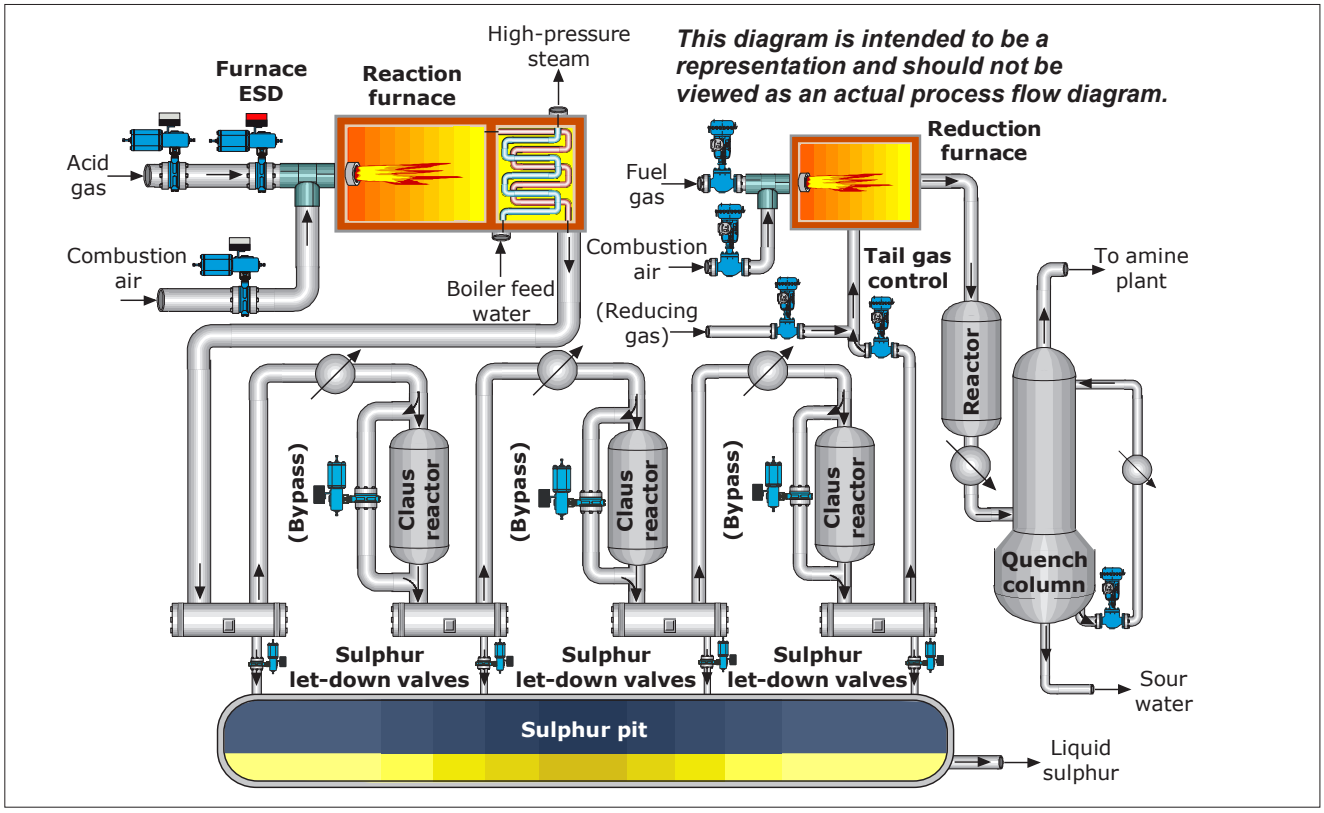
Sulphur recovery and tail gas treatment



Process overview

Various processes such as hydrotreating, cracking and coking produce gases that contain hydrogen sulphide (H_2S) and occasionally carbon dioxide (CO_2). The amount of sulphur in refinery and gas plant gases is legislated to meet HSE and gas pipeline specifications. Therefore most of the H_2S has to be removed from the gas before it can be burned or processed further.

The acid gas enters the reaction furnace where H_2S reacts with oxygen producing sulphur dioxide (SO_2). This SO_2 then reacts with unreacted H_2S producing elemental sulphur. Around 60 % of the sulphur is recovered in the furnace. The feed is then preheated before entering the Claus reactor section to prevent sulphur condensation. In the reactor, most of the remaining H_2S and SO_2 is catalytically converted into elemental sulphur. Finally the elemental sulphur is condensed and run down into a sulphur pit. Typically, two- or three-stage processes are used allowing a recovery of around 90-98 %.

Environmental legislations in most countries require a recovery efficiency in the range of 98.5-99.9 %. To achieve an efficiency this high, it is necessary to further treat the remaining tail gas.

The tail gas flows into a furnace with optionally added hydrogen gas (H_2) or a mixture of H_2 and carbon monoxide (CO). The furnace heats the feed to around 275-340 °C (530-650 °F). It also hydrolyses present CO into H_2. The reactor then converts all non-H_2S sulphur compounds into H_2S by hydrogenation or by hydrolysis. The resulting mixture is then cooled down and sent to a quench column.

After exiting the quench column, the sour gas enters an amine plant, where H_2S and CO_2 is separated and recycled to the sulphur recovery section.

Process applications

The best operating results for sulphur recovery are achieved when feed flows and compositions are maintained constant. It is vital to keep the correct H_2S/SO_2 ratio in the tail gas. This is controlled by manipulating the inlet air flow rate to the unit. Proper catalyst performance is required in order to meet the SO_2 target levels. If the catalysts lose activity, there is a danger of SO_2 breakthrough. This can cause corrosion in the circulating quench water circuit, and the SO_2 poisons the amine in the amine plant. Increasing environmental demands require correct performance of these units, which are critical to the operation of the entire plant. Correct valve selection for control and isolation is therefore a critical factor in overall performance.

Furnace applications

Acid gas is fed via the acid gas control valve to the reaction furnace. Typically, around 60 percent or more of the sulphur is recovered in the first stage.

The tail gas control valve admits the remaining tail gas from the sulphur recovery process into the tail gas treatment section.

Combustion air is fed to both the reaction and reduction furnaces. An optimal amount of air ensures that complete combustion occurs without excess oxygen passing through to the reactors.

The reduction furnace uses separate fuel gas, usually natural gas, to permit combustion. This amount is controlled by the fuel control valve.

Reducing gas can either be supplied into the process or optionally generated in the furnace by operating the furnace sub-stoichiometrically or by supplying steam to the furnace. When producing the reducing gas in the furnace, it is often referred to as a gas generator.

Accurate control is required of all these valves to ensure a good yield and to prevent unwanted side-reactions. For acid gas service, fugitive emissions control and fire-safety are important and in many cases NACE is applied. Possible sulphur build-up is also of concern in valves handling the process medium.

Neles™ solution for furnace valves

We offer three different valve types that are suitable for these applications. The exact choice depends on process parameters and customer preferences.

Neles globe valves provide the optimal solution for accurate control and noise and/or cavitation concerns.

- **Best possible control accuracy,** ensuring that the sulphur recovery efficiency can be maximised
- **Fugitive emission certified** according to ISO 15848
- **Tendril trim design option,** excelling at low noise and anti-cavitation applications

Neles segment valves are the valves of choice for extreme rangeability requirements enabling single valve solutions.

- **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

Neles triple-eccentric Neldisc™ valves provide a reliable and economical solution especially for larger pipe sizes.

- **Triple eccentric design,** reducing wear and ensuring tight shut-off
- **Optimum flow characteristics,** providing accurate control even at low opening angles
- **Low emissions** as a result of utilising rotary design and a reliable stem packing

Neles globe valve

Furnace ESD valves

Prior to the furnaces, there are several ESD valves installed in the acid gas and fuel gas lines. These valves are required to shut off feeds to the burners immediately in case of a process or equipment failure.

High reliability is required from these valves, since the feeds to the burners must be shut off immediately. Tight shut-off, corrosion resistant construction, protection against sulphur build-up, high temperature compatibility and fire safe design are typical valve requirements. Fugitive emission control is important for acid gas service and in many cases NACE is applied.

Neles solution for furnace ESD valves

Neldisc butterfly valve with steam jackets on the valve body available as a standard option and the intelligent safety solenoid ValvGuard™ ensures reliable ESD valve operations.

- **Reduce emissions** with a reliable stem packing and rotary design which is inherently less prone to leaks
- **Rugged metal seated construction,** ensuring a long lasting tight shut-off
- **Mechanically induced disc to seat contact,** meaning that the seal does not rely on assistance from differential pressure
- **Meet reliability targets,** as the partial stroke testing capability of the ValvGuard ensures that the valve is operational
- **Detect problems in advance,** with the diagnostics that ValvGuard provides on the valve performance
- **Reduced engineering work,** as ValvGuard makes wiring easier saving commissioning costs

Neles butterfly valve with ValvGuard

Bypass and sulphur let-down valves

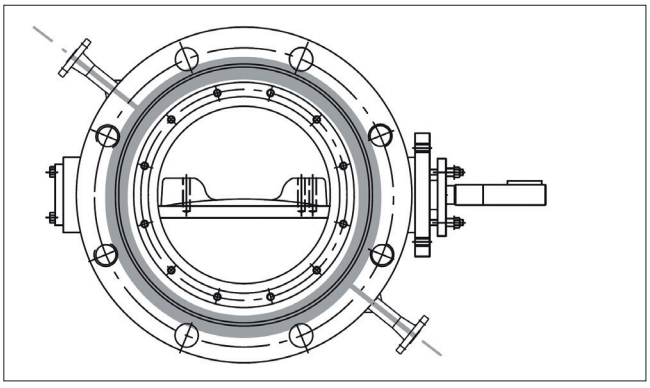
The Claus reaction continues in the catalytic step and serves to boost the sulphur yield. To protect each of the reactors against excess temperature or other plant upset, an optional bed bypass valve may be installed. After the reactor, the elemental sulphur is run down from the condensers into a concrete sulphur pit. Each sulphur condenser drain line, including valves, is typically fully steam jacketed. There are a number of block valves that isolate the condenser from the storage pit.

Tight shut-off, corrosion resistant construction, protection against sulphur build-up and high temperature compatibility (for bypass valves) and fire safe design are usual valve requirements.

Neles solution for bypass and let-down

Neldisc butterfly valves with steam jackets on the valve body as a standard option provide a light, simple and economical valve solution.

- **Long lasting bi-directional tightness,** as the valve utilises metal seats
- **Fire-safe construction,** ensuring the availability of the valve
- **Sulphur build-up prevention** due to rotary stem and protected bearing
- **High temperature compatibility** as standard, performing well up to 600 °C (1110 °F)
- **Advanced diagnostics as an option,** with the intelligent valve positioner SwitchGuard



Steam jacketed Neles butterfly valve

Benefits

- Improved control accuracy increasing sulphur recovery efficiency
- Meet process uptime targets with robust valve designs
- Minimise fugitive emissions to meet strict environmental regulations
- Predictive maintenance with diagnostics provided by smart valve controllers

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