel-based catalyst under high temperature (600-850 °C/1100-1560 °F) into hydrogen and carbon monoxide.

If the produced hydrogen is to be used for ammonia synthesis, a secondary reformer is usually present where the reforming is finalized and nitrogen is admitted into the process as part of the process air. Alternatively, an air separation unit can be used to admit the nitrogen directly into the ammonia synthesis loop.

The reformed feed is then taken to the CO shift section where one or two shift converters are present. These convert carbon monoxide and water into carbon dioxide and hydrogen gas via the water-gas shift reaction.

After the CO shift section, the resulting gas is then purified in the CO₂ removal section. This is usually done by using pressure swing adsorption or acid gas scrubbing.

A methanator may also be present after the CO₂ removal section, in which carbon monoxide is converted to methane to protect the downstream process from catalyst poisoning.

The product is then ready to be used in refinery applications or for synthesis of ammonia or methanol.

Steam reforming applications

Valve reliability in steam reforming is an important concern. Malfunctioning valves in either the steam or fuel gas inlet section can cause a runaway situation in the steam reformer which causing severe damage. The presence of hydrogen gas also poses restrictions on the material selection for certain valves.

Feed control valve

The feed control valve controls the flow of hydrocarbon feed (natural gas or naphtha) to the pre-heating section before the feed is desulfurized (if needed) and then mixed with steam. The mixture then enters the steam reformer.

If natural gas is used as the feed, it may contain entrained dust or droplets of liquid (oil or water). Feed control valves present before the pre-heating face near ambient temperatures of about 30 °C (90 °F). If the valve is located after the preheater, the temperature can be up to 400 °C (750 °F).

Metso solution for feed control

Neldisc triple-eccentric butterfly valve with a piston actuator and an ND valve controller offers a reliable and economic solution for feed control.

- **High temperature compliant as standard**, operating without a hitch at temperatures up to 425 °C (800 °F)
- **Full metal seat design**, ensuring lasting tightness over long time periods
- **Compact size and weight**, reducing material and piping costs
- **High flow capacity**, due to two-piece shaft design, decreasing pressure drop or allowing the usage of smaller valve sizes
- **No resilient parts exposed to the medium**, ensuring a longer life time for the valve

Steam control valve

The steam control valve controls the flow of process steam to the mixing point with the hydrocarbon feed. It is either medium or high pressure steam and can also be a mixture with process condensate stripper exhaust steam.

It is critical for proper steam reformer functionality that the steam to hydrocarbon ratio doesn't get too low. A low steam concentration allows the formation of carbon depositions which may result in "hot bands" on the tubes, eventually leading to tube failure. Therefore, reliability is a must and a minimum stop may be required. Noise may also be a concern and the temperature of the steam can be up to 400 °C (750 °F).

Neles solution for steam control

Neles cage guided globe valves with a spring diaphragm actuator and an ND intelligent valve controller ensure a reliable and consistent steam supply.

- **Best possible control accuracy**, assuring that the steam amount can be kept at the desired level
- **Mechanical stopper** available as standard option
- **Extension bonnet** allowing temperatures up to 425 °C (800 °F)
- **A variety of trims available**, including the Tendril design, reducing noise and eliminating cavitation
- **Predictive maintenance** is made possible with the online diagnostics provided by the ND valve controller



Neles globe valve

Fuel gas/oil control

The furnace heats the feedstocks into the temperature required for the steam reforming reaction to take place. 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. 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

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. This is followed by burner shut-off valves.

It is imperative that the ESD valves operate properly even after extended periods of non-operation. Type approvals are also becoming a standard requirement by local authorities. Typical conditions are similar to the control valve.

Neles solution for burner shut-off/ESD

Jamesbury™ soft-seated ball valves with a piston actuator and a ValvGuard™ safety solenoid to ensure operability in case of an upset.

For shut-off valves, **Jamesbury soft-seated ball valves** with a Valv-Powr™ 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 VG9000 safety solenoid
- **Fire-safe design** acc. to API 607 or ISO 10497
- **Low fugitive emission approvals** by third party authorities
- **Certified up to SIL 3** by third parties
- **Gas burner valve type approvals** acc. to EN161, EN264, ISO 23553-1, AGA, FM and CSA



Jamesbury ball valve

Shift converter control valve

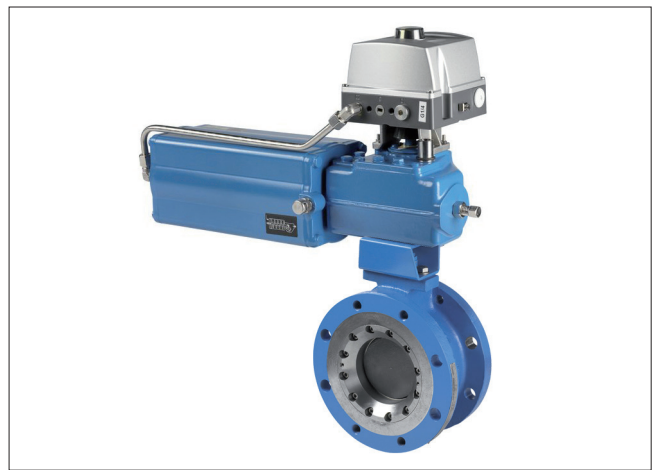
The shift converter control valve controls the flow of reformed gas into the shift converters, where additional hydrogen is produced from the feed.

The temperature at this location may exceed 260 °C (500 °F). This, combined with the composition of the medium makes these valves susceptible to hydrogen attack. It is therefore important that the material of the valve is capable of resisting hydrogen attack to ensure a long life-time for the valve. Due to the volatile nature of hydrogen, fugitive emissions are also a concern.

Neles solution for shift converter control

Neles triple-eccentric butterfly valves with an ND intelligent valve controller ensure reliable syngas control.

- **ASTM A351 CF8M body**, providing good resistance against hydrogen attack due to its chromium and molybdenum content
- **Live-loaded stem seal** ensuring fugitive emission control
- **Thermal shock resistant**, operating reliably even in large thermal cycling
- **Good controllability** via smoothly rising installed characteristics curve at both very small openings and nearly full Cv positions
- **Fire-tested** per API 607



Neles butterfly valve

Benefits

- Field proven long term tightness for safe and reliable reformer operation
- Improved process control, reducing downtime and increasing efficiency
- Save piping and valve costs with compact and lightweight valve solutions
- Meet noise, emission and fire safety regulations set by local authorities
- Highest safety and availability for ESD applications

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