

Diverter Valves

3, 4, 5, and Multi-Way



SchuF  **FETTEROLF**

Diverter Valves – General Overview

The Diverter valve was invented by SchuF in 1965. The first diverter valves were the simple combination of two or more piston or disc valves. Over the past 45 years, SchuF Fetterolf developed this original idea into a valve category in its own right. The name comes about as a result of the fact that the construction enables a process flow to be diverted (or routed) into two or more directions. Diverter valves are sometimes called switch valves, multi-way, or combination valves.

Diverter Valve Applications

Diverter valves have the primary purpose of splitting or combining process media into one or more streams. They can be widely found in the chemical, polymer, and refining industries and are used in a broad variety of applications:

- To split one large process line into many smaller lines
- To replace several isolation valves and T-pieces in order to eliminate back flushing of dead spaces
- To keep one line in service whilst maintaining another
- Switching between filters, without downtime or pressure and flow variations
- To switch between control valves or pumps
- For high viscosity media, where dead or slow spaces lead to poor product quality
- To combine a process isolation and a start up dump valve in one valve body
- Where space does not permit larger valves or extensive piping
- To integrate multiple valve process functions into one valve

Operating Principles

In its simplest form a diverter valve has one inlet and two outlets or vice versa. When the medium flows through the inlet it can either be routed to **1)** outlet A only, **2)** outlet B only, or **3)** to both outlet A and B simultaneously. This is achieved by two pistons (or discs) that move into the valve body and cover all or part of the outlets from either side. This action results in a completely dead space free valve.



4 Way R type Diverter Valve

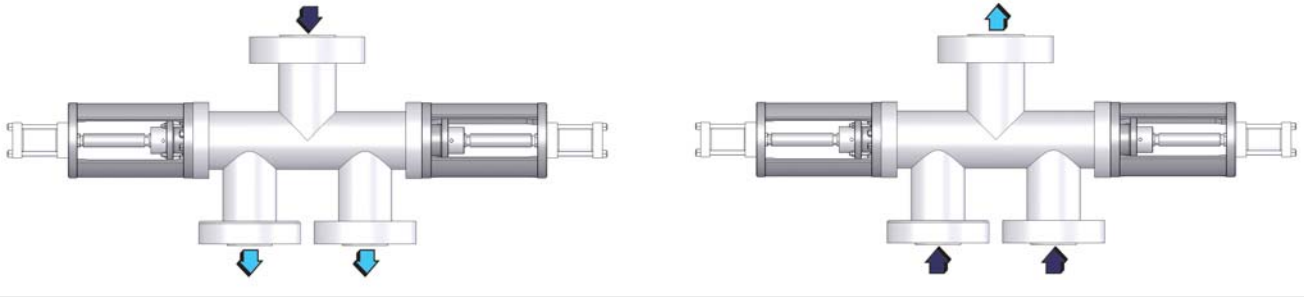
Alternatively, the valve can have multiple inlets and outlets. This allows for different substances to be brought together as required and routed to one or multiple lines or vessels.

Key Features & Options

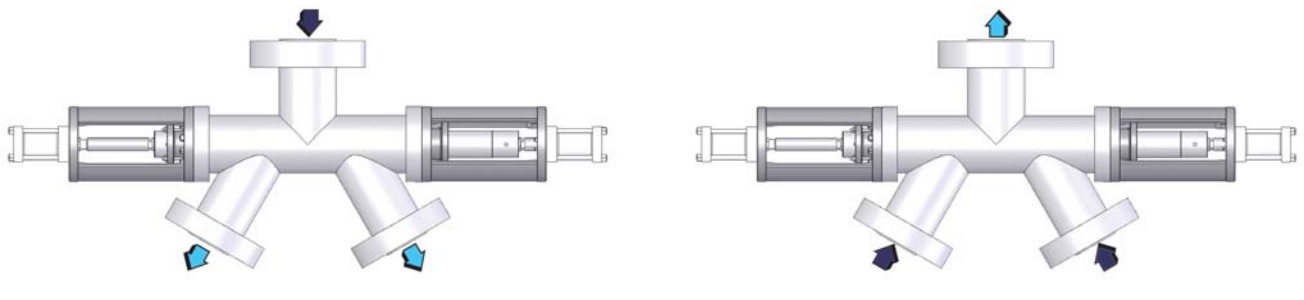
- Modular design
- 2, 3, 4, or multiple inlets/outlets
- Dead space free, unimpeded flow
- Slow space avoidance
- Metal to metal bubble tight seal
- Stuffing box seal to atmosphere
- Rotating and contoured pistons/discs
- Control functionality option
- Repairable in place
- Customised design

Diverter Valve Configuration Options

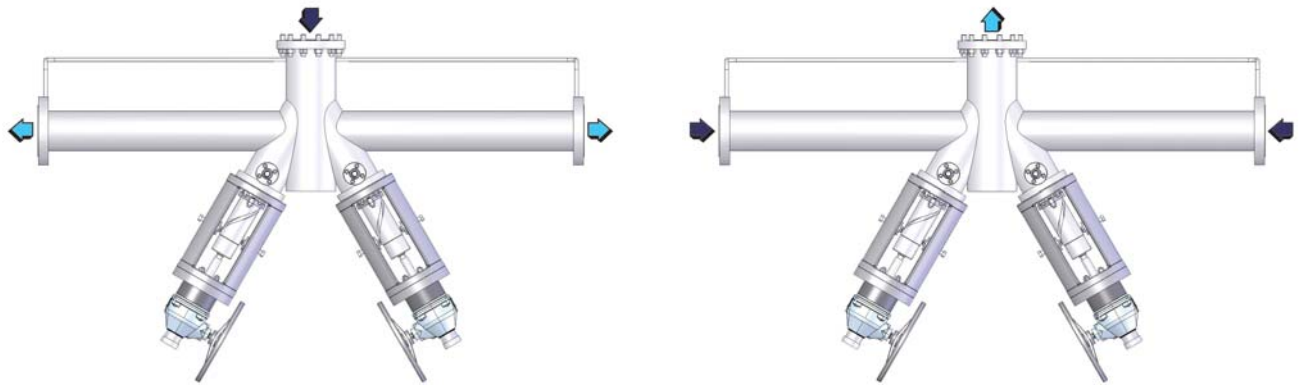
1. T Type Diverter Valves with 90° inlet/outlet angle



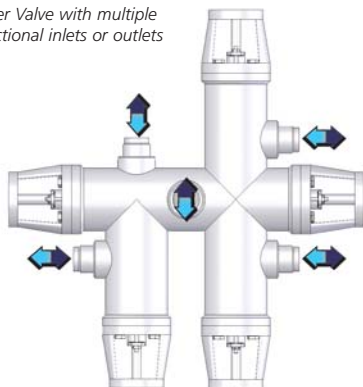
2. T Type Diverter valves with 45° or 60° inlet/outlet angle



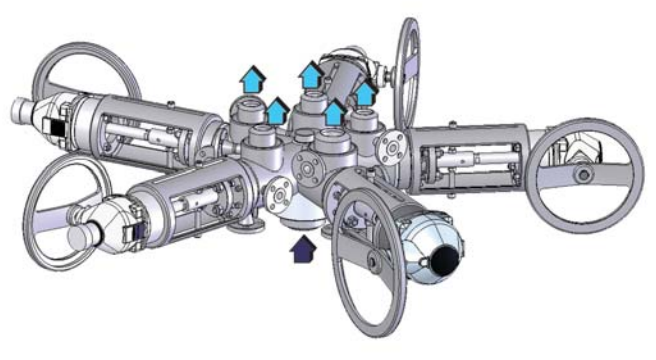
3. R Type Diverter Valves with outlet at right angle to inlet



4. Diverter Valve with multiple bi-directional inlets or outlets



5. Multi-way Star Design Diverter Valve



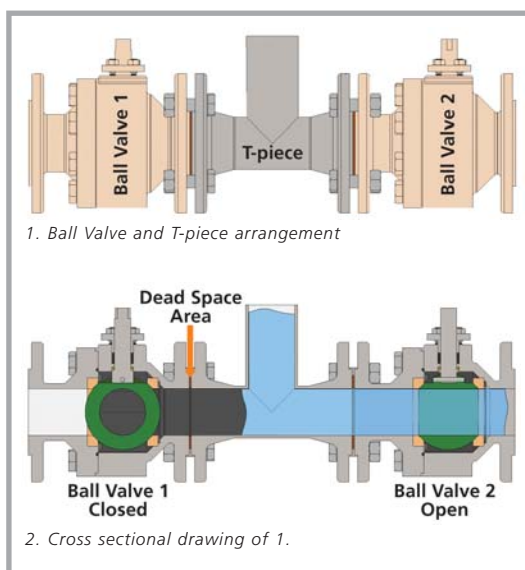
Dead and Slow Space – The Process Killers

Process Dead Space Problems

Dead space can lead to many unwelcome consequences. In plastic and polymer production, the medium can be contaminated by trapped particles, rendering it worthless. In the refinery, dead space can lead to accumulation of coke like particles, catalyst fines or clumps which necessitates back flushing and thereby reduces line capacity.

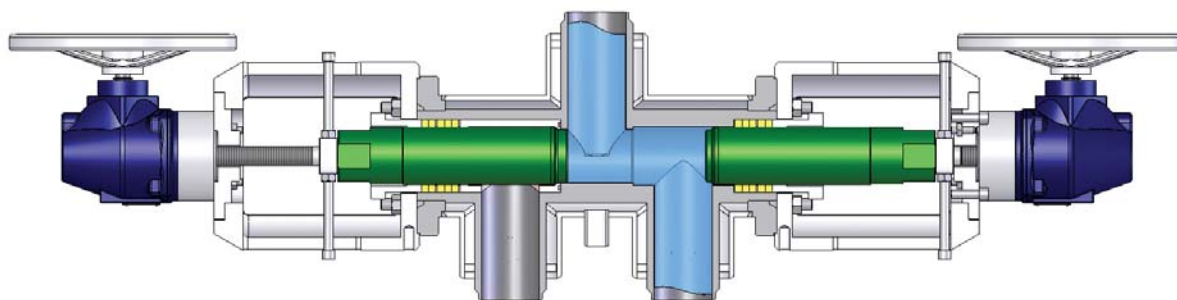
Traditional Isolation Approach

Traditionally, isolation valves interconnected with T-piece piping are used to isolate the process flow in one direction. This is achieved by using two ball valves and a T-piece as shown above.



When one of the ball valves is closed and the medium contains solid particles or highly viscous liquid, a 'Dead Space' is created by the medium in and around the ball, between the ball and the valve body, and in the left section of the T-piece. The dead space area is shown in black in the second drawing. When this ball valve is opened, part of the residue that filled the dead spaces will either stick to the piping reducing the full through bore and over time require the valve to be removed for maintenance. Alternatively the residue will form clumps that over time break away to damage other equipment downstream or contaminate other media in the batches that follow.

The Modern Alternative



3 Way T type Diverter Valve – Dead Space Free, unimpeded flow

The clean and modern alternative is a SchuF Fetterolf Diverter valve as illustrated above. The piston seals flush to the inlet body in the closed position and flush with the outlet take off point in the open position.

The media can flow freely through the valve and there are no cavities, spaces or areas where sediment can stick or accumulate. For all intents and purposes, the SchuF Diverter valve becomes a full bore extension of the pipeline.

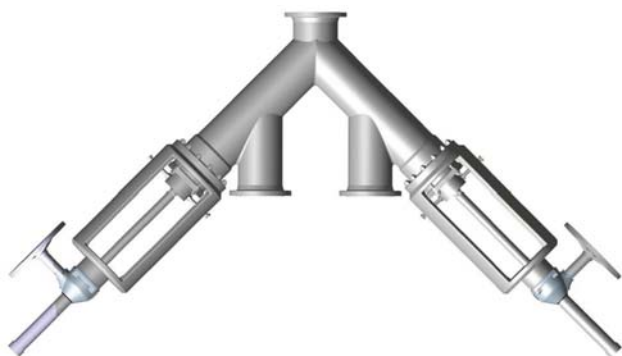
Dead space is eliminated!

Flexible and Efficient Design

The valve consists of several key parts – an enclosed cast, forged or welded body, two or more pistons or discs (depending on the number of inlets and outlets required), a stuffing box, packing rings, gearing, a hand wheel and electric, hydraulic, or pneumatic actuation.

Design Options

A standard **Y type** diverter valve with one inlet and two outlets is illustrated in the picture below:



3 Way Y type Diverter Valve

The process flow enters the top connection and the outlet flow is to either or both of the outlet lines existing in parallel below the valve body.

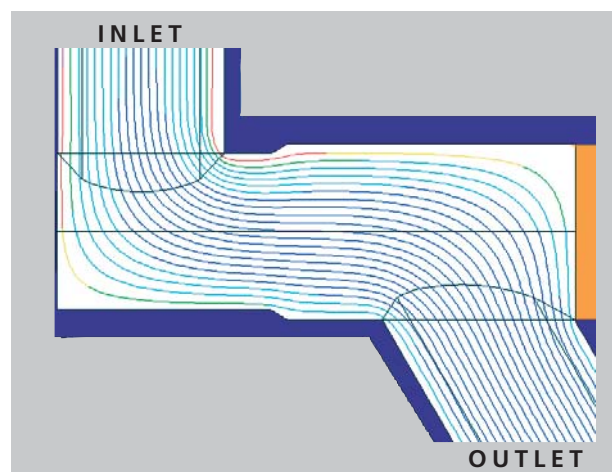
The **R type** diverter valve (illustrated on page 6) is similar to the Y type except that the outlets are at right angles to the inlet flow. This design frequently utilises rotating, contoured pistons/rams on one or both sides to assure smooth, unobstructed flow. This is a particularly useful feature for highly viscose media such as polymer or heavy gas oil with high solids content.

SchuF Fetterolf also provides a **T type** and an **S Type** (short for Star configuration with multiple inlets and outlets) diverter valves. In all designs the angular relationship of the outlet ports may be changed to meet the requirements of the installation. Special designs are also available for large size valves or high flow rates.

Full heat jacketing is available in all designs and may be zoned so that only the flowing side is heated.

Valve and Process Efficiency

SchuF's attention to quality and ensuring optimal valve efficiency is reflected in our use of finite element simulation analysis. These simulations enable us to advise the best valve design for a specific process. The example below shows the results of a valve simulation for a polymer like medium.



Diverter Valve FE simulation

Each flow line is colour coded to show how far the polymer will have travelled in a given time. Deep blue shows how far the polymer would travel in the first 2 seconds, light blue in six seconds, green in 9 seconds, yellow in 13 seconds and so on. The simulation shows that there are variances in residence time between the flow in the centre and the flow through the corners. The pressure drop is less than 1 bar.

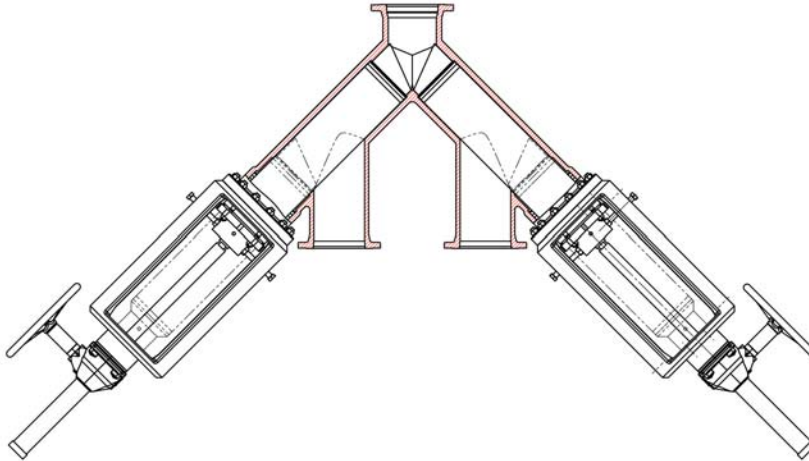
For many applications this level of performance is superior to existing valve solutions. However, certain media (such as polyester) necessitate the elimination of even the slightest slow spaces. Without this consistent high quality end product cannot be assured.

SchuF has been able to successfully produce valves for these slow and dead space applications. In fact it has also led to other SchuF "process customised" designs and in turn to improved customer end product and more efficient processes.

Standard and Customised Diverter Valve Designs

Standard Y type, T type and R type Diverter Valve

3 Way Y type Diverter Valve – with Piston – Model 40YK

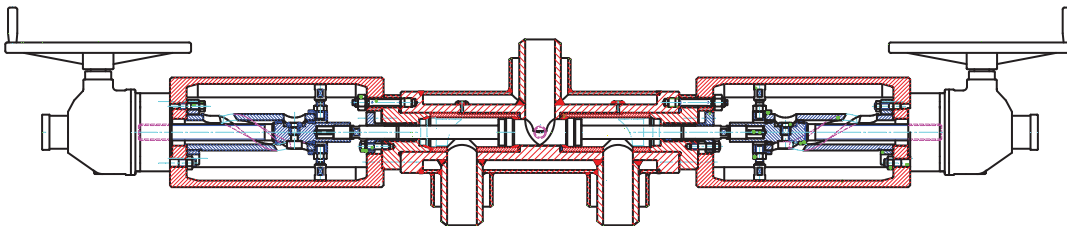


The drawings shown on this page illustrate 3 basic Diverter Valve designs:

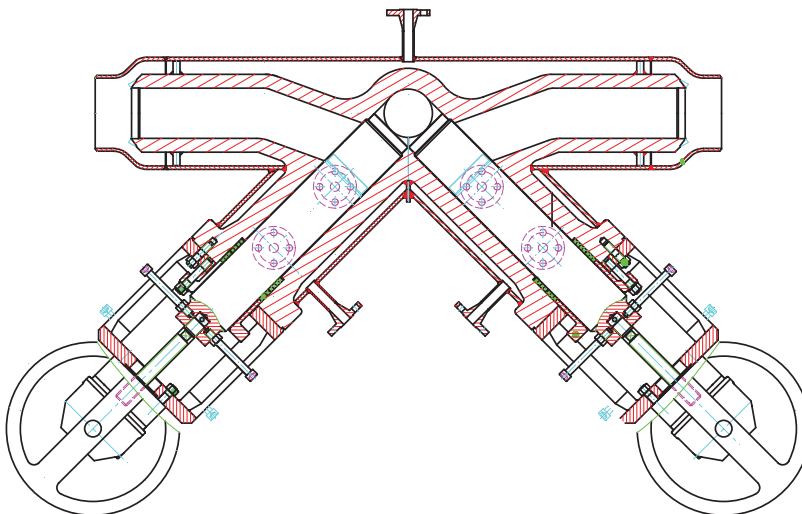
- Y Type
- T Type
- R Type

The drawings opposite show several customised designs.

3 Way T type Diverter Valve – with Disc – Model 43TT



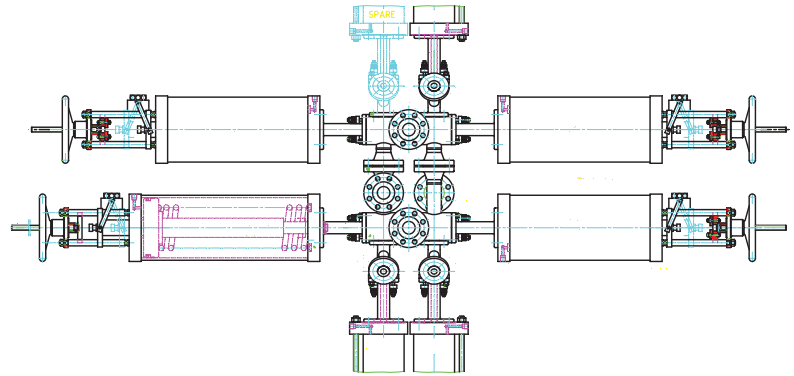
3 Way R type Diverter Valve – Piston with jacketing – Model 45RK



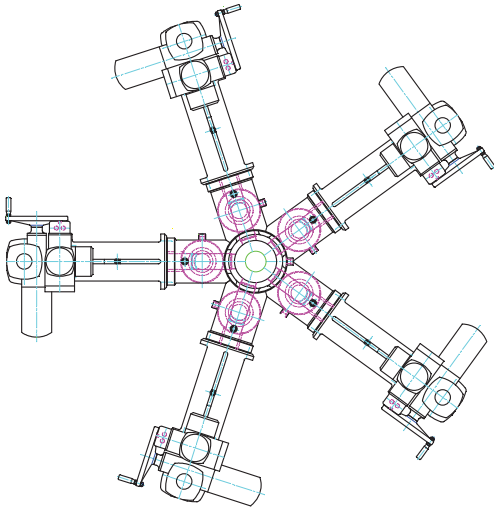
Multiway and Customised Diverter Valve

Choice of valve configuration or type depends on a number of factors including: flow characteristics of the medium, available space, piping layout and process or application requirements.

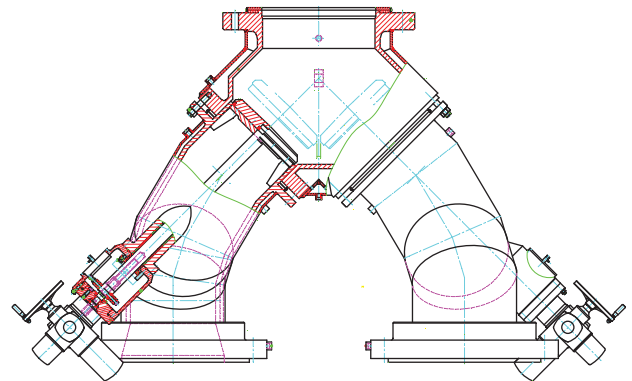
5 Way Double T Diverter Valve – with integral flushing – Model 49VS



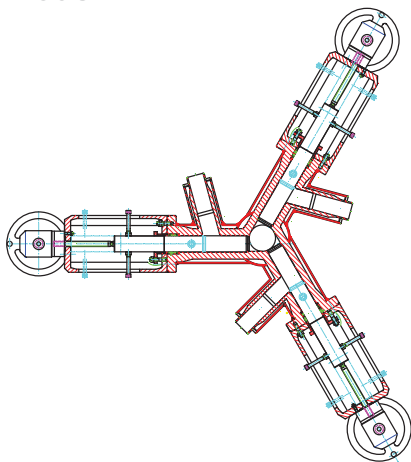
6 Way Diverter Valve – Model 42FK



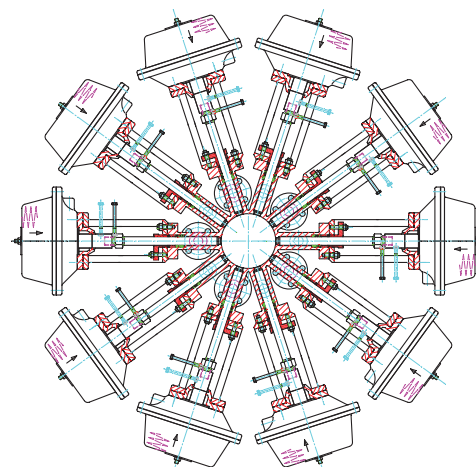
High Vacuum Diverter Valve – Model 44YB



4 Way Tangential Star Diverter – Model 47DK



10 Way Diverter Valve- Model 42ZK



Product Range and Technical Data

Diverter Valve Product Portfolio

Product Range	Description
Standard Diverter Valves	From 1 inch (DN 25) to 18 inch (DN 450) and up to ASME 2500# (PN 320) pressure class
High Pressure Diverter Valves	High Pressure Diverter valves from 1 inch (DN 25) to 14 inches (DN 350) and up to ASME 4500# pressure class
Maritime & Offshore Valves	Maritime & Offshore Diverter valves with special body and trim material
Customised	Custom designed diverter valves

Diverter Valve – Technical Data

Item	Standard	Optional
Size	1" to 18" as standard	Larger as per requirement
Body	Stainless steel 1.4408 (CF-8M) or 1.4401 / 1.4404	Carbon Steel, 304, 316L, Duplex, Hastelloy, Monel, Titanium, Nickel, Inconel, Incoloy, etc.
Valve Lining	n/a	PTFE, glass, ceramic or rubber
Inlet	Perpendicular to body	Inlet larger than outlet; same size inlet/outlet; off-set to body; bi-directional inlet/outlet etc.
Outlet	45°, 60° or 90°	Angle per customer requirement
Piston	Stainless steel 1.4401 / 1.4404 or 1.4541 (321)	17-4PH, hard faced, PTFE and all materials under "Body - Optional"
Disc	Stainless steel 1.4401 / 1.4404	As piston above
Spindle	Stainless steel 1.4122 (420)	Others are possible on request
Seat	Integrated seat (hard faced)	Replaceable seat, sleeve or ring
Sealing to atmosphere	Stuffing box	Fully enclosed yoke
Temperature	minus 100° to 500° C	Higher or lower on request
Process sealing	Metal to metal	Radial seal; vacuum yoke
Pressure range	All up to ASME 2500 (PN 320)	Higher on request
Connection types	Butt weld end or flanged	Clamp type
Actuators	Manual, hydraulic or electric	Pneumatic
Heating jacket	n/a	Full or semi jacketing
Surface coating	n/a	Anodising, Canadizing, Titanium Nitriding, Ceramic and Tungsten
Control Characteristics	On/off (straight or contoured piston)	Linear, equal %, or SchuF gap control (patented control contour)
Add ons	Flushing ports	Integral drain valve, sampling valves, mechanical lock

The m-Factory Diverter Valve

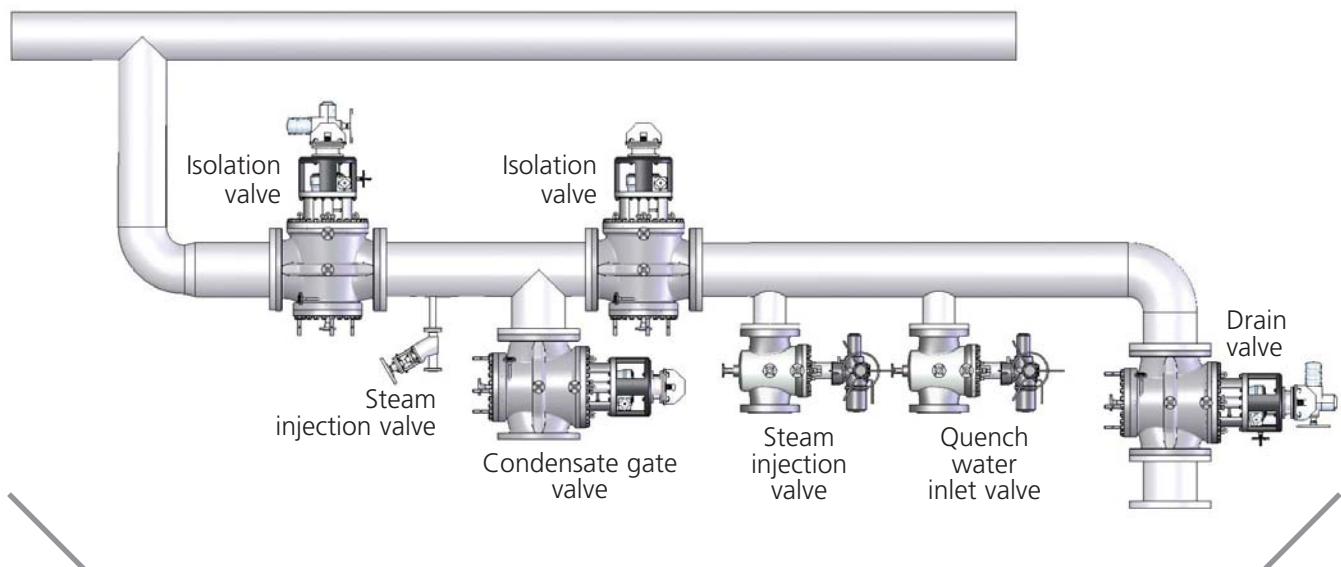
Challenges for new plant or plant redesign

The Diverter valve is an ideal tool to reconstruct, replace or redesign a process or plant layout. It is also an essential ingredient in new plant design – where capital cost and space are primary concerns.

The picture below shows the piping, valve and space requirements for part of a refinery

process. This part of the refinery includes equipment for isolation, steam injection, quenching, condensate, and draining.

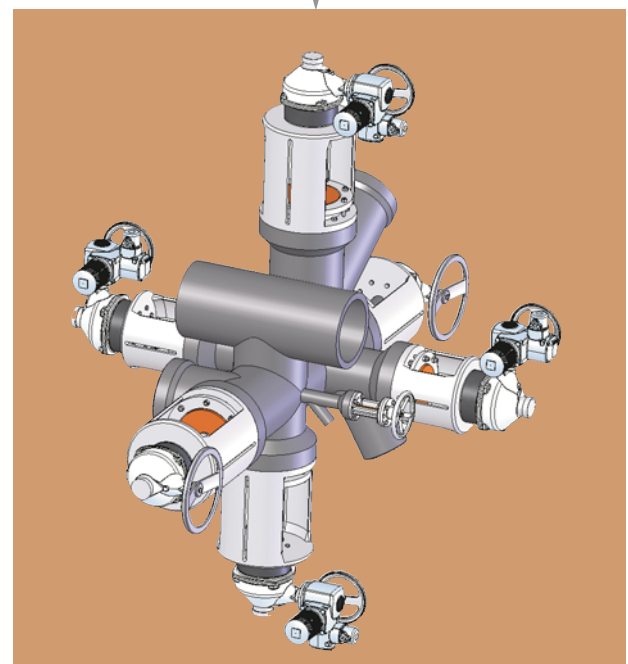
In addition to the equipment, a significant length of piping is required. This in turn has to be kept clean and regularly maintained. All in all the initial capital outlay and ongoing operating costs are high.



mini-Factory Diverter Valve Solution

In response to these problems, SchuF has developed special new diverter valve assemblies. They incorporate many valve functions in one, including all of the piping and valves shown above. The critical switching valve can also be included. In addition, the required floor space, the initial capital outlay and the on-going maintenance is significantly reduced. Moreover dead space and consequentially back flushing is eliminated. An added extra benefit is that sealing performance and thereby plant safety is improved.

The mini-Factory diverter valve is the SchuF Fetterolf answer to the ever increasing need to reduce operating costs without sacrificing technical performance. It shows the Diverter valve to be one of the most versatile, reliable and innovative valve designs available to industry today.



Case Study - The Worlds Most Advanced Diverter Valve

In December 2008, a major coal producer launched the first full scale commercial trial for a coal to liquid refinery based on the Bergius process. The plant was designed to produce 900,000 tons of gasoline, diesel and kerosene per annum. The Bergius process uses ground coal as feed, which is then processed under temperatures up to 500°C and high pressure (to 240 bar). These operating conditions create a series of problems for equipment and in



particular for valves. The control valves have to handle pressure drops of up to 200 bar with a high solids content and high temperature.

Original Design

The original design foresaw four pressure let down valves installed in parallel, and the associated extensive piping, T-pieces, and double block isolation valves, running from the HHPS (Hot High Pressure Separator) to the HMPS (Hot Medium Pressure Separator). The dead space created from the inlet take off point of the T-piece to the ball valve necessitated constant and significant back flushing. This reduced capacity in the open line. A second alternative had all four control valves operating partially open, which resulted in unacceptably high erosion rates.

New SchuF Diverter Approach

SchuF Fetterolf proposed a completely new design based on a star type Diverter valve. In this solution the effluent exiting the HHPS

enters a star shaped diverter valve from above and is directed to one of the four outlets, whilst the other three remain closed. Once the initial process run is complete, the first outlet is closed and another is opened.



There are many advantages to this approach:

SchuF Fetterolf Design Benefits

- Back flushing was eliminated and full line capacity usage was achieved.
- Switching time from one line to the next is minimised.
- Significant piping and space has been saved.
- The associated control valves (also delivered by SchuF) showed no signs of erosion, and could be closed as and when required.
- Significant capital investment and on-going maintenance cost savings have been made.

SchuF Fetterolf Valve Portfolio

SchuF Fetterolf has delivered over one million valves during its almost 100 year history to a wide variety of industries in over 50 countries worldwide.

Headquartered near Frankfurt in Germany, the company has additional design and manufacturing centres in Brazil, India, Ireland and the United States.

The SchuF group has sales and agent offices covering almost every country in the world.

We manufacture valve products that control, isolate, divert, and sample liquids, gases, powders, and slurries. Our product range of engineered, customised valves includes:

Bottom Outlet Valves	Control Valves	Coker Valves	Diverter & Changeover Valves	In-Line Valves	Sampling Valves	Other Products
Pistom / Ram Bottom Outlet	Angle Control Valve	Coker IsoPlug	Multiport Diverter Valve	Y-Globe Valve	Line Sampling Valve	Line Blinds Cam-Set® & Stacey
Disc lowering Bottom Outlet	Globe Control Valve	Coker SwitchPlug	Lift Plug Diverter Valve	Lift Plug On-Off Isolation	Screw-In Sampling Valve	Spray Rinse Valve
Disc rising Bottom Outlet	Wafer Control Valve	Coker ControlPlug	Changeover Valve	Lift Plug Switching	Submersed Sampling Valve	High Pressure Angle Valve
	Backpressure Control Valve	Coker Quench Valve	Changeover Combination Valve	Lift Plug Bypass	Wafer Sampling Valve	Tank Storage Valve
	Automatic Recirculation Valve			Special Gate Valve	Sampling Systems	Steam Injection Valve
						In-lying Disc Valve

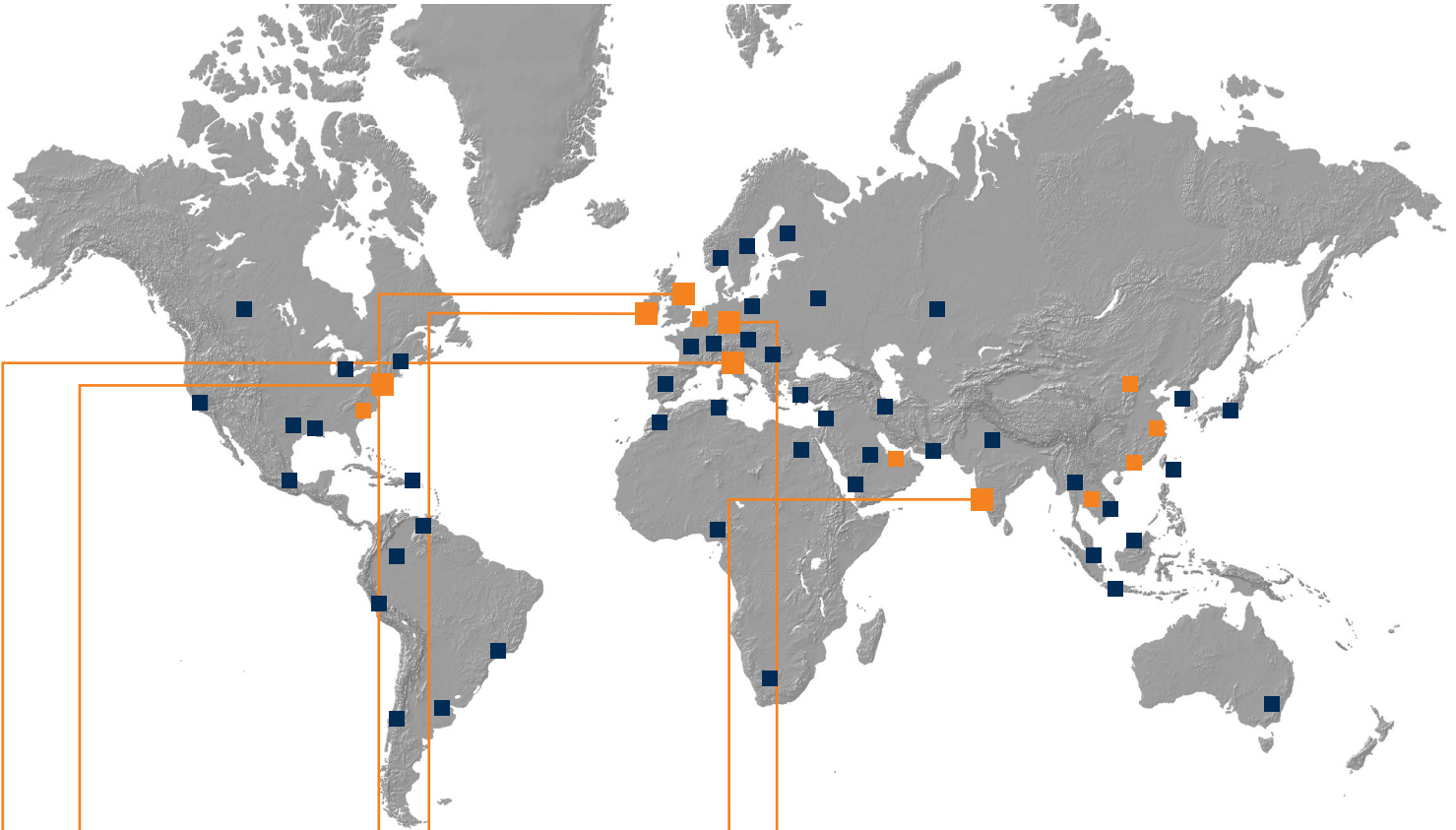
Sample Diverter Valve Client List:

- | | | |
|---------------------------|--------------------------|-------------|
| ■ Alok Industries | ■ E.on / VEBA | ■ Sabic |
| ■ Aker Solutions | ■ Far Eastern OPC | ■ Samnam |
| ■ BASF | ■ Formosa Petrochemicals | ■ Samsung |
| ■ BP | ■ Fuji Filter | ■ Shell Oil |
| ■ China Petrol & Chemical | ■ Indorama | ■ Shenhua |
| ■ Dow Chemical | ■ Invista | ■ Sasol |
| ■ Du Pont | ■ Lonza | ■ Tuntex |
| ■ Eastman | ■ Reliance Industries | ■ Yizheng |



6 Way Star Diverter Valve

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