Metal Bellows Accumulators
for Heavy-Duty Diesel Engines

1. DESCRIPTION

In the fuel injection system of heavy-duty diesel engines (e.g. marine engines and engines for power plants / two and four-stroke), pressure fluctuations are generated during the injection process by the high pressure pumps.

In most heavy-duty diesel engines each cylinder has its own injection pump. During the phases of fuel extraction from the supply line, compression and injection as well as the release of unused fuel into the return line, cyclic pressure pulsations may result.

Example:

$$\frac{600\ [\text{rpm}] \times 8\ [\text{cylinders}]}{60\ [\text{s}] \times 2\ [\text{4-stroke}]} = 40\ [\text{Hz}]$$

The supply line and the return line are at a lower pressure than that required for fuel injection and in such dual-pipe systems the above-mentioned pressure fluctuations can cause problems, depending on the size of the pressure variations. It is for this reason that superimposed pressure fluctuations from 0 to approx. 13 bar can occur in a 4.5 bar return line (see the graph at section 2). In other systems pressure peaks of over 50 bar have been measured.

This fluctuating pressure with its unacceptable pressure peaks not only creates an additional stress on the pipe system but also an additional load for all integrated fittings and equipment. Valves, filters, measurement and monitoring devices, e.g. viscosity meters, ... can be seriously impaired, damaged, sometimes even irreparably.

Until now a standard method for reducing or eliminating the pulsations has been to use hydraulic accumulators with nitrogen as the damping element and an elastomer diaphragm or bladder as the separating element between the gas and the fuel. The best damping results may be obtained by installing one damper in the supply line and one in the return line close to the engine. However, standard diaphragm and bladder accumulators have two main limitations:

Problems with elastomer resistance to fuels and high temperatures.

Fuels other than diesel oil, such as bio-oils or heavy fuel oil, require higher injection temperatures. These can reach 160 °C. Even FKM used for the diaphragm or bladder has compatibility problems under such extreme conditions.

Gas loss through the elastomer

The accumulator gradually loses gas through the elastomer and the higher the temperature the higher the gas loss. If it is not possible to recharge the accumulator regularly, its function will deteriorate and the diaphragm or bladder will split.

These last two disadvantages can only be prevented by a relatively high investment in monitoring and maintenance. Depending on the type of fuel and its operating temperature, it can be necessary to replace the elastomer part after specific intervals.

HYDAC set itself the task of developing a pulsation damper without the problems outlined and which above all would also avoid the problems generated by other solutions (e.g. piston accumulators, spring-type accumulators, accumulators with elastic damping elements inside). These solutions have problems either with friction and abrasion or fuel leakage. One of the prime targets was to relieve the system operator of the burden of excessive monitoring and maintenance.

The recently developed solution from HYDAC is the Metal Bellows Accumulator. Instead of a bladder or diaphragm, a metal bellows is used as the flexible separating element between fluid and gas. This bellows is resistant to all conventional fuels over a very wide temperature range. Heavy fuel oil at temperatures of up to 160°C is no problem for these dampers. The metal bellows is welded to the other components and is therefore completely gas-tight. It is able to move up and down inside the accumulator without any friction or abrasion and it can operate for a very long time (years) with just one adjustment. Monitoring and maintenance for this type of damper is therefore reduced to a minimum.

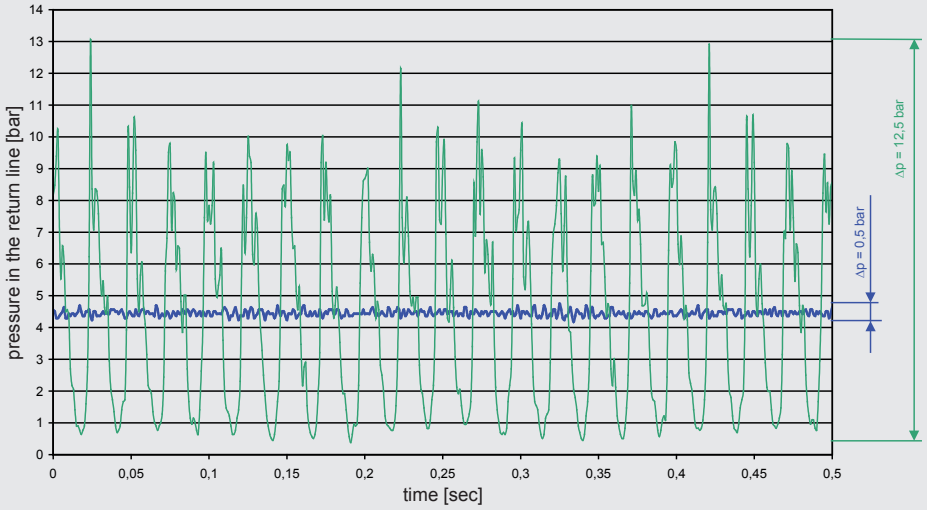
A diverting block is built into the fuel side of the damper which forces the fuel directly into the accumulator, thereby increasing the damping efficiency considerably. If two dampers are fitted to the fuel system (in both supply and return line), no pressure fluctuations can leave the engine before passing through one of the metal bellows dampers.

With this metal bellows accumulator, HYDAC has developed a competitively-priced damper which is unrivalled in terms of maintenance. The purchase costs will be recouped within a short time and as a result of reduced maintenance, the availability of the entire system is increased.
For further benefits, see below:

1.1. BENEFITS OF THE SM50P-...

- Maintenance-free
  – extremely gas-tight
  – frictionless parts (non-wearing)
- Fluid resistant across whole temperature range
- Cost-effective:
  "fit and forget"

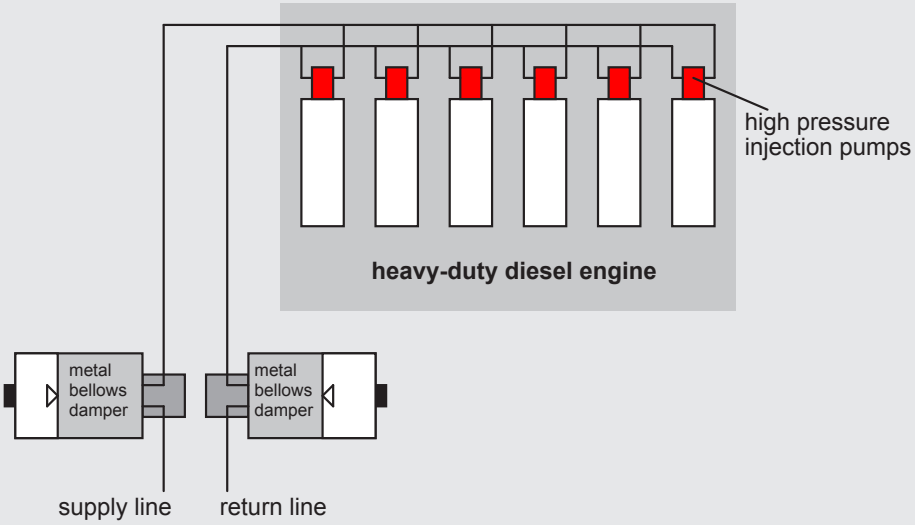
2. PRESSURE GRAPH



green = without damper
blue = with damper

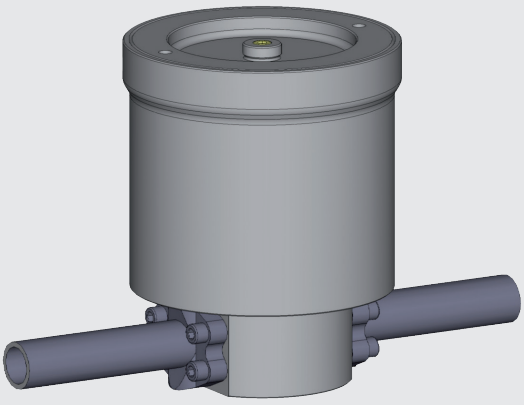
3. INSTALLATION OF THE SM50P-...

3.1. DIAGRAM



3.2. MODEL

3-D standard model, e.g. for inline installation.



Special connections on request

4. TECHNICAL SPECIFICATIONS

4.1. TECHNICAL DATA

Operating pressure:
3 ... 12 bar (others on request)

Max. pre-charge pressure:
4 bar (at max. operating temperature)

Design temperature range:
-10 °C ... +160 °C

Operating fluids:
Diesel and heavy fuel oil, biofuels

Total volume:
3.8 litres

Effective gas volume:
0.5 litre (nitrogen)

Gas-side fluid pre-charge:
0.6 litre (ethylene glycol)

Fluctuating volumes:
max. 0.04 litres (others on request)

Material:
Carbon steel (primed externally)

Design and Approval:
PED / ABS / DNV / GL /
LR / BV / AS1210 / ...

Fluid connection:
SAE 1 1/4" - 3000 psi
SAE 2" - 3000 psi
SAE 3" - 3000 psi

Gas connection:
M28x1.5 for Universal Charging and Testing Unit FPU-1
Part No.: 3398235

Mounting position:
Vertical (gas connection at top)
Others on request

Weight:
22 ... 33 kg depending on the connection size

4.2. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SM50 P – 0,5 W E 1/ 116 U – 50 AAJ – 2,5

Series

Type code
_ = accumulator without diverting block*
L = light-weight accumulator*
P = damper with diverting block

Capacity [l]

Version
W = convoluted bellows
M = diaphragm bellows*

Type of shell
A = screw type
E = weld type*
G = formed type*

Type of gas-side connection
1 = gas pressure adjustable (M28x1.5)
2 = gas pressure pre-set, non-adjustable gas locking screw*
3 = gas pressure adjustable (M16x1.5)

Material code

Fluid connection
1 = carbon steel
2 = carbon steel with corrosion protection
3 = stainless steel

Accumulator shell
1 = carbon steel
2 = carbon steel with corrosion protection
4 = stainless steel

Seal material
0 = no seal
2 = NBR*
5 = low temperature NBR*
6 = FKM

Certification code
U = European Pressure Equipment Directive (PED)

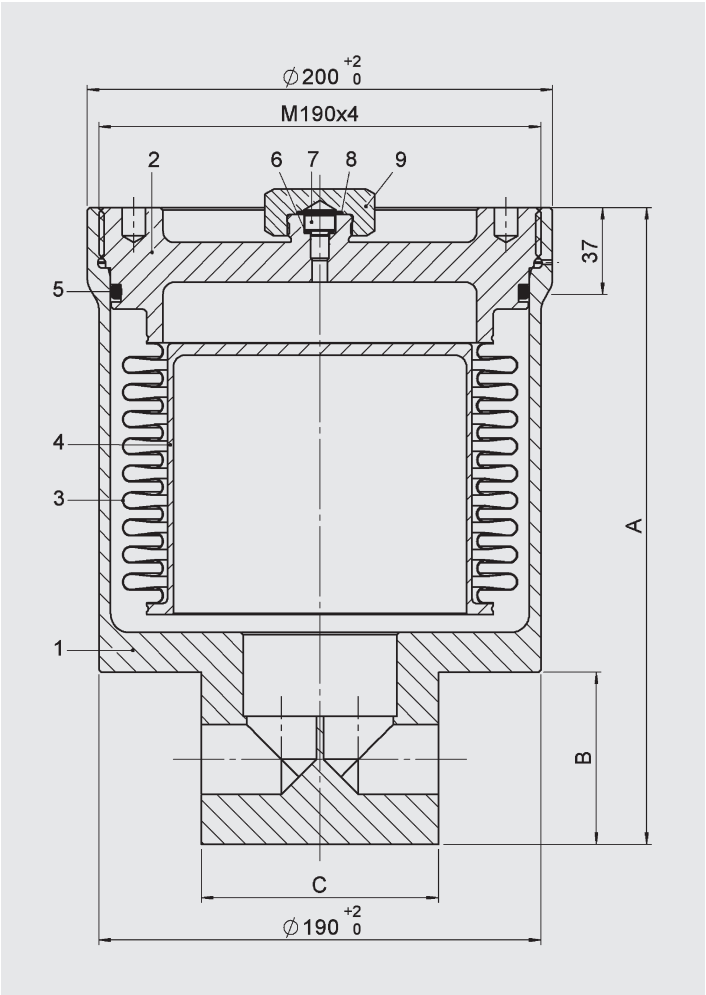
Permitted operating pressure [bar]

Fluid connection
See tables in catalogue section 3.301, Piston Accumulators

Pre-charge pressure p_0 [bar] at 20 °C,
must be stated clearly, if required!

* currently only on request

4.3. DIMENSIONS



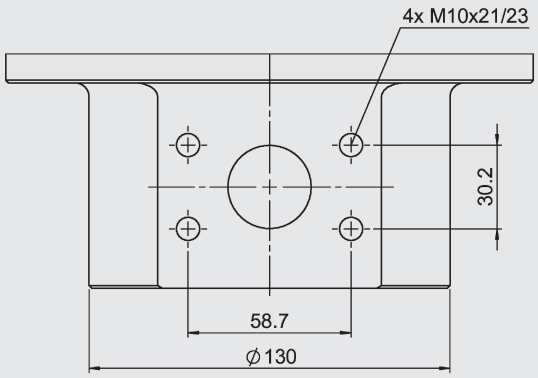
Item	Description
1	Accumulator lower section
2	Accumulator cover plate
3	Metal bellows
4	Bowl
5	O-ring
6	Seal ring
7	Adjustable locking screw
8	O-ring
9	Protective cap

4.4. ACCUMULATOR CONNECTION

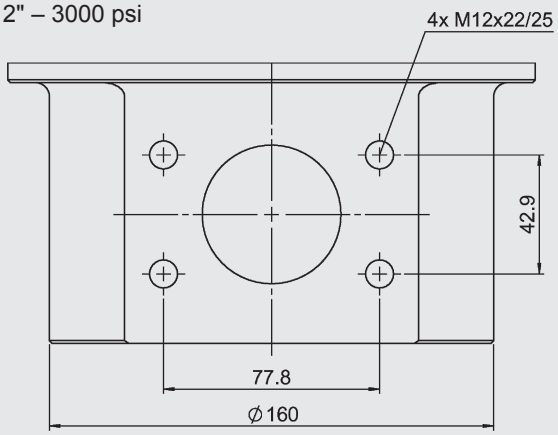
	Dimension [mm]		
	SAE 1 1/4" (FCD)*	SAE 2" (FCF)	SAE 3" (FCH)
A	274	294	333
B	74	94	134
C	102	120	133

* FCD = formerly AD

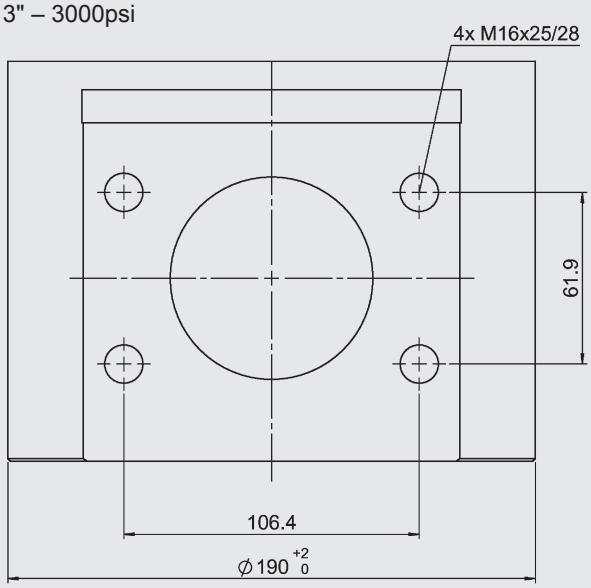
SM50P-3.8A6/116...FCD
SAE 1 1/4" – 3000 psi



SM50P-3.8A6/116...FCF
SAE 2" – 3000 psi



SM50P-3.8A6/116...FCH
SAE 3" – 3000psi

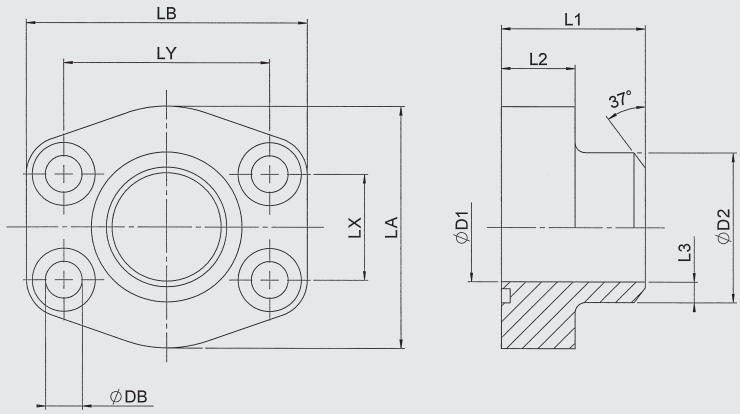


4.5. FLOW RATES / TEMPERATURE DEPENDENCY

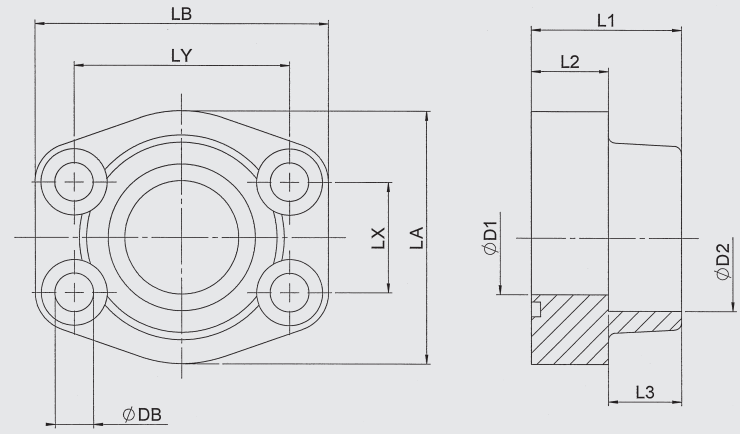
Series SM50P-... Flange SAE [inch] - 3000 psi		Bore [mm]	Max. flow rate Q_{max} [m³/h]	Weight [kg]	A [mm]	Ext. diam. D_a [mm]
1 1/4	**...FCD**	30	< 8	22	274	200
2	**...FCF**	50	8 - 21	25	294	
3	**...FCH**	73	> 21	33	333	

4.6. BUTT WELD AND SOCKET WELD FLANGES

Pressure: 3000 psi
Seal: FKM



Series SAE [inch]		D1 [mm]	D2 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	LA [mm]	LB [mm]	LX [mm]	LY [mm]	DB [mm]	Screws
1 1/4	**Butt weld flange**	31	42.8	41	21	3	< 74	≅ 80	30.2	58.7	10.5	M10x40
2		50	61	45	25	5.5	< 94	≅ 103	42.9	77.8	13.5	M12x45
3		73	89	50	27	8	< 134	≅ 135	61.9	106.4	17	M16x50



Series SAE [inch]		D1 [mm]	D2 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	LA [mm]	LB [mm]	LX [mm]	LY [mm]	DB [mm]	Screws
1 1/4	**Socket weld flange**	31	42.8	41	21	20	< 74	≅ 80	30.2	58.7	10.5	M10x40
2		50	61	45	25	24	< 94	≅ 103	42.9	77.8	13.5	M12x45
3		73	90.5	50	27	28	< 134	≅ 135	61.9	106.4	17	M16x50

5. NOTE

The information in this brochure relates to the operating conditions and applications described.

For applications and/or operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

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