Automatic Recirculation Valves

SchuF
Automatic Recirculation Valves

An automatic recirculation valve (ARV) is a multi-functional valve whose primary purpose is to ensure that a pre-determined minimum flow is assured through a centrifugal pump at all times. This is important as centrifugal pumps suffer from over heating and cavitation and can be permanently damaged if they run dry.

One Valve, Many Functions

An automatic recirculation valve encompasses all of the hardware required in a conventional bypass system in a single housing. The valve consists of several key parts:

- the check valve running vertically from the pump inlet below to the outlet above, which not only protects against reverse flow, but provides excellent pulsation dampening of the fluid.
- the bypass valve operates by sensing the main flow and automatically controlling the medium flow into the bypass line. This avoids the use of any electrical power, control wiring or the need for instrument air support.
- the pressure letdown unit located in the bypass section of the valve (on the right of the drawing) is designed to handle the required pressure drop from the process to the pump inlet. The automatic recirculation valve is therefore a check, bypass, minimum flow and pressure control valve in one body.

ARV Design

SchuF Fetterolf manufactures several standard automatic recirculation valves as well as customised designs for special process requirements and severe operating environments. The standard SchuF SureFlo™ design is illustrated opposite.

SureFlo™ Operating Principles

The automatic recirculation valve is installed in the pump discharge line in the position of the main check valve that it replaces. The valve opens as soon as the pump builds sufficient flow to move the internal valve disc in the main line into an open position. Decreasing flow through the valve causes the spring loaded disc to return to its seat closing the process outlet. Simultaneously, a bypass outlet is uncovered allowing a minimum flow of liquid to be routed back to the pump.

Features

- Modular design
- Automatic bypass operation
- Non return function
- Pressure modulation in bypass
- Self cleaning bore
- Linear or customised pressure control
Centrifugal Pump Protection Scenarios

Centrifugal pumps transform mechanical energy into pressure energy by means of centrifugal force resulting from impeller rotation acting on the fluid within the pump. The pump requires a minimum liquid flow in order to avoid overheating. If a predefined minimum flow is not maintained, the pump can be permanently damaged. A number of different pump protection scenarios are reviewed below.

1) Non return scenario
The pump has no back-flow prevention and therefore product will flow back through it once it has stopped. A non return valve (NRV) is therefore usually placed after the outlet of the pump. A reservoir is used to take the pumps output when there is no process demand.

2) Continuous flow scenario
A manual bypass or leakage path can be added to allow the required minimum flow back to the pump inlet. This system is simple and effective, but is in constant operation and therefore is inefficient and costly (energy costs).

3) Control valve scenario
This comprehensive control valve solution is highly effective. In this scenario, a flow control valve is connected to a flow meter and allows the main line flow to be metered. As main line flow decreases the control valve opens to allow the correct minimum flow required. However, it is a highly capital intensive solution that requires flow metering equipment, control and non return valves. No reservoir is required.

4) ARV solution
The previous approach stands and falls with the integrity of the control system and its associated cost. A safer system is to combine the non return valve, the bypass valve and the control valve into an interconnected unit, the so called “automatic recirculation valve”. This valve closes when there is no flow, automatically opening the bypass line, which is sized for minimum flow. When the main line takes flow but less than minimum, the bypass line and the main line are both partially open.
ARV Operating Conditions

1. Main Flow Only – Bypass Closed
When the process associated with the pump is in the normal operating condition, the main line is open. The pressure created from the media flow is sufficient to compress the spring in the check valve disc and lift it from its seat to the fully open position.

As the connected disc stem rises, the bypass exit in the stem funnel is moved against the valve body and the bypass system is closed. The recirculation flow is blocked, thus eliminating wasted energy. This is illustrated in figure 1. The bypass flow is therefore inversely proportional to the main pump flow. When the check valve is fully opened, the bypass is fully closed.

2. Combined Flow
As the flow requested by the process is reduced the pressure on the disc spring is lowered and the disc moves towards its seat. The check valve part of the automatic recirculation valve moves first to a partially open position (illustrated in figure 2). In this position there is partial flow to the outlet and a minimum flow to the bypass is maintained.

3. No Main Flow – Bypass Only
When no product is required by the process the valve disc returns to its seated position. There is insufficient flow to compress the spring and allow the disc to rise.

In this position, the curved part of the hollow stem is now flush with the entrance to the bypass funnel. A predefined minimum flow can now move from the pump through the bypass section and be recirculated to the front end of the pump. The centrifugal pump is protected from overheating or cavitation.
ARV Product Range

**SureFlo™**
- For 1 to 10 inch pump applications
- Fixed letdown in the bypass
- Up to ASME 2500# pressure class
- Variable bypass delay
- Fewer moving pieces
- Cast housing in CS or SS material

**HighFlo™**
- For 10 inch+ pump applications
- Fixed letdown in the bypass
- Better noise attenuation
- Up to ASME 4500# pressure class
- Variable bypass delay
- Forged or cast body

**ControlFlo™**
- Size independent
- High pressure design
- Multistage letdown
- Enhanced bypass sealing
- Letdown varies with stroke
- Enhanced noise attenuation
- Forged or cast body in CS or SS material
- Non return valve in bypass

**BackFlo™ Pressure Regulator**
- Used with ARV
- Assures a defined backpressure
- Eliminates flashing and cavitation
- 1 to 8 inch pipelines
- Up to ASME 2500#
- Stainless steel, flanged or butt weld
Product Range & Technical Data

Product Range

<table>
<thead>
<tr>
<th>Product Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SureFlo™</td>
<td>1 inch (DN 25) to 10 inch (DN 250) pumps and up to ASME 2500# pressure class</td>
</tr>
<tr>
<td>HighFlo™</td>
<td>10 inch (DN 250) to 16 inch (DN 400) and up to ASME 4500# pressure class</td>
</tr>
<tr>
<td>ControlFlo™</td>
<td>for enhanced bypass sealing and multistage letdown</td>
</tr>
<tr>
<td>BackFlo™</td>
<td>to create a defined pressure differential in order to eliminate flashing and cavitation in special applications. Used with an automatic recirculation valve</td>
</tr>
<tr>
<td>Maritime &amp; Offshore ARV</td>
<td>with special maritime body and trim material – size and pressure class as required</td>
</tr>
<tr>
<td>Custom designed ARV</td>
<td>for special pump applications or unique operating environments and severe media</td>
</tr>
</tbody>
</table>

Technical Data

<table>
<thead>
<tr>
<th>ARV</th>
<th>Standard Features</th>
<th>Optional Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>To protect pumps and ensure minimum flow conditions</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>1&quot; to 16&quot; as standard</td>
<td>To 30&quot; or larger as custom design</td>
</tr>
<tr>
<td>Body and bypass</td>
<td>Carbon or Stainless steel (316L)</td>
<td>Duplex, Hastelloy or Titanium</td>
</tr>
<tr>
<td>Valve Lining/Sleeves</td>
<td>n/a</td>
<td>Ceramic</td>
</tr>
<tr>
<td>Trim materials</td>
<td>Stainless steel (316L)</td>
<td>Duplex, Hastelloy, Ceramic, Inconel, Titanium or Tungsten Carbide for severe service applications</td>
</tr>
<tr>
<td>Spindle</td>
<td>Stainless steel 1.4404 (316L)</td>
<td>as above</td>
</tr>
<tr>
<td>Spring</td>
<td>Stainless steel</td>
<td>Inconel X750 (2.4669)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Minus 20°C to 300°C</td>
<td>Minus 100°C to 500°C</td>
</tr>
<tr>
<td>Process sealing</td>
<td>Metal to metal</td>
<td>n/a</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>All up to ASME 2500 (PN320)</td>
<td>To ASME 4500# or higher on request</td>
</tr>
<tr>
<td>Connection types</td>
<td>Butt weld end or flanged (DIN or ASME)</td>
<td>ISO, BS, JIS, NF on request</td>
</tr>
<tr>
<td>Heating jacket</td>
<td>n/a</td>
<td>Full or semi jacketing</td>
</tr>
<tr>
<td>Bypass trim design</td>
<td>Throttle plates</td>
<td>Multi stage, hollow, or cage trim in bypass</td>
</tr>
<tr>
<td>Control Characteristics</td>
<td>Linear</td>
<td>Equal %</td>
</tr>
<tr>
<td>Installation</td>
<td>Vertical</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Flow direction</td>
<td>Flow to open, no reverse flow (integral check valve)</td>
<td>n/a</td>
</tr>
<tr>
<td>Other options</td>
<td>Maritime sea water service ARV design</td>
<td>Valves conforming to NACE MR0175</td>
</tr>
</tbody>
</table>

ARV Business Benefits

- Protects the business investment in critical pump equipment
- Saves power costs by eliminating the need for continuous recirculation to cool the pump
- Includes reverse flow protection
- Avoids additional investment in pressure reduction equipment
- Needs no electrical wiring, plant or instrument air
- Reduces downtime – and is easy to maintain
## Selected ARV Dimensions and Parts List

### Dimension Table

<table>
<thead>
<tr>
<th>Inlet/Outlet Size</th>
<th>Bypass Size</th>
<th>Pressure Class</th>
<th>a in mm</th>
<th>b in mm</th>
<th>H in mm</th>
</tr>
</thead>
</table>
| 1”/1”;
DN25/25         | ½”;
DN15         | ASME 150    | 188     | 145     | 271     |
| 2”/2”;
DN 50/50       | 1½”;
DN40        | ASME 300    | 283     | 236     | 425     |
| 3”/3”;
DN75/75       | 3”; DN75    | ASME 300    | 277     | 295     | 420     |
| 4”/4”;
DN100/100     | 1½”;
DN40        | ASME 300    | 297     | 300     | 450     |
| 4”/4”;
DN100/100     | 2”; DN50    | ASME 300    | 297     | 305     | 450     |
| 4”/4”;
DN100/100     | 3”; DN75    | ASME 300    | 297     | 310     | 450     |
| 6”/6”;
DN150/150     | 3”; DN75    | ASME 300    | 357     | 385     | 520     |
| 6”/6”;
DN150/150     | 4”; DN100   | ASME 300    | 357     | 390     | 520     |
| 8”/8”;
DN200/200     | 3”; DN75    | ASME 300    | 524     | 430     | 795     |

The dimension table below is for illustrative purposes for automatic recirculation valves up to eight inches. SchuF can produce automatic recirculation valves in all sizes and pressure classes as required by the application or operating conditions.

### SureFlo™ Parts List
(High temperature design example)

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Upper body</td>
<td>ASTM A217 WC1</td>
</tr>
<tr>
<td>20</td>
<td>Lower body</td>
<td>ASTM A217 WC1</td>
</tr>
<tr>
<td>30</td>
<td>Disc with spindle</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>40</td>
<td>Spring guide</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>50</td>
<td>Bypass body</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>60</td>
<td>Control bushing</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>70</td>
<td>Bush</td>
<td>2.0550; Brass</td>
</tr>
<tr>
<td>80</td>
<td>Spring guide</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>90</td>
<td>Letdown unit</td>
<td>1.4404; 316L</td>
</tr>
<tr>
<td>100</td>
<td>Wire wound gasket</td>
<td>Graphite</td>
</tr>
<tr>
<td>110</td>
<td>Spring</td>
<td>2.4669; Inconel</td>
</tr>
</tbody>
</table>

### Nominal Size and Maximum Flow Examples

<table>
<thead>
<tr>
<th>Main Inlet/Outlet size</th>
<th>1”</th>
<th>1.5”</th>
<th>2”</th>
<th>3”</th>
<th>4”</th>
<th>6”</th>
<th>8”</th>
<th>10”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Flow GPM</td>
<td>65</td>
<td>132</td>
<td>264</td>
<td>616</td>
<td>1,100</td>
<td>2,422</td>
<td>4,400</td>
<td>8,805</td>
</tr>
<tr>
<td>m³/h</td>
<td>15</td>
<td>30</td>
<td>60</td>
<td>140</td>
<td>250</td>
<td>550</td>
<td>1,000</td>
<td>2,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bypass size</th>
<th>0.75”</th>
<th>0.75”</th>
<th>1”</th>
<th>2”</th>
<th>3”</th>
<th>4”</th>
<th>6”</th>
<th>8”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Flow</td>
<td>GPM</td>
<td>62</td>
<td>62</td>
<td>88</td>
<td>176</td>
<td>330</td>
<td>660</td>
<td>1,320</td>
</tr>
<tr>
<td>m³/h</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>40</td>
<td>75</td>
<td>150</td>
<td>300</td>
<td>560</td>
</tr>
</tbody>
</table>

The above table is for illustrative purposes and is intended to give a quick estimate of the size of valve required based on main and bypass flow. The indicated flow values are based on fluids with a specific gravity of 1. For fluids with different specific gravity, please inquire with SchuF directly.
Control Trim and Control Valve Options

ARV Control Trim Options

SchuF offers a variety of automatic recirculation valve control trim options. Choice will depend on many factors such as the medium, the required pressure drop, solid contents and the nature of the process. The most common form of pressure control in the bypass line is achieved via a series of nozzle plates. The required pressure drop is achieved by varying the number, size and position of the nozzles in the bypass and the number of plates used.

For high pressure drop requirements, a single piece multistage disc and spindle is placed in the bypass.

Pressure can then be reduced in 2, 3, or up to 6 stages. The disc contours can be varied for different media or letdown patterns. For applications where noise or vibrations are of concern a cage labyrinth design can be used in the bypass or integrated into the main line check valve design.

Minimum Recirculation Control Valve

Despite the diversity of control options available for the automatic recirculation valve, there are still situations where an independent control valve may be the best option.

Processes that require independent and variable control or where the media contains solid particles, crystals or is highly viscose generally require a separate control valve to protect the centrifugal pump. An example of a SchuF minimum recirculation control valve used in a severe application is shown below.

The control valve shown above was designed for a severe service pump application that included a high pressure drop (Δp 40 bar), 30% solid contents and significant flashing.

It has the following key features:

**Key Features**

- Flow to open (piston opens into the valve body)
- Accelerating body geometry design
- One piece disc and spindle
- Linear or equal % control characteristics
- Standard heavy yoke (ideal for vibrating service or high delta p flow)
- Hard trim material to match process or medium conditions
ARV Applications and Media

Automatic recirculation valves have the primary purpose of protecting pumps. They are found in most industries and can be used with a broad variety of pump applications:

**ARV Applications**
- General centrifugal pumps
- Boiler feed water pumps
- Cooling plant feed pumps
- Crude oil pumps
- Fluid gas pumps (for LNG, LPG etc.)
- Process liquid pumps
- Booster pumps
- Seawater injection pumps
- Fire fighting pumps

**ARV Media and Industry Examples**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Medium</th>
<th>P Class</th>
<th>Temperature</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical plant</td>
<td>Various solvents</td>
<td>PN 16</td>
<td>30 °C</td>
<td>DN40; 1½&quot;</td>
</tr>
<tr>
<td>Chemical plant</td>
<td>Butadiene</td>
<td>ASME 150</td>
<td>-4 °C</td>
<td>DN50; 2&quot;</td>
</tr>
<tr>
<td>LNG plant</td>
<td>Fire- / Fresh- and Seawater</td>
<td>ASME 150</td>
<td>-10/+20 °C</td>
<td>DN300; 12&quot;</td>
</tr>
<tr>
<td>Offshore</td>
<td>(HP) Methanol / LDHI</td>
<td>ASME 150</td>
<td>35 °C</td>
<td>DN50; 2&quot;</td>
</tr>
<tr>
<td>Power plant</td>
<td>Demin. Water</td>
<td>ASME 150</td>
<td>-10/+32 °C</td>
<td>DN80; 3&quot;</td>
</tr>
<tr>
<td>Power plant</td>
<td>Filtered Water</td>
<td>ASME 150</td>
<td>60 °C</td>
<td>DN100; 4&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Drain Liquid</td>
<td>ASME 150</td>
<td>75 °C</td>
<td>DN80; 3&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Oil</td>
<td>ASME 150</td>
<td>50 °C</td>
<td>DN80; 3&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Hydrocarbon-fluid</td>
<td>ASME 150</td>
<td>25 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Boiling Blowdown Water</td>
<td>ASME 150</td>
<td>60 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Kerosene</td>
<td>ASME 150</td>
<td>-10/+20 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Sour Water</td>
<td>ASME 300</td>
<td>60 °C</td>
<td>DN80; 3&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Fractionated Naphta</td>
<td>ASME 300</td>
<td>275 °C</td>
<td>DN350; 14&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Whole Naphta</td>
<td>ASME 300</td>
<td>84 °C</td>
<td>DN300; 12&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Vacuum Gas Oil</td>
<td>ASME 300</td>
<td>243 °C</td>
<td>DN200; 8&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Unstabilized Naphta</td>
<td>ASME 300</td>
<td>131 °C</td>
<td>DN200; 8&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Fractionated hydrocarbons</td>
<td>ASME 300</td>
<td>354 °C</td>
<td>DN200; 8&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Reflux Naptha</td>
<td>ASME 300</td>
<td>99 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Premium Diesel Product</td>
<td>ASME 300</td>
<td>242 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Reflux Naphta</td>
<td>ASME 300</td>
<td>99 °C</td>
<td>DN150; 6&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Boiler Feed Water</td>
<td>ASME 300</td>
<td>121 °C</td>
<td>DN100; 4&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>LPG</td>
<td>ASME 300</td>
<td>42 °C</td>
<td>DN100; 4&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Whole Naphta</td>
<td>ASME 300</td>
<td>108 °C</td>
<td>DN100; 4&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Heavy Gas Oil</td>
<td>ASME 300</td>
<td>353 °C</td>
<td>DN100; 4&quot;</td>
</tr>
<tr>
<td>Refinery</td>
<td>Stabilized Naphta</td>
<td>ASME 300</td>
<td>40 °C</td>
<td>DN100; 4&quot;</td>
</tr>
</tbody>
</table>

SureFlo™ in a boiler feedwater application
Automatic Recirculation Valve – Data Sheet

Please use this data sheet to send your inquiries to us. Items marked in bold print indicate essential information.

Part 1 – Company Information

Name:  
Title:  
Company:  
Telephone:  
E-mail:  
Fax:  

Part 2 – Order Information

General:  
Quantity:  
Tag No.:  
Application:  
Project Name:  
Valve Model: 78PS Automatic Recirculation Valve  
Project No:  
Pump Information:  
Qmin = m³/h  
HM = m  
Suction pr. PV: (bar/psi)  
Q100 = m³/h  
H100 = m  
Backpress. P1: (bar/psi)  
Qmax = m³/h  
Backpress. PN: (bar/psi)  
QBy = m³/h  
Differential pr. (P1-PN): (bar/psi)  

Process Information:  
Process:  
Medium: Liquid or Gas:  
Density: kg/m³  
Op.Temp.: °C  
Fluid Vapor Pressure: (bara)  

Notes:  
Send To: SchuF Fetterolf  
E-Mail: valves@schuf.com  
Fax: +49 6198 571200

Part 3 – Valve and Process Information

Valve Information:  
Valve Inlet Size (DN/Inch):  
Valve Inlet Pressure Rating:  
Valve Outlet Size (DN/Inch):  
Valve Outlet Pressure Rating:  
Bypass Outlet Size (DN/Inch):  
Bypass Outlet Pressure Rating:  
Materials Housing:  
Materials Trim:  
Installation: Vertical or Horizontal  

Part 4 – Please use the charts below to define the information required in part 3

Pump Information:  
Qmin = m³/h  
Hmin = m  
Q100 = m³/h  
H100 = m  
Qmax = m³/h  
QBy = m³/h  

Notes:  

Send To: SchuF Fetterolf  
E-Mail: valves@schuf.com  
Fax: +49 6198 571200
Product Portfolio Overview

In over one hundred years, the SchuF Group has delivered more than one million valves 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 Italy, India, Ireland, UK and the USA. 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:

Sample ARV Client List:

- BASF
- Bayer
- BP
- CB&I
- Chevron Phillips Chemical
- Conoco Phillips
- Dyno Nobel Asia Pacific
- Exxon
- Fluor
- Foster Wheeler
- GE Oil & Gas
- Indian Oil
- Lanxess Butyl
- MAADEN
- Malaysian Refining
- Peru LNG
- Petrobras
- Petronas Malaysia
- Reliance
- Rio Tinto
- Sabic
- Samsung
- Shell
- Thai Nippon Steel