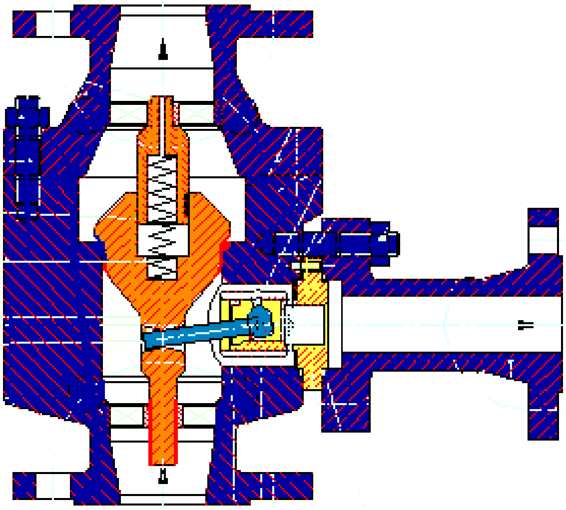
Pump Recirculation Valve Pumpenschutzumlaufventil

78PS

Pump recirculation and protection valves



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Principle of operation:

The combined bypass and check valve protects centrifugal pumps automatically during low load operation. As the pumps load drops below a preset flow rate the valve's disc will move towards its seat and cause the bypass bush to open a bypass flow path and maintain the pump minimum flow rate. A common application is for pumps handling hot water for, say, boiler feed or cooling water plants, when partial evaporation of the water content might otherwise cause the pump to run dry. Even when the flow rate through the main valve to the boiler is completely shut off a minimum flow is maintained.

The valve is normally installed vertically. Sufficient flow causes the disc to rise. A lever pushes the bypass bush back, closing off the bypass flow through bypass seat. The bypass flow is therefore inversely proportional to the main pump flow. When the check valve is fully opened, the bypass is fully closed and can even be designed to offer a bubble tight shut off.

When flow rate and pressure drop in the main line (evaporation) the spring will partially close the main check valve. The lever on the valve stem will allow the spring of the bypass valve to open it in proportion to the closing of the main valve. Part of the flow is thereby returned to the front of the pump and the pump remains fully primed even when the pressure and flow are reduced in the feeder line. The trim of the bypass valve is designed to reduce the pressure in the recirculation line to a suitable pump intake pressure.

Body materials are forged carbon steel (with st.st. trim), but cryogenic or stainless steel versions are also available. Valve options include a rotating pivot action lever and a non-return or a throttling device in the bypass.

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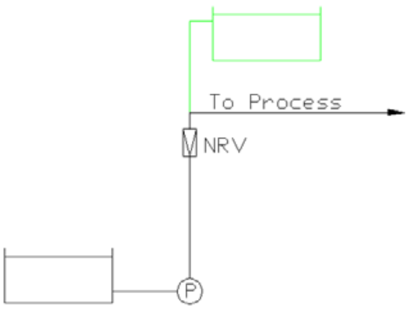
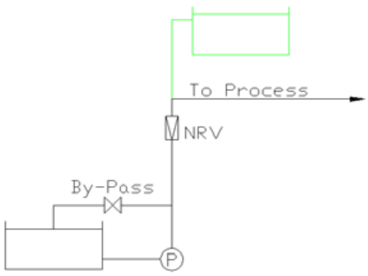
Pump requirements:
Centrifugal pumps operate on the principle that they force liquid out from the inside at increasing velocity. The velocity head acquired as the liquid leaves the impeller blade tips is changed to pressure head as the liquid passes into the volute chamber and thence out the pumps discharge. The pump is self cooling and would burn out quickly if it was kept in operation when there is no flow through it. A minimum flow is therefore specified as required to protect the pump.

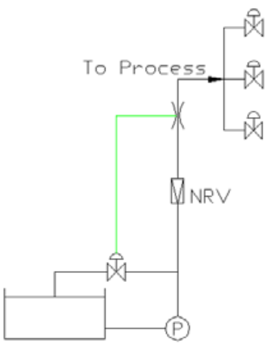
Modes of protection:



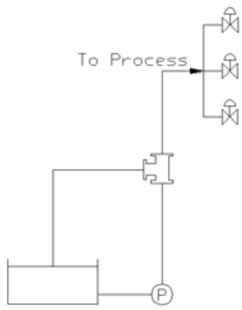
The pump has no back-flow prevention and therefore product will flow back through it once it has stopped. A non return valve is therefore usually placed after the outlet of the pump. A reservoir is used to take the pumps output when there is no user.



A simple bypass or leakage path can be used to allow the required minimum flow to flow back to the pump inlet. This system is simple and foolproof, but of course is in constant operation and therefore only viable if the minimum flow rate is very low in relation to the main flow.



More expensive in terms of initial outlay is to measure the flow and the use a flow control valve to allow difference between the required minimum flow and the actual flow taken by the main line to bypass the pump back to the inlet. No reservoir is required.



The previous approach stands and falls with the integrity of the control system. A safer system is to combine the non return valve and the control valve into an interconnected unit, the pump recirculation valve. This valve closes in the main line when there is no flow, automatically opening the bypass line, seized for minimum flow. When the main line takes flow but less than minimum, the bypass line and the main line are partially open.

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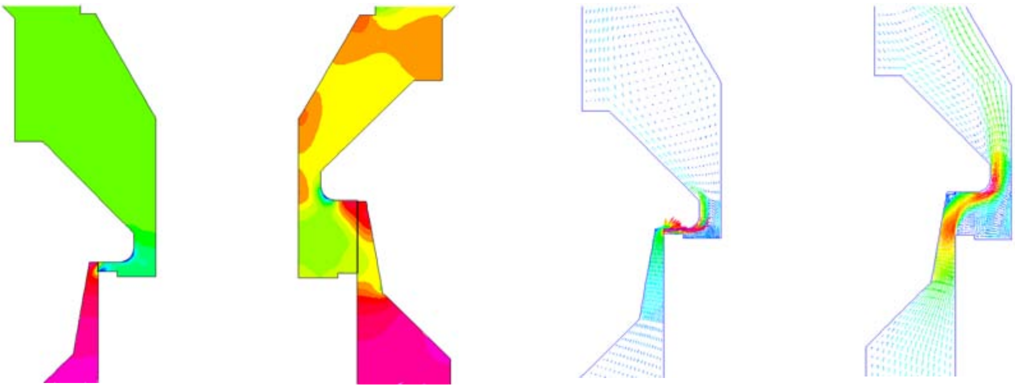
Design principles:

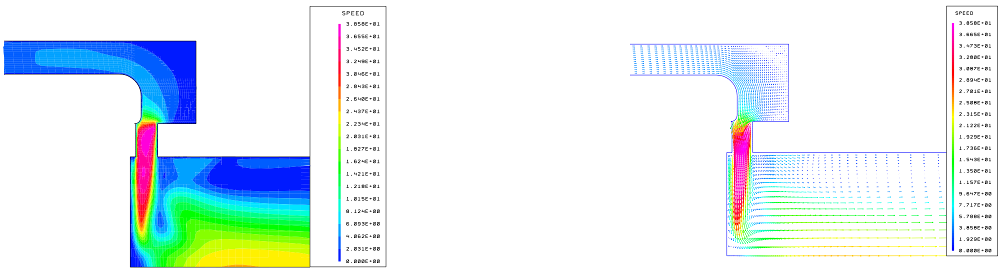
The main difficulties in the designing of pump recirculation valves lie in the fact that the design has to combine many partially contradictory designs. The end points are simply – full flow the valve is fully open and the by-pass is closed. Also when no flow is taken by the user, the valve is closed and the by-pass is fully open. Minimum flow back through the bypass is guaranteed as long as the by-pass valve is correctly designed, with the right Cv. It is almost impossible for most fluid to calculate the Cv with no margin for error; therefore control valves are usually oversized. However in this case if the bypass is oversized, the pressure drop will be insufficient and the pressure at the pump's inlet will be too high.

Another problem is that the valve acts as a non-return valve and should therefore allow little or no leakage to flow back through the valve. This can be achieved by proper sizing of the spring. However, the spring should not be too strong, as this will prevent prompt opening of the valve once flow is again required by the user.

In order to optimise these different requirements, SchuF cooperated with renowned flow control experts in the Technical Universities of Magdeburg and Darmstadt to come up with detailed FEM simulations, which where then tested with a test rig.



Pressure distribution and speed vectors at different stages of opening, main valve. (TU Magdeburg)
Druckverteilung und Geschwindigkeitsvektoren bei verschiedenen Öffnungsgraden des Hauptventiles



Pressure distribution and speed vectors for one nozzle, bypass valve. (TU Magdeburg)
Druckverteilung und Geschwindigkeitsvektoren einer Bohrung des Bypass-Ventils

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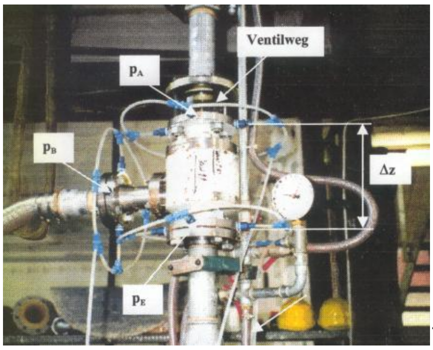
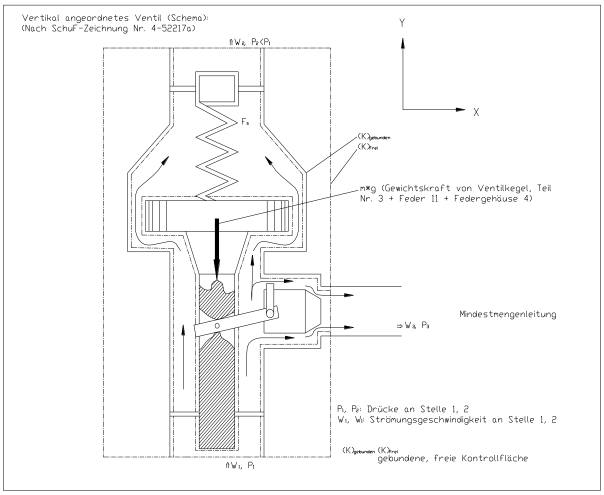


Test rig, TU Darmstadt

These simulations lead to a set of equations describing the behaviour of the flow through the valve and the bypass. Formulas were derived calculate the disc and spindle size, the spring forces required to close the valve, the Cv of the main valve and bypass, as well as the size and quantity of the nozzles in the bypass.

As an example the formula of the spring force at which the flow can push the main disc into the open position is given by:



Federkraft (Spring force) Fs
*Impulssatz für stationäre inkompressible Strömung in Y-Richtung: *)*

$$\rho . \int_{(K)} Wy.dV = Ky + Py + Ry$$

mit
ρ = Dichte der Flüssigkeit
Ky =Schwerkraft der Flüssigkeit innerhalb der Kontrollfläche
Py = Druckkraft auf die freie Kontrollfläche
Ry = resultierende Oberflächenkraft auf die gebundene Kontrollfläche
(z.B. Strömungswiderstand); R>0; Kraft von Körper / Wand auf Flüssigkeit.)

The complete set of equations have been combined in an excel sheet, printing out all required data for the customers and design engineers convenience.

Pumpenschutz- und Umlaufventil

Diese Umlaufventile bieten Kreiselpumpen automatischen und wirksamen Schutz bei Betrieb mit geringen Fördermengen. Je geringer die Menge desto weiter nähert sich der Kegel des Ventils seinem Sitz. Dies ermöglicht, daß die Bypass-Hülse mittels einer Feder aufgedrückt wird und so ein Mindestmengenkreislauf aufrecht gehalten wird. Eine häufige Anwendung ist für Heizwasserpumpen in Kesselspeise- oder Kühlwasseranlagen. Die partielle Verdunstung des Wassers könnte sonst bewirken, daß die Pumpe trocken laufen würde. So kann sichergestellt werden, daß selbst wenn der Durchfluß zu dem Kessel ganz abgestellt wird, die Mindestmenge aufrecht erhalten wird.

Das Ventil wird vertikal eingebaut. Bei genügendem Durchfluß hebt sich der Kegel. Ein Hebel schiebt die Umlaufhülse zurück und schließt damit sukzessiv die Löcher im Bypass-Sitz. Die Umlaufmenge verändert sich also im umgekehrtem Verhältnis zur Hauptdurchgangsmenge. Wenn das Rückschlagventil voll geöffnet ist, wird der Bypass komplett geschlossen und kann auch eine blasenfreie metallische Abdichtung anbieten.

Sollte der Hauptstrom abfallen, schiebt die Hauptfeder den Kegel zurück. Die Bypassfeder öffnet das Umlaufventil proportional. Ein Teil der Umlaufmenge wird somit an den Pumpeneinlauf zurückgeführt und durch diesen Kreislauf ein Mindestdurchfluß aufrecht erhalten. Die Umlaufgarnitur ist so ausgelegt, daß der Druck in dem Umlauf auf den Pumpeneinlassdruck reduziert wird.

Das Gehäusematerial ist standardmäßig in Schmiedestahl mit Edelstahlinnenteilen. Tieftemperatur- und Edelstähle sind natürlich auch erhältlich. Ventiloptionen beinhalten einen Drehbetätigungshebel und ein Rückschlag- oder Entspannungseinheit im Umlauf.

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Pos.	**Beschreibung**	***Description***	**Material**	***AISI equiv.***
10	Gehäuseunterteil	*Body Upper*	1.0460	C22.8
20	Gehäuseoberteil	*Body Lower*	1.0460	C22.8
30	Kegel	*Disc*	1.4541	321
40	Welle	*Shaft*	1.4541	321
50	Wellenanschlag	*Shaft-Stop*	1.4571	316 Ti
60	Führungsbuchse	*Support Bush*	1.4571	316 Ti
70	Feder	*Spring*	1.8159	1.8159
80	Buchse	*Bush*	1.4541	321
90	Flachdichtung	*Gasket*	NBR/ARAMID	NBR/ARAMIDE
100	Flachdichtung	*Gasket*	NBR/ARAMID	NBR/ARAMIDE
110	Abgang	*Body outlet*	1.0460	C22.8
120	Sitz	*Seat*	1.4571	316 Ti
130	Feder	*Spring*	1.8159	1.8159
140	Feder	*Spring*	1.4571	316 Ti
150	Hebel	*Lever*	NBR/ARAMID	NBR/ARAMIDE
160	Flachdichtung	*Gasket*	1.4571	316 Ti
170	Verdrehsicherung	*Anti-rotation pin*	A4-70	316
180	Schraube	*Stud*	A4	316
190	Schraubenmutter	*Nut*	A4-70	316
200	Schraube	*Stud*	A4	316
210	Feder	*Spring*	1.8159	1.8159
220	Sicherheitsstift	*Check ring*	1.4571	316 Ti