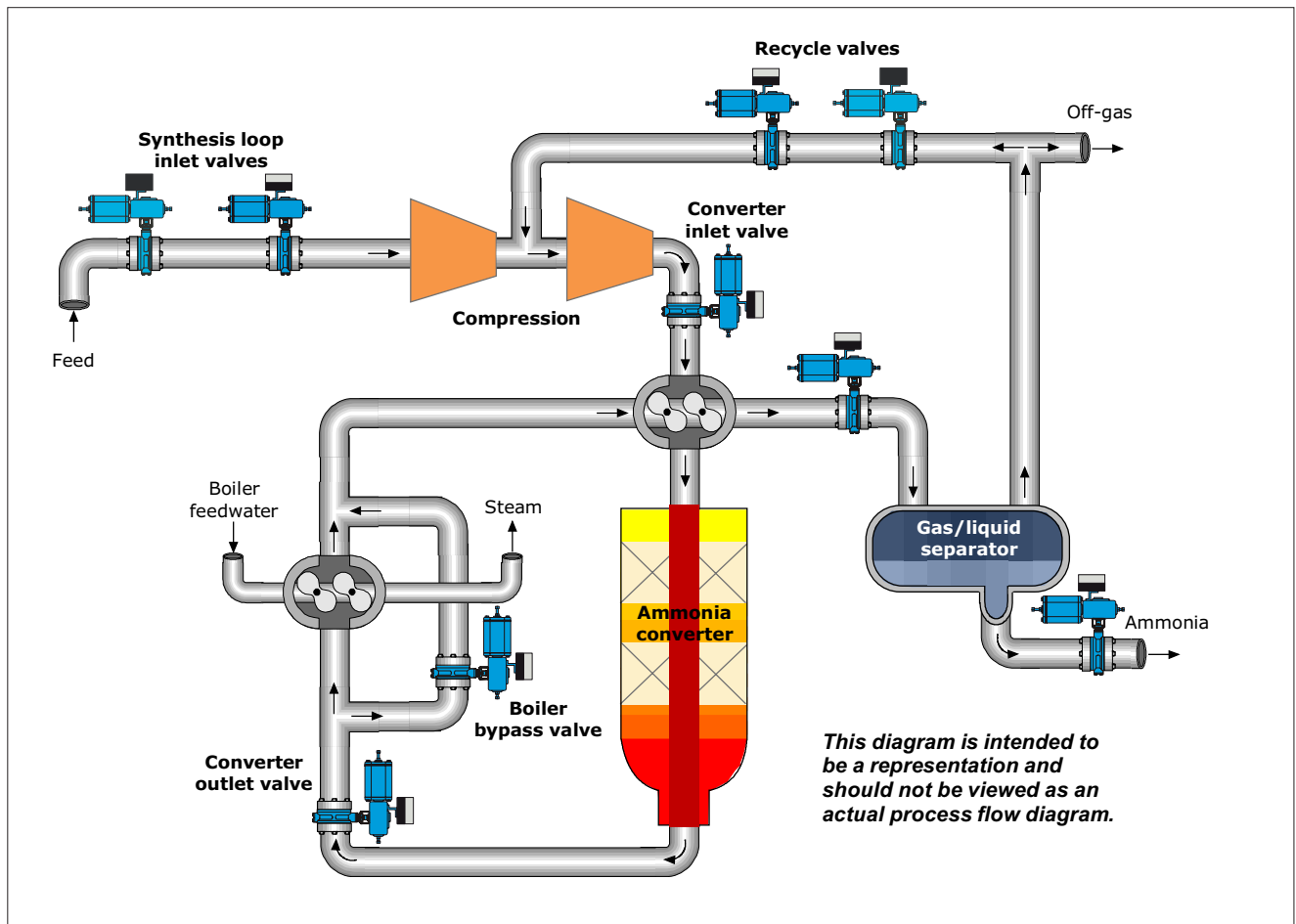


## Ammonia synthesis



### Process overview

Ammonia synthesis is used to produce ammonia from nitrogen and hydrogen. The produced ammonia can then be used as a fertilizer, or it can be further processed into urea or nitric acid.

A mixture of hydrogen and nitrogen, usually originating from a steam reformer, is admitted to the synthesis loop and then compressed in two stages into the synthesis pressure of 150-300 bar (2200-4400 psi). The stream is preheated by heat exchange with the hot effluent coming out of the converter before entering the ammonia converter.

The ammonia conversion process is a compromise between temperature and pressure. For the catalyst to be efficient a temperature of at least 400 °C (750 °F) is needed, but since the reaction is exothermic a higher temperature negatively affects product yield. To counter this issue, the pressure is increased to push the reaction equilibrium toward ammonia (thus increasing product yield).

Heat is recovered from the effluent by generating steam and by pre-heating the incoming feed. The effluent is then sent to refrigeration before the product is separated from the medium and unreacted gas is recycled to the start of the synthesis loop.

## Process applications

There are various valves present in the ammonia synthesis loop, controlling the flow of synthesis gas into the converter and ensuring proper recycling of the unreacted synthesis gas.

### Converter inlet valve

This valve is used to adjust the flow of synthesis gas into the converter. The flow may need to be adjusted to cope with temperature fluctuations in the converter.

### Converter outlet valve

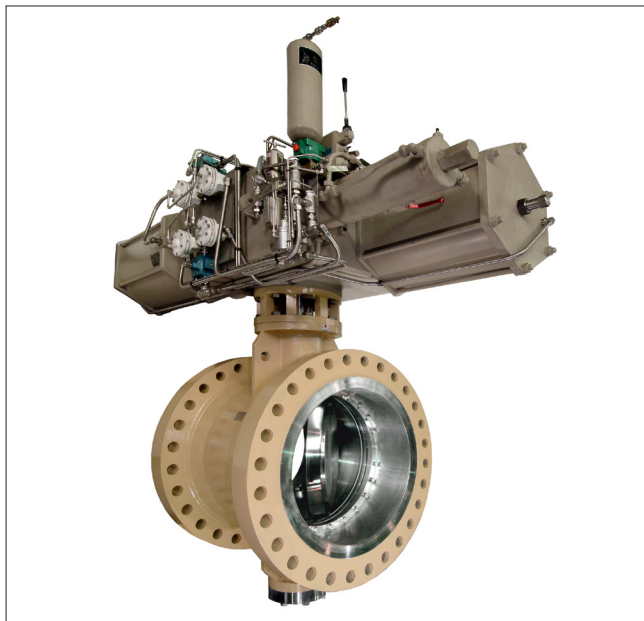
This valve is located after the reactor and is used to regulate the flow of effluent to the boiler.

### Boiler bypass valve

This valve is used to control the flow of reactor effluent that bypasses the boiler, allowing the amount of pre-heating by the synthesis gas heat exchanger to be controlled.

## Process challenges

- High temperature, between 200 °C and 450 °C (400-840 °F)
- Very high pressure (130-220 bar / 1900-3200 psi)
- Presence of hydrogen and ammonia make for a challenging environment as both hydrogen attack and nitriding may occur
- Emission control is important due to toxicity of the media being handled
- Since pressure is a very expensive commodity, efficiency in the synthesis loop is important to keep the operating costs down



Neles triple-eccentric butterfly valve

## Neles solution

**Neles™ triple-eccentric butterfly valves** provide the optimal solution for ammonia synthesis loop isolation and control valves.

Their wide design options make them suitable for all on-off/control applications in the ammonia synthesis loop.

- **Pressure classes 150-2500#**
- **Temperatures up to 1150 °C (2100 °F)**
- **Wide selection of body & trim materials**, ensuring a lasting design in the harshest of conditions
- **Shut-off tightness up to ANSI Class VI**

### Reliability

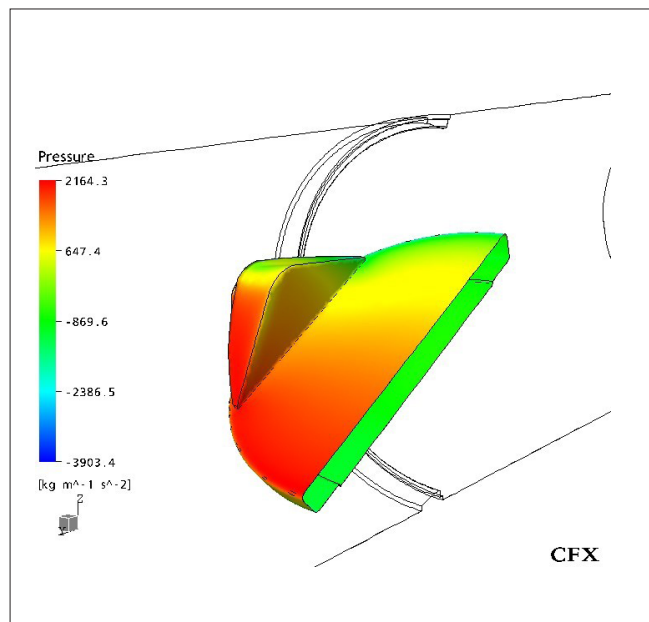
- **Triple offset design**, reducing wear and providing extended operational life in control and shut-off applications
- **No resilient parts exposed to the medium**
- **Interchangeable seats**, without needing to disassemble the disc and shaft

### Safety

- **Live-loaded stem seal as standard**, ISO 15848 and TA-Luft/VDI 2440
- **Fire-tested** per API 607, 6th edition
- **Certified up to SIL 3**, with select designs

### Efficiency

- **Solid metal seat** allowing highest possible flow velocities without damaging the seat
- **Unique two-piece shaft** gives the valve a higher flow capacity and reduces the torque requirements for operating the valve

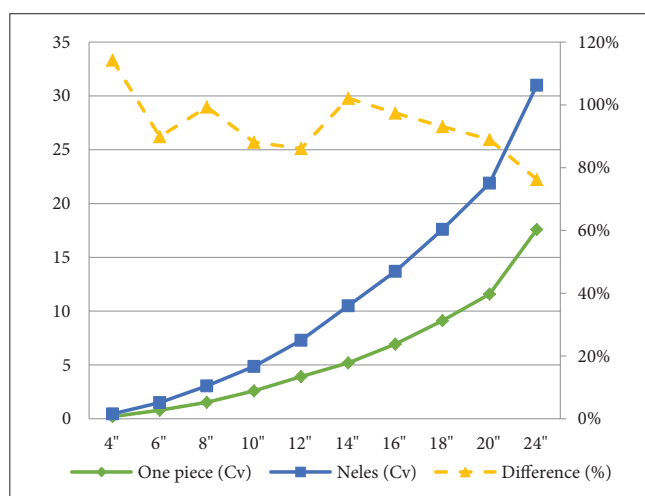


CFD pressure profile of two-piece shaft butterfly valve

The unique **two piece-shaft** gives the following advantages:

- **Lower pressure drop** across the valve, reducing operation costs, due to the higher flow capacity
- **Use smaller valve size** for the same flow amount, reducing capital costs
- **Smaller actuator** due to lower torque requirements, further decreasing capital costs
- **Lower pipe stress** as less torque is applied by the actuator
- **Less torque** also allows better controllability of the valve

For example, a flow 2000 m<sup>3</sup>/h (8800 US gal/min) through a valve giving a pressure drop of 2 bar vs 3 bar (30 psi vs 45 psi) allows potential energy savings of about \$45 000 per year in pump operations.



Flow coefficient comparison of 150# butterfly valve: Cv on the left (thousands), valve size on the bottom

## Benefits

- Reduce operation costs with higher flow capacities giving a smaller pressure drop, reducing pump energy consumption
- Reduce capital costs with smaller valves and torques resulting in a smaller valve + actuator package
- Reduce maintenance costs with modular and simple valve designs
- Ensure safety of personnel and minimize material waste with emission certified valves
- Reliable and field proven valve designs



Neles 1500# butterfly two-piece shaft design

**Valmet Flow Control Oy**

Vanha Porvoontie 229, 01380 Vantaa, Finland.

Tel. +358 10 417 5000.

[www.valmet.com/flowcontrol](http://www.valmet.com/flowcontrol)

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