

## Direct Coal Liquefaction

The process of direct coal liquefaction was developed in the 1920's in Germany. Until the mid 1950's the process was operated at several sites in Germany to derive liquid hydrocarbons from coal as a substitute to standard crude oils. In the 80's and 90's the Kohleoel-Anlage in Bottrop plant was operated for almost 20 years, of which the last years were in heavy oil upgrading mode.

In the first step of the direct coal liquefaction process the coal is ground and mixed with oil to yield a pumpable paste. This paste is pumped to high pressure (200 - 300 bars) and is heated to the desired process temperature of about 450 – 460 °C. Together with hydrogen, the coal paste is feed to the slurry reactor section, where the coal molecules are cracked and hydrogen saturates the Carbon bonds of the molecules ("Hydrogenation"). The so derived main product fractions from the reactors are light hydrocarbons and unconverted slurry. Both fractions are separated in the High Pressure Hot Separator. Whilst the light hydrocarbons will be further processed to high value market products, the unconverted slurry – containing high amounts of solids – is distilled under vacuum to increase the total oil yield and minimise the hydrogenation residue fraction.

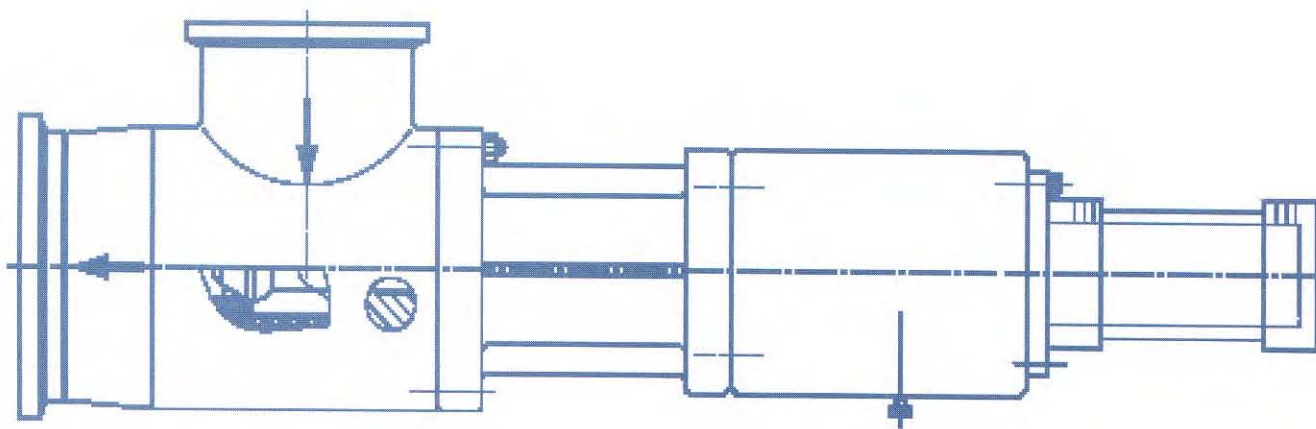
The depressurisation from the High Pressure Hot Separator to Vacuum is done in several steps, from which the first let down step from high to middle pressure is the most severe step.

### HHPS let down

The first separator is the Hot High Pressure Separator (HHPS), which is situated directly behind the reactor. Pressure here is still around 200bar, temperature still over 400°C. The slurry must be let down to the HMPS (hot mid pressure separator), through a let down valve. SchuF has already introduced multi-stage let down valves for use in Hydrocrackers, but these valves are not suitable for this service because of the 3 phase nature of the media.

The high solids content prevents the use of anything other than a simple single stage let down valve. The single seat will unfortunately cause huge cavitational effects and the high degree of flashing coupled with the solid content will completely destroy the trim and possibly the valve in very short time.

This can be minimised by the use of suitable hard metal trims, optimised trim design and a special SchuF control modus. Due to the high pressure drop these valves are usually hydraulically actuated.



Type **74CS** control valve, 2" to 20" XXS or ANSI 2500#, pneumatic and hydraulic

SchuF has developed a valve specially for this service featuring:

Extensive use of best suited Hard-metal materials, such as special grain Tungsten Carbides

Optimised trim design

Proprietary control sequence

Easy to replace trim, allowing the valve to remain in service



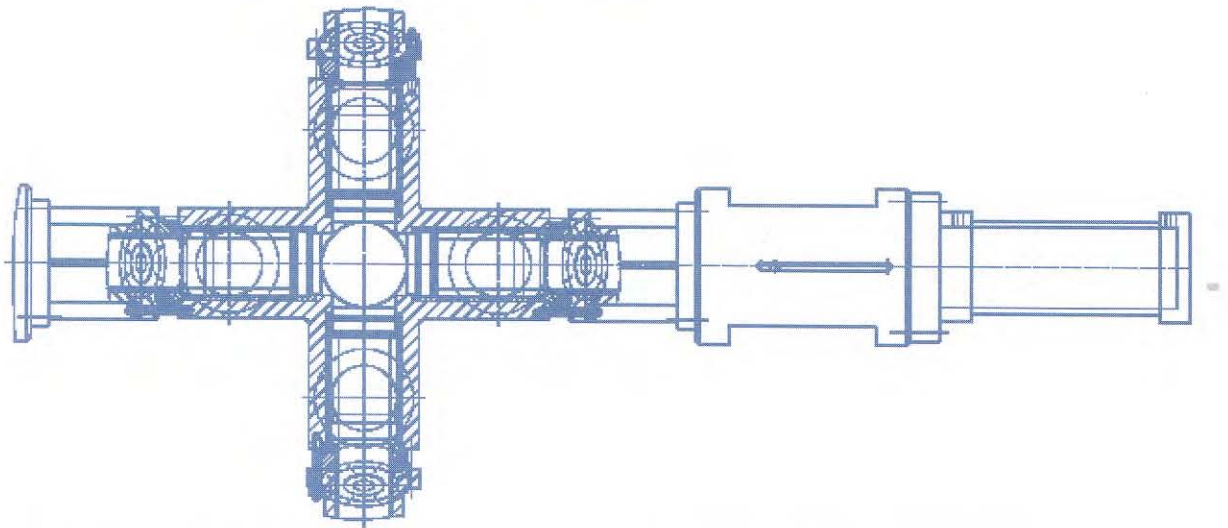


## HHPS Block and bleed

Even with the best design and material, this let down service is so severe that the trims have to be changed frequently. In order to ensure that this can be accomplished without plant interruption at least two let down valves are used in parallel.

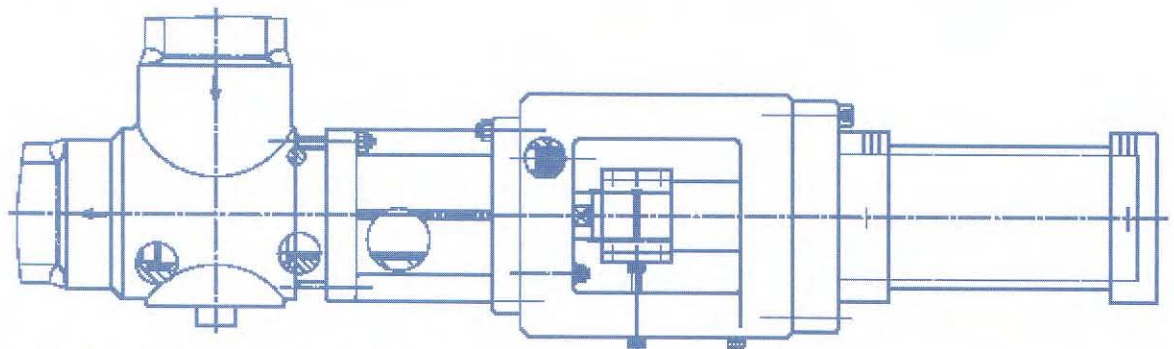
This will allow one to be overhauled while the other remains in operation. This can only be achieved by isolating the control valve to be exchanged. Safety concerns mean that two zero leakage isolation valves will be required upstream of the valve, while one will normally suffice downstream. Experience from old plants show that ball or plug valves are not suitable for the upstream double block and bleed.

Instead SchuF offers a unique combination of isolation valves for this service. Thus the first isolation valve is a multi-port valve. Advantage to this valve is that this valve closes the line to the unused control valve from the branch-off with absolutely no dead space. Using any other type of valve will require a T-piece with a short branch leading up to the first isolation valve. The media (coal slurry) means that this short branch will clog completely, leading to severe problems when the unused control valve has been repaired and is to be taken into service.



Type **42VK** diverter, here with 1 inlet and 4 independently, hydraulically operated outlets.

The second isolation valve is a SchuF angle valve. These valves are helped to seal by the line pressure, given an extra margin of safety. The packing is protected by special internal sealing arrangements.

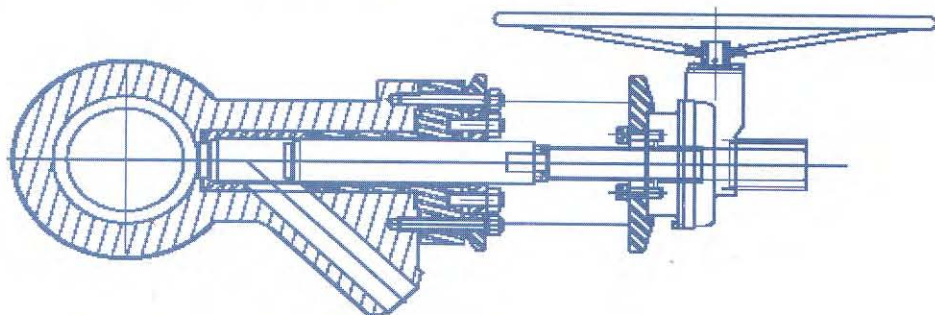


Type **71KS** angle isolation valve, zero leakage, 2"-20" XXS or ANSI 2500



## HHPS Flush

While the choice of valves is critical, the correct operations procedure is equally critical. Thus changing out a control valve while the plant is in continued operation is a very complex procedure which includes prolonged hot oil flushing.



Type 30PH flushing valve

SchuF not only offers to supply the required flushing valves but also the complete installation, start-up, operating and maintenance procedures required to operate these plant critical lines

## Other coal liquefaction valve requirements:

SchuF offers control, isolation, diverter, drain and flushing valves for all parts of the coal liquefaction plant. Apart from the HHPS let down, these include:

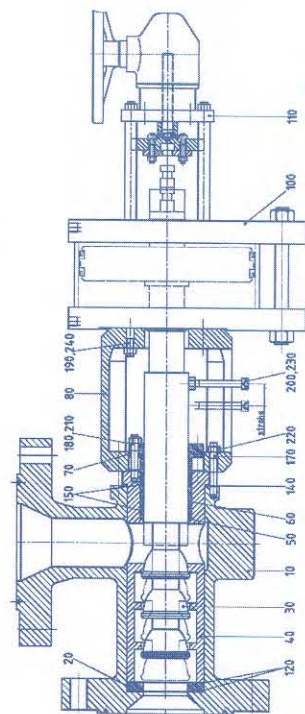
- ✓ Booster pump start up and minimum recirculation control
- ✓ Heat exchanger flow control
- ✓ Reactor let down ('caviar' removal)
- ✓ HMPS let down
- ✓ Pump discharge into the vacuum distillation
- ✓ Vacuum residue handling
- ✓ Emergency shut down systems

Please contact SchuF for solutions for your problems in the gasification and liquefaction of coal.

## Similar Applications

SchuF would also be glad to help in other similar processes where similar severe services can be found:

- Heavy Oil Upgrading
- Tar sands oil recovery
- Hydro- and Residue Crackers



Typical cracker control valve





## COAL GASIFICATION CONTROL

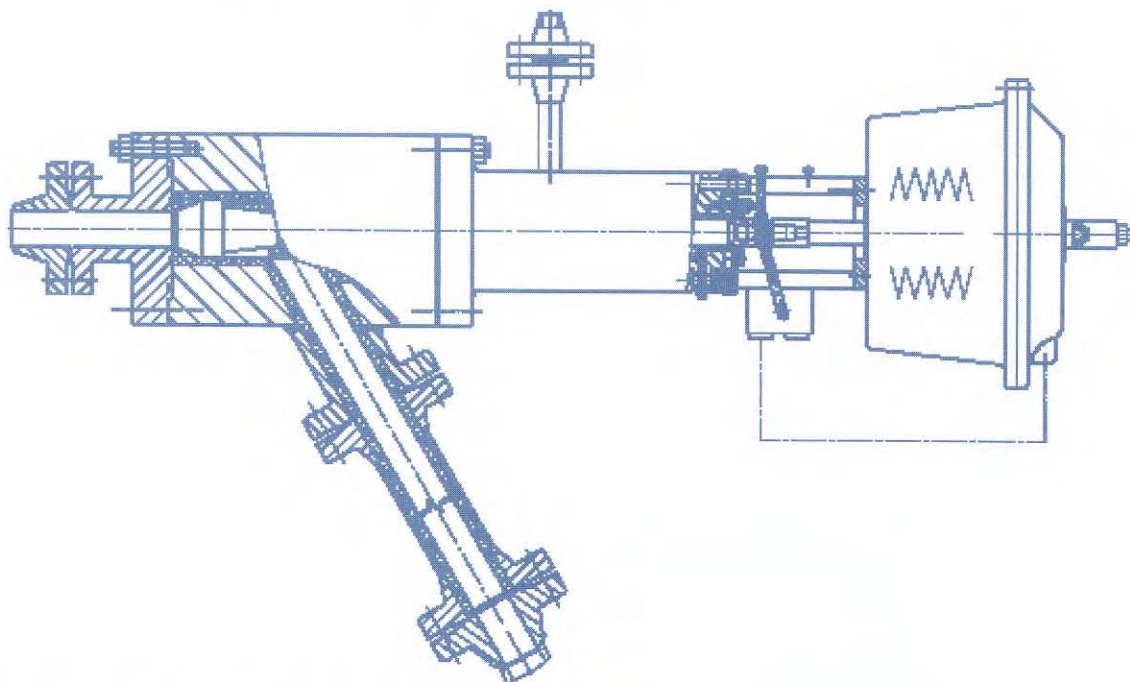
This technology uses coal, refinery tars, high sulfur fuel oils and mixes them with Oxygen and steam in the reducing environment of a gasifier to obtain syngas (mostly CO & H<sub>2</sub>) which can then be used either as further feedstock for the chemical industry or for gas fired power stations. Coal is in plentiful supply and often in stable political environments or close to the locations that have the greatest need for energy. It is considered clean because it is burned under controlled conditions with the emissions associated with coal fired power stations.

The Gasification process also requires let down valves etc similar to the liquefaction process. SchuF can supply the same valves to the Gasification process as listed on previous pages or multi-stage angle valve (see Hydrocracker control brochure). Additionally, SchuF supplies valves to control the flow of coal feed either as a slurry or as dry feed.

In the Shell process, the coal is finely ground and is transported by the use of carrier gas into a gasifier. The control of the flow of the coal suspended in carrier gas is a critical and complex task for a control valve. Complex because the valve must be sized in a way to prevent settling of the coal in the valve, which means maintaining certain minimum speeds of coal flow. However at these speeds, the coal is very abrasive, which means that the choice of material will have to include solid Tungsten Carbide parts.

The high solids contents mean that a multi-stage control valve is not suitable, while the abrasion means that a traditional single seat will erode too quickly, leading to a special control disc and seat design. Finally the clean air requirements mandates the use of a bellows in to the yoke. This bellows must be protected from the very coal that it is meant to seal.

For the Shell process, SchuF has further developed a coal feed control valve to include many unique features to enhance its performance, while reducing the cost.



Type **74CS** DN 25 – 100, PN 100 (1" to 4", ANSI 600) pneumatically operated