FLOW FORCE

Global Only 1. Company
For Professional Fluid Engineering Solution

'Customer value,
Technology-driven global market leader'

Accumulator Technology

Bladder (FB Series)
Piston (FP Series)
Diaphragm (FLM Series)
Bellows (FBL Series)

U CE All Class...

FLOWFORCE CO., LTD.

Contents

1 SUMMARY

2 MODEL & SPECIFICATION

3 ACCESSORIES & PARTS

4 CALCULATION & SELECTION

5 HANDLING & APPENDIX

Manufacturing Innovation Industry 4.0

"First localization of accumulators that FLOWFORCE changed customers' attention who relied on imports after 1988. Once again, FLOWFORCE will be your successful partner by leading manufacturing innovation industry 4.0"

Top-5 Shared features

1 ■ **Improve performance / durability / safety of hydraulic system**

· FLOWFORCE Accumulators are usable for emergency operation(emergency breaking), energy accumulation, pulse absorption, shock absorption, thermal expansion compensation and for protect internal parts in hydraulic system.

2 ■ **Environmental preservation**

· Apply to fuel savings and emission reductions in hydraulic regeneration system(HCU/HPS)

3 ■ **Reduce investment and production operation cost**

· Contribute to the initial investment and operating cost savings through down-sizing of hydraulic pump/motor by utilizing the energy accumulation.

4 ■ **Increase productivity and process innovation**

· Optimizing working cycle & improving mechanical efficiency by storing & discharging of accumulator.

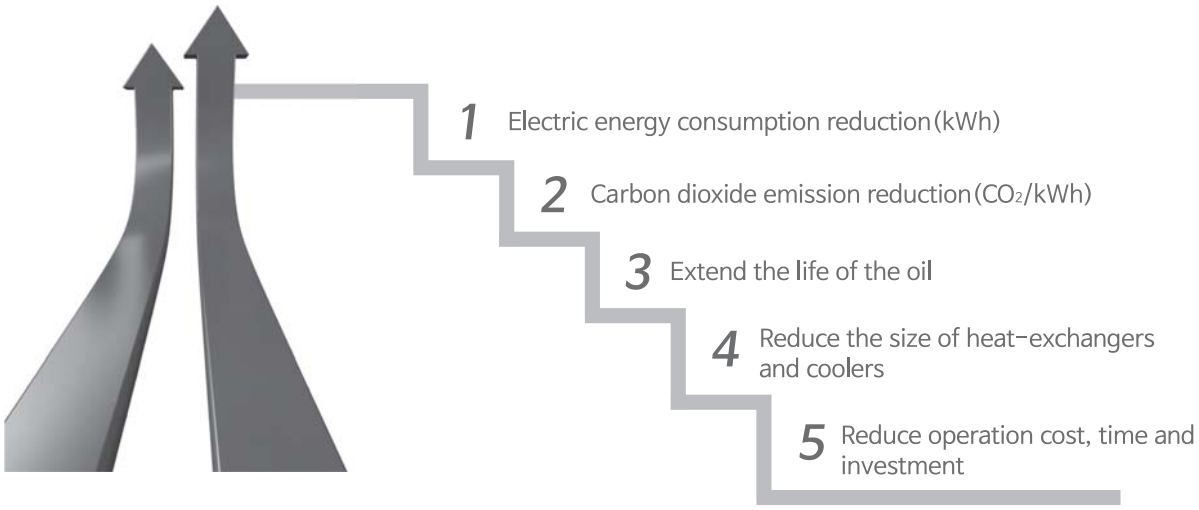
5 ■ **Manufacturing process innovation(Manufacturing Innovation Industry 4.0)**

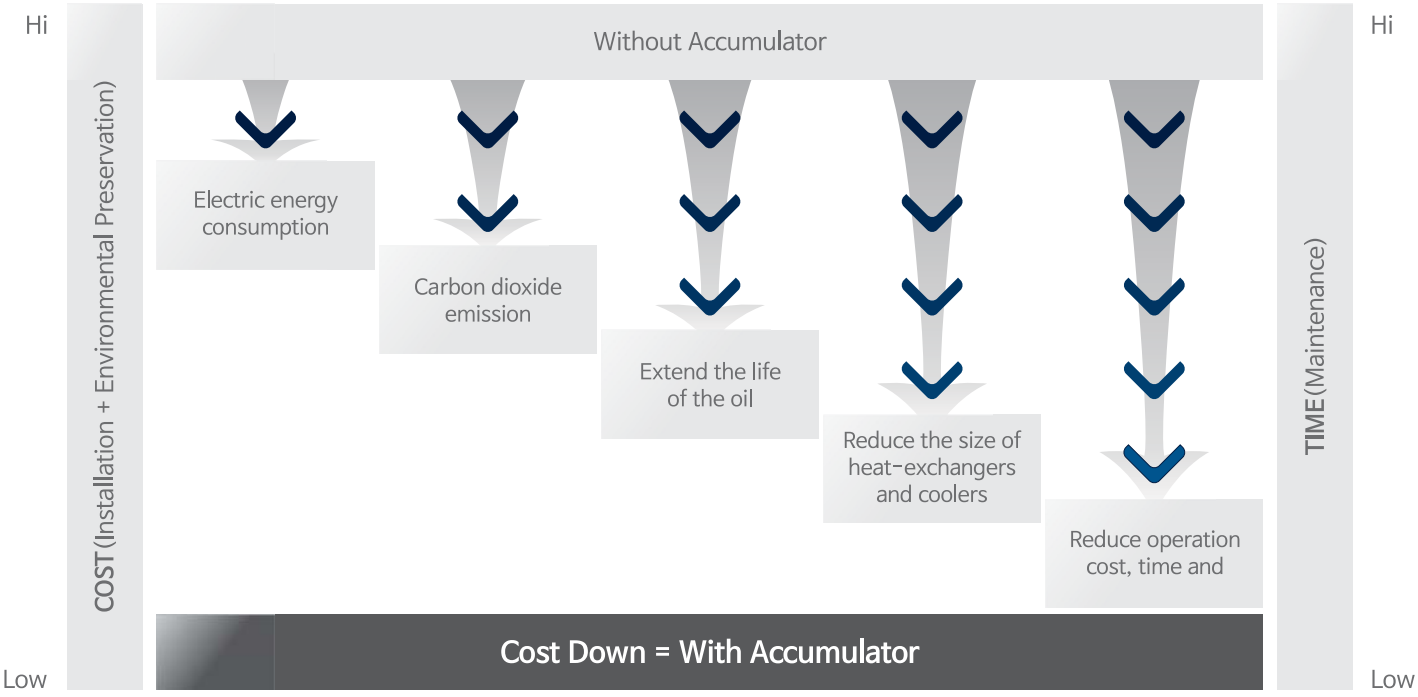
· 3 leading technologies(Configurable, Networkable, Energy-efficient) for next-generation of hydro-power unit that optimize smart function.

Shared features with Accumulators

Using accumulators are the way to contribute to global environmental conservation by saving energy.

Top-5 Benefits with Accumulators



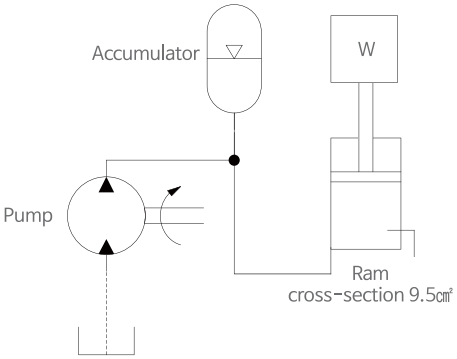


1 Electric energy consumption reduction (kWh)

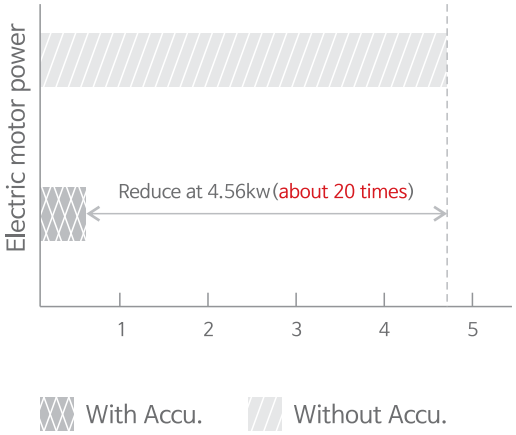
When using accumulators for energy accumulation, the required power of the electric motor driving the pump in the hydraulic system can be reduced about 1/20 compared to when not using the accumulators.

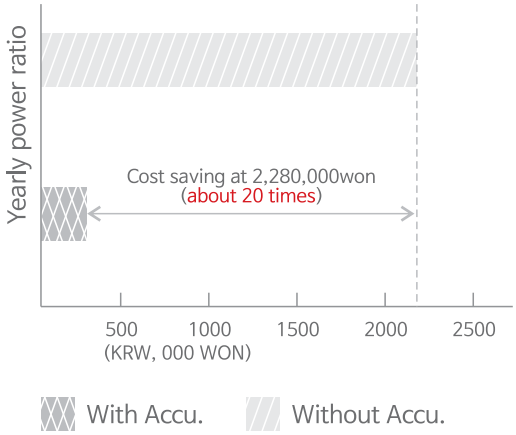
Working Condition

- Ram Load : 9.5 Ton
- Load pressure : 100bar(10MPa)
- Average RPM speed : 5cm/sec
- Stroke : 15cm
- Operating cycle : 0.5/min
- Pump pressure : 200bar(20MPa)



Item		Accumulator	
		With Accumulator	Without Accumulator
Required amount of oil		9.5 ㎠ x 15cm = 1,425㎤ = 1.43 ℓ	
Flow rate per second		9.5 ㎠ x 5cm/sec = 475㎤/s = 0.48 ℓ/sec	
Acc. Required flow	Necessary discharge flow rate of accumulator	= Required amount of oil = 1.43 ℓ	
	Discharge time	$\frac{1.43\ \ell}{0.48/s}$ = 2.98sec	
	Accumulation time	0.5sec/min = 120sec-2.98sec = 117sec	
	Accumulating flow per second	1.43 ℓ / 117sec = 0.012 ℓ/sec	
Necessary discharge flow of pump		0.012 ℓ/sec	0.48 ℓ/sec
Motor power		0.012 ℓ/sec x 20MPa=0.24kw	0.48 ℓ/sec x 10MPa=4.8kw
Total electric motor power reduction		4.8kw - 0.24kw = 20(4.8kw - 0.24kw = 4.56kw)	
Yearly saving power ratio		4.56kw x 10hr x 250day = 11,400kw x 200won(kw/h) = 2,280,000won	



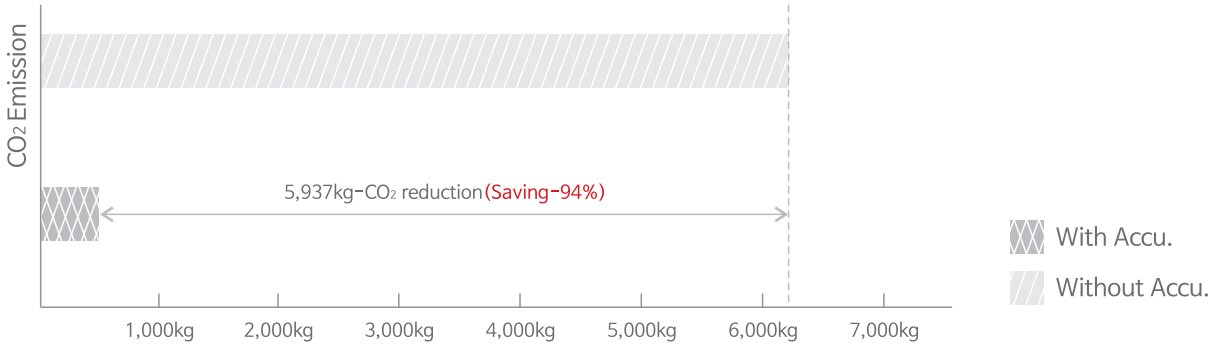


LOW FORCE Shared features with Accumulators

2 Carbon dioxide emission reduction

Estimated based on the operating conditions in conjunction with applying the same calculations.

	① With Accumulator	② Without Accumulator
Yearly power consumption (10 hours per day, 250days per year)	0.24kw x 10hr x 250days = 60kwh	4.56kw x 10hr x 250days = 11,400kwh
CO_2-kg emission (0.55 kg-CO_2/kwh)	600kwh x 0.55 = 333kg-CO_2	11,400kwh x 0.55 = 6,270kg-CO_2
CO_2 emission reduction ratio	1-②/① = 1-333/6,270 x 100 = 94%	



3 Extend the life of the oil

Operating oil life cycle will be reduced every 1℃ raising.
(Optimal oil temperature is about 40˚C but the oil service life will be decreased every 10˚C after the oil temperature at 60˚C)

4 Reduce the size of heat-exchangers and coolers

About 30% of the incoming power(pump) is converted into heat(kcal/h) that loses energy.
Thus, use of accumulators can allow small size of the coolers by reducing heat-exchange rate.

	With Accumulator	Without Accumulator
Heat-exchange rate	0.24kw x 30% = 0.072 kw x 860 = 61.92 kcal/h	4.8kw x 30% = 1.44kw x 860 ≒ 1,280 kcal/h

5 Reduce operation cost, time and investment

- Save more than 50% of the total investment in hydraulic system(Pump 〉 Accumulator)
- FLOWFORCE FT-Series(Top opening) can be able to replace the bladder kit without removing that reduces repairing time by 70% and even save labor cost and time during maintenance.

Certifications & Classifications

Based on ISO9001 & ISO14001 which are quality management & environmental management system that FLOWFORCE supplies most of certifications(classification) in comply with the rule of countries and nations.

Available Certifications

Nations

Country/Nation	Classification	Regulation
The European Union	CE Mark	· PED 97/23/EC [Pressure Equipment Directive] · EN14359:2006
USA / North America	ASME U-Stamp (ASME+CRN)	Code Section VIII Div.1
CHINA	SELO	Special Equipment Licensing Office (To Export)
AUSTRALIA	AS1210	Australian Standard

[Note 1]
기타 표시되지 않은 국가 및 기관의 Certificate는 18페이지의 12번 항목 참조

[Note 2]
Gas Bottle(KGS approved) / Back-up Nitrogen Bottle for accumulators

Classifications

Classification of institutions (English)	Classification of institutions (Korean)	Regulation
KR	한국 선급협회	Korean Register of Shipping
LR	영국 선급협회	Lloyd`s Register of Shipping
DNV	노르웨이 선급협회	Det Norski Veritas
ABS	미국 선급협회	American Bureau of Shipping/PDA(Product Design Assessment)
BV	프랑스 선급협회	Bureau Veritas
GL	독일 선급협회	Germanicher Lloyd
RINA	이탈리아 선급협회	Rrsistro Italiano Navale
NK	일본 해사협회	Nippon Kaiji Kyokai
CCS	중국 선급협회	China Classification Society
RS	러시안 선급협회	Russian Maritime Register of Shipping

Classifications for Quality & System


CE


ABS


GL


RINA

ISO 9001

ISO 14001

1. Function of Accumulator

Main function

FLOWFORCE Accumulator makes use of the difference in the compressibility of gas(N_2) and a liquid(hydraulic fluid). It is good to be used for hydraulic system, hydraulic equipment and other machinery that utilize fluids can enable the accumulation of pressure.

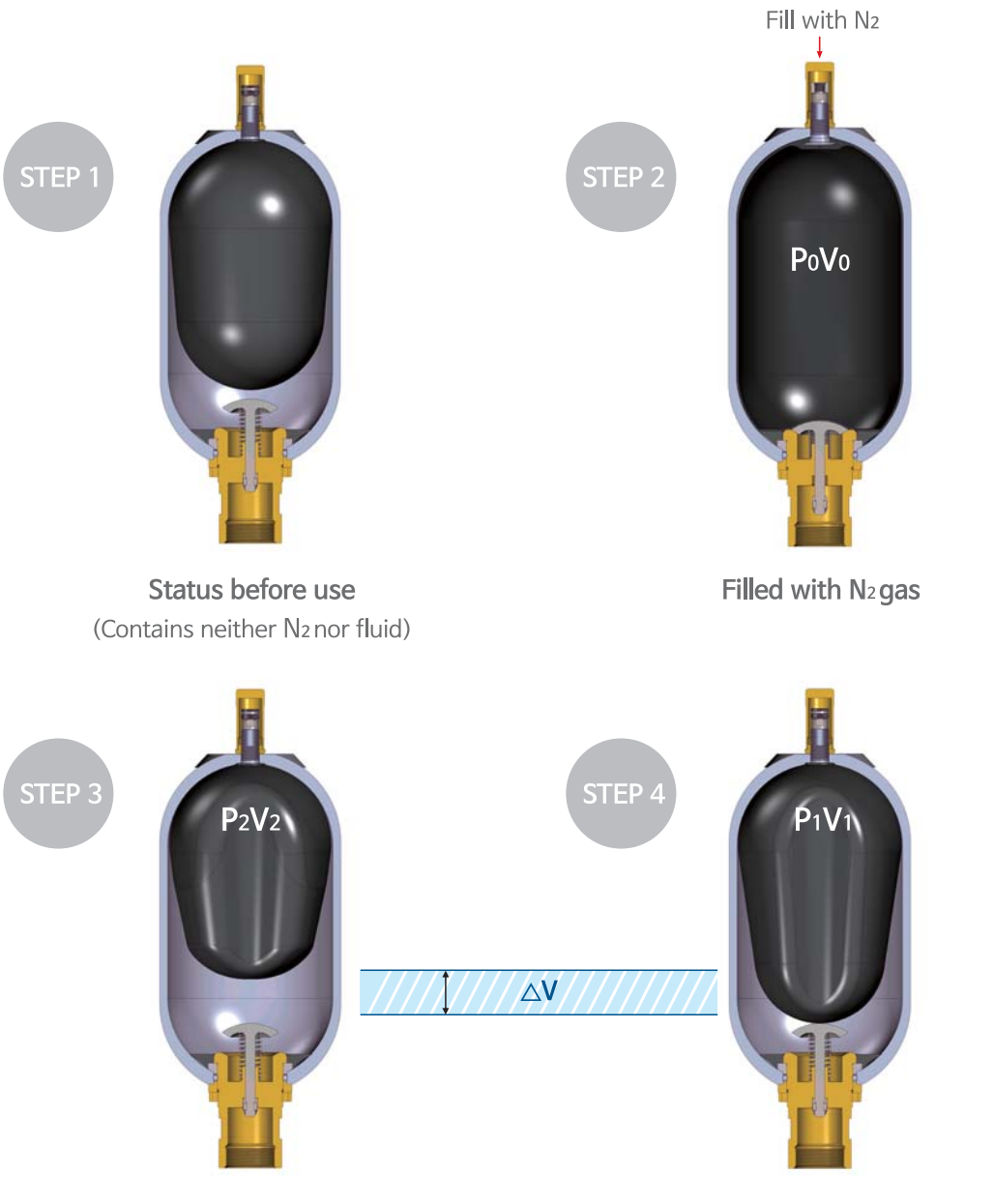
The main functions are

- Storing energy under pressure
- Absorbing hydraulic shock
- Dampening pump pulsation & flow fluctuations
- Improving system efficiency

Working Cycle

$P_0V_0=P_1V_1=P_2V_2=C$

※ Example of Bladder Accumulator



Status before use
(Contains neither N_2 nor fluid)

Filled with N_2 gas

Fluids flows inside

Discharge required of fluid

2. Type & Feature of Accumulator

FLOWFORCE Accumulators can be classified according to the method of separating N_2 gas and hydraulic fluid.

Main Technology by Type

Bladder Type

- Selection of a variety of material & inside coating options
- Covering low to high working temperature from -40℃~120℃
- Quick discharge/response time(Optional as High flow port)
- Variety of media(water/oil)
- Can be installed vertically and horizontally

Diaphragm/Membrane Type

- Compression ratio of 8:1 (P_2/P_0=Max. charging pressure of oil and N_2)
- Can be installed vertically and horizontally
- Welded type : Non-repairable
  Thread type : Bladder repairable
- Compact design
- Quick response

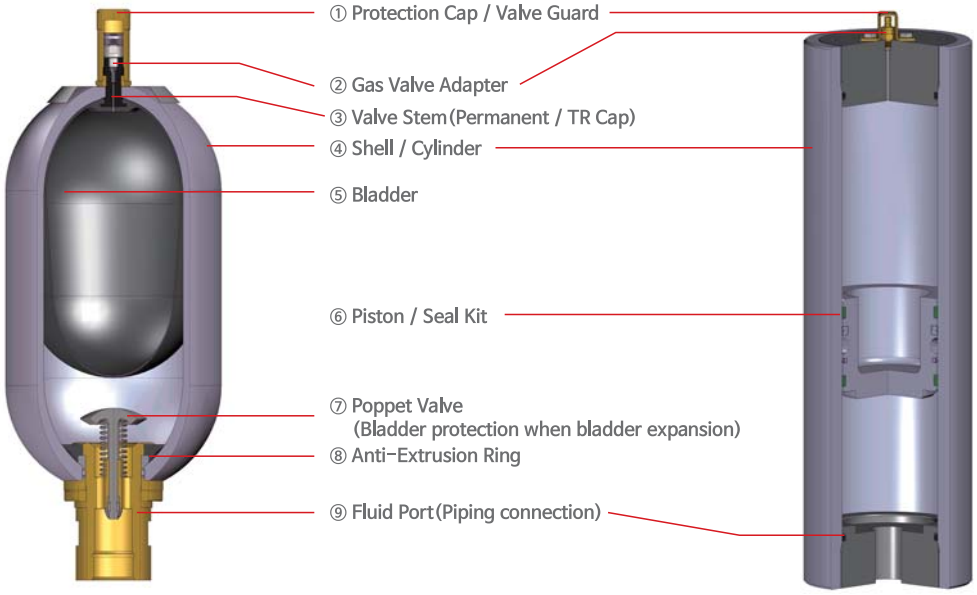
Piston Type

- Measurable Gas volume/pressure
  (Optional Piston Position Indicator)
- Max. compression ratio(P_2/P_0) and Maximize flow of charging/discharging

  (Back-up Nitrogen Bottle for accumulators)
- Available for the customized volume / pressure(up to 1,200bar)

3. Structure of Accumulator

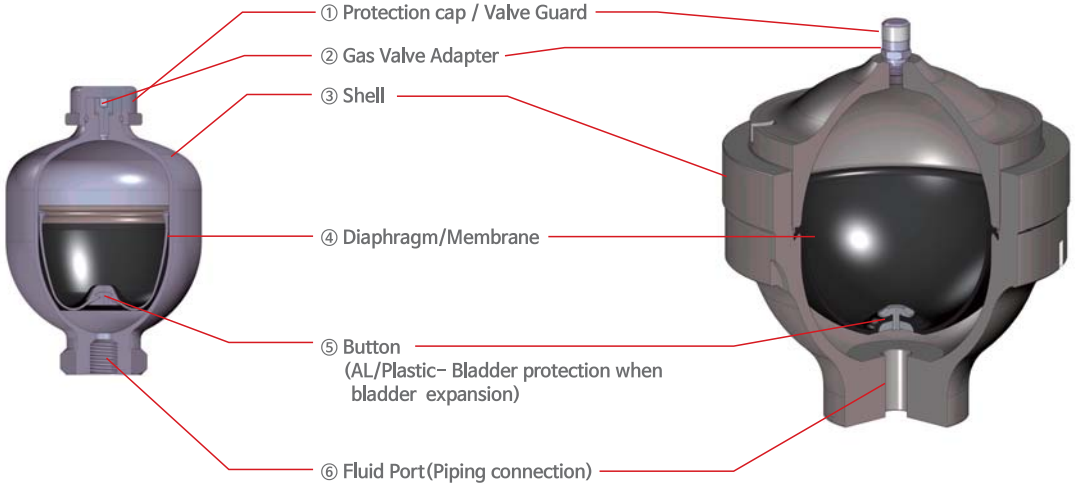
Main parts



Bladder Type

Piston Type

Main parts

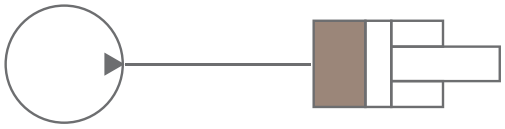


Diaphragm / Membrane Type

4. Application of Accumulator

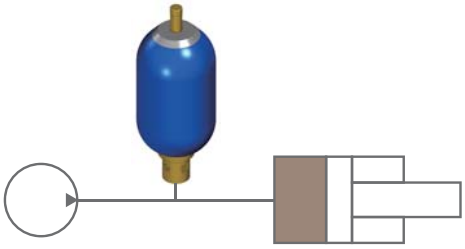
1 Energy Accumulation

Accumulators are widely used as a supplementary energy source.
Pressurized and discharged oil from the accumulators are used to operate cylinders enable down-sizing of the pumps, reduce cycle time and converse energy.



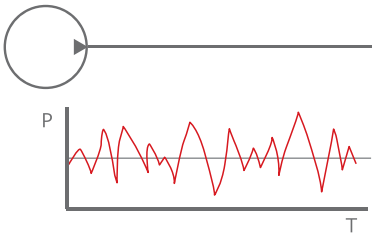
Main application

- Hydraulic press machine
- Die-Casing machine
- Injection molding machine
- Steel mill, chemical and power plant
- Substation circuit breakers
- Vibration test bench
- Water supply system
- Breaking system
- Vessel engine
- Hydraulic power unit



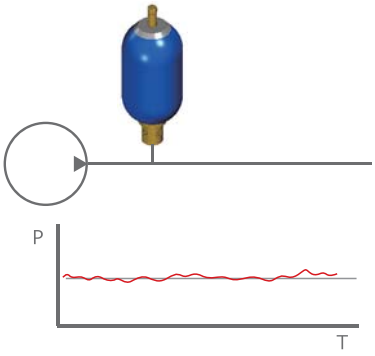
2 Pulsation Absorption

There is a pulse from the pump when the pressurized fluid discharged.
Pulse produces noise and vibrations that make the system as instability and the components are being damaged. Using the accumulator can reduce the pulsation and stabilize requested pulsation.



Main application

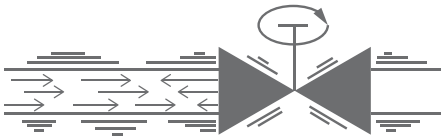
- Machine tools
- Heavy equipment(Breaker, Concrete pump car)
- Hydraulic Elevator
- Water purification system
- Power sprayer
- De-Scaling equipment



4. Application of Accumulator

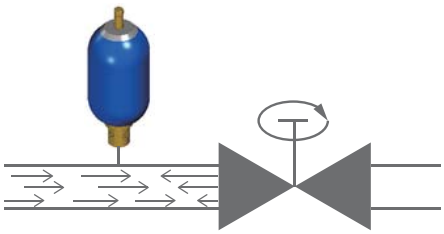
3 Surge Absorption

When rapid closure of valve or sudden load changes in hydraulic system, there is an impact pressure in pipe lines which can lead to noise or damages to pipes or internal parts. The use of accumulators can be reduce such internal shocks.



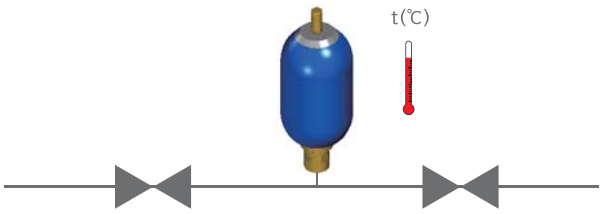
Main application

- Jet fuel injection equipment
- Water pipes
- Wastewater pumping system
- Other pipe lines



4 Thermal Expansion Compensation

Increase or decrease of the internal pressure occurs due to the temperature changes in a closed circuit. It is also one of the accumulator functions that reduce the fluctuations in the pressure.



Main application

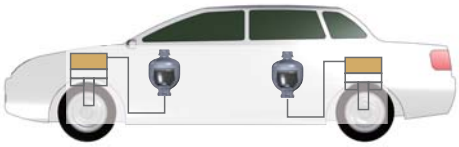
- Boilers
- Pressurized water heating system
- Fire extinguishing system
- Central heating system

5 Gas Spring

Accumulator is to be used as a gas spring that enables large load systems to be downsized.

Main application

- Vehicle suspension
- Construction equipment
- Agricultural machinery suspension
- Coal mill
- Cement mill
- Con-Crusher machine

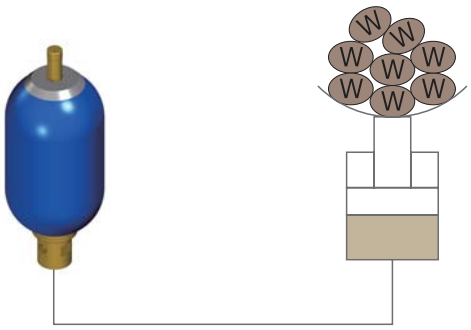


6 Equilibrium Action

Accumulators can be used as counter balances that the accumulators smoothly balance the weight or impact of products and machinery

Main application

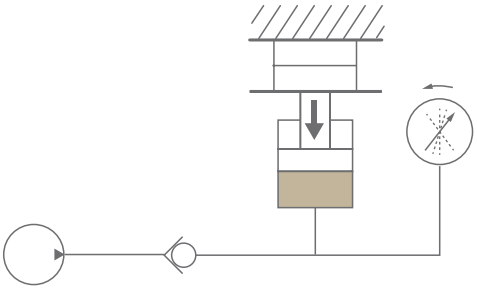
- Large crane
- Large size of machinery tools
- Large hydraulic molding machine

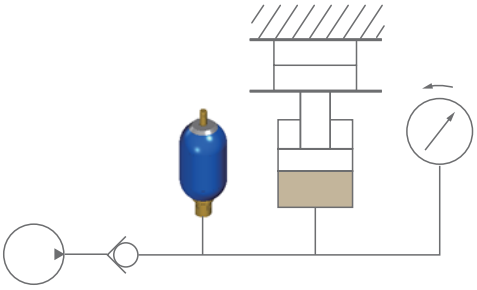


4. Application of Accumulator

7 Leak Compensation

The accumulators can be used for the compensation of any pressure decrease due to internal leakage or during maintenance work.



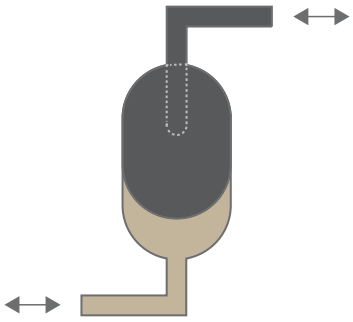


Main application

- Clamping equipment
- Other hydraulic equipment

8 Transfer Barrier

The accumulators are also used as transfer barriers that transfer different type of fluids or gases without mixing.



Main application

- Compressor lubricant supplier
- Booster
- Sealed tanks

5. Selection Procedure of Accumulator

FLOW FORCE Using the following procedure to choose the appropriate accumulator.

1 Determine the application of accumulator

Choose the application of the accumulator for its intended use.

Example of intended use	Application of Accumulator
· Instantaneous operation of hydraulic cylinders	Energy accumulation
· Reducing the power supplied to a hydraulic press	Energy accumulation
· Prevention damage on devices from pump pulsations	Pulsation dampener
· Preventing damage on pipes	Impact absorption
· Preventing damage on devices when a closed circuit at high temperature	Thermal expansion compensation
· Car, crane suspension system	Gas spring
· Small power operation of heavy object	Equilibrium action
· Preventing any loss in pressure due to leakage while pumps are under suspension	Leak compensation
· Compressing high-viscosity lubrication using hydraulic oil	Transfer Barrier

2 Calculation of the required gas volume

★ Refer to Page 73. ★

Calculate the required gas volume under the working condition.
Please refer to the calculation sheet on page 73~90 for energy accumulation, pulse absorption, impact absorption and thermal expansion compensation.
※. Please contact FLOWFORCE for the sizing program or special applications.

3 Accumulator Model Code

★ Refer to Page 18. ★

After calculating the required gas volume, please see the following specifications to select the most appropriate accumulators.

Specification & Setting	① Max. working pressure	System pressure or greater
	② Gas volume	Calculated required gas volume or greater
	③ Bladder material	Select the bladder material according to working condition
	④ Max. discharge rate	Necessary rate or greater than flow rate
	⑤ Fluids	Must comply with the fluid used
	⑥ Thread for oil port	Appropriate connectors
	⑦ Specification for gas port	Appropriate connectors

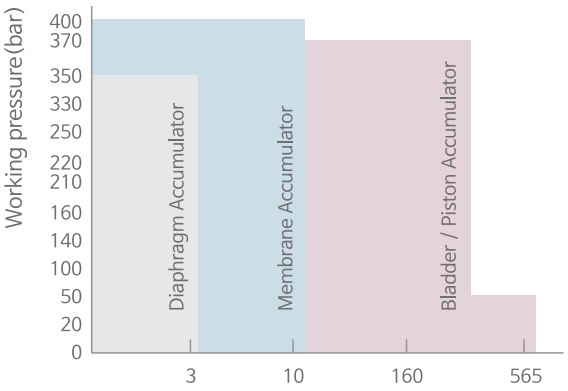
Please contact FLOWFORCE in case you need any following certifications required.

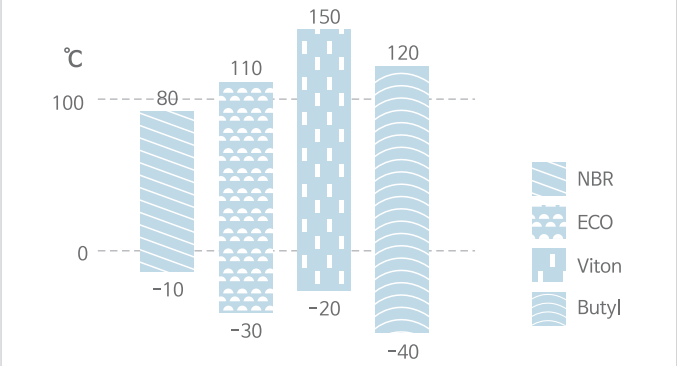
- KGS / Gas Bottle(Back-up Nitrogen Bottle for accumulators)
- SELO
- ASME
- DNV, LR, BV, GL, NK, ABS, KR, RINA, CCS

6. Accumulator Product Range

Table for Max. operating pressure compared to the capacity

Series	Volume (Liter)	Working pressure											
		50	100	160	207	210	220	250	315	330	350	375	400	690
FLM FLMS	0.075							FLM						
	0.16							FLM						
	0.2												FLMS	
	0.32					FLM		FLM						
	0.5					FLM		FLM						
	0.75			FLM		FLM		FLM			FLM			
	1					FLM								
	1.4							FLM			FLM			
	2		FLM					FLM			FLM			
	2.5												FLMS	
	2.8							FLM			FLM			
	3.5							FLM			FLM			
	4												FLMS	
	10												FLMS	
FB FT FH FF FS FP	0.2					FB					FP			
	0.5					FB					FP			
	0.75										FP			
	1						FP				FB, FP	FP		FB
	1.5										FP			
	2						FP				FP	FP		
	2.5										FB, FP			FB
	3										FP			
	4										FP			FB
	5										FP			
	6						FP				FB, FP	FP		
	10			FS	FT,FH		FP			FB, FF		FP		FB
	12									FB				
	12.5													
	20			FS	FT,FH		FP			FB, FF	FP	FP		FB
	24.5									FB, FF				
	30						FP				FP	FP		
	32			FS	FT,FH					FB, FF				FB
	37													
	40						FP				FP	FP		
	42			FS	FT,FH					FB, FF				FB
	50						FP			FB	FP	FP		FB
	57			FS	FT,FH					FB, FF				FB
FT FL FP	60						FP				FP	FP		
	63								FT					
	80						FP		FT		FP	FP		
	100	FL					FP		FT		FP	FP		
	125								FT					
	150	FL					FP				FP	FP		
	160								FT					
	180								FT					
	200	FL							FT					
	300	FL												
	350						FP				FP	FP		
	375	FL												
	475	FL												
	500	FL									FP			
	530	FL												
	575													



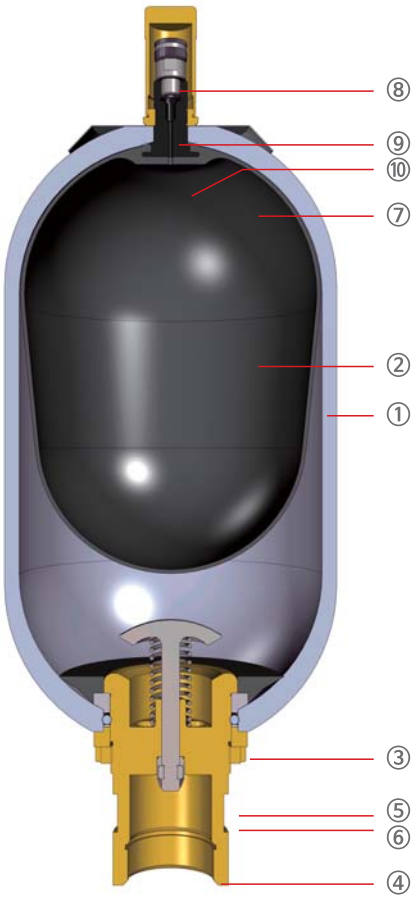


Bladder material based on working temperature

7. Specification of Bladder Type Accumulator

1 Basic Information

Type / Series	FB, FT, FL, FF, FS
Max. Working Pressure	50 / 330 / 350 / 690 bar
Volume	1~57ℓ, 200ℓ, 565ℓ
Material	Steel, Stainless Steel, Special material
Fluids	· HFC, HLP, HFD · General mineral oil · Phosphate ester · Glycogen · Water emulsion
Working temperature	-40℃ ~ +130℃
Max. flow rate	125 ~ Max.4800ℓ/min
Installation	Vertical / Horizontal
Shell	· Carbon Steel · Stainless Steel · Sand Blast · Primer Coating · Teflon / Nickel coating as an option
Oil Port / Gas Valve Size	· Carbon Steel · Stainless Steel
Fluid Port Size	· PF(Standard) · Flange(SAE) · Special Connection available
Bladder Material	· NBR · Butyl · EPDM · Viton · ECO Bladder
Certification	· PED 97/23 EC · ASME+CRN · ML China · All Class



No.	Parts	Material
1	SHELL	Carbon Steel (Option-Stainless Steel)
2	BLADDER	NBR(Standard)
3	ANTI-EXTRUSION RING	NBR(Standard)
4	FLUID PORT ASS'Y	SCM
5	FLANGE WASHER	S45C
6	LOCKING RING	S45C
7	LABEL METAL	AL
8	PROTECIVE CAP	S45C
9	GAS VALVE	SCM
10	STEM NUT	S45C

※ Above material is our standard for each part but the main parts of FSS series are stainless steel.

7. Specification of Bladder Type Accumulator

2 Ordering Model Code for All type of Bladder Accumulator

FB	N	-	330	-	2.5	-	A	-	C25	-	S6	-	1	-	T	-	BT5	-	Blank	-	01	/	SH
01	02		03		04		05		06		07		08		09		10		11		12		13

01 Series(Product type)

FB	Bottom repairable type(Standard)
FT	Top repairable type
FL	Large size type
FH	High flow type
FF	SAE Flange type
FS	Stainless steel type

02 Bladder Mix/Materials

N	Standard nitrile (Buna-n)
L	Low temperature nitrile
H	High temperature nitrile
P	Nitrile low permeability
C	Hydrin (ECO)
E	EPDM
B	Butyl
V	Viton (FKM)

03 Maximum Working Pressure

50	50bar
100	100bar
207	207bar
330	330bar
350	350bar
690	690bar

04 Nominal Volume in Gal/Liter

0.05	0.05G	0.2L
0.13	0.13G	0.13L
0.25	Quarter	1L
0.7	0.7G	2.5L
1	1G	4L
1.5	1.5G	6L
2.5	2.5G	10L
3	3G	12L
5	5G	20L
6.5	6.5G	24.5L
10	10G	32L
11	11G	42L
14	14G	50L
15	15G	57L
16	16G	63L
20	20G	80L
25	25G	100L
32	32G	125L
40	40G	160L
45	45G	180L
50	50G	200L
80	80G	300L
100	100G	375L
125	125G	475L
140	140G	530L
150	150G	575L

G=Gallon / L=Liter

05 Standard Gas Valve Adapter

Blank	Not Applied
A	1/4BSP(Standard)
B	5/16-24UNF
C	7/8-14UNF
D	M14 x 2
G	5/8-18UNF
S	Special Gas Valve, to Customer Specification
U	Back-up Bottle Usage Models

06 Gas Valve Configuration(Option)

Blank	Without(Not Applied)
C00	*With CPGI
C03	CPGI(30bar)
C05	CPGI(50bar)
C10	CPGI(100bar)
C25	CPGI(250bar)
T01	TR CAP(1/4BSP)
T02	TR CAP(5/8-18UNF)
B01	PBD(270bar)
B02	PBD(Other)
B03	Burst Disc (Setting Pressure: 315bar)
U50	UPMH Adapter
E22	Eye Bolt (Stem valve Dia: 22mm)
E50	Eye Bolt (Stem valve Dia: 50mm)

07 Material Code

(Fluid port, CPGI etc.)

Blank	Standard(Carbon steel)
S4	SUS 304(Stainless steel)
S6	SUS 316(Stainless steel)
HT	High tensile steel
LT	Low temperature steel

08 Internal Coating for Accumulator Shell

Blank	Without(Not Applied)
N	Chemically nickel-plated
E	Epoxy Paint
P	Plastic Coated
T	Teflon Coated

09 Fluid Port Configuration

Blank	Standard Specification by Series
1	NPT 2"
2	1 7/8" UNF
5	MESH M205X3
6	PF 3/4
7	R/H
8	SAE 40A 3000 PSI
9	SAE 50A 3000 PSI
10	SAE 80A

10 Fluid Port's Fittings

Blank (Not Applied)	Without	Blank (Not Applied)	Without	Blank (Not Applied)	Without
B	Bushing	M	M Thread	1	1/4"
N	Nipple	S	Split Flange	2	3/8"
S	Socket	T	PT Thread	3	1/2"
F	Flange (*Refer to page 47.)	G	PF Thread	4	3/4"
XX	Special specification separate code	N	NPT Thread	5	1"
		X	Special Specifications	6	1 1/4"
				7	1 1/2"
				8	2"
				9	2 1/2"
				A	3"
				B	4"

11 Order for Core Part's Selection

Blank	Finished Product
100	Bladder kit
200	Shell
300	Fluide port kit
400	Other

12 Approvals* According to:

Blank	No Certificated	11	CCS
01	CE(PED2014/68/EU)	12	KR
02	ASME	13	KGS
03	ABS	14	UKCA
04	DNVGL	15	ASME+CRN
06	LR	16	KHK
07	BV	17	AS1210(CE+ASME)
08	NK	18	DOSH
09	RINA	19	Dual Certificate(Specified)
10	SELO		

(FB,FF series only)

13 Max. Discharge Flow Rate

Blank	Standard(STD)
SH	1,200 ℓ /Min.
H	1500 ℓ /Min.
UH	1800 ℓ /Min.

[Note]

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

3 Order for Bladder Repair Kit

1) Select the model
: FBN 330-5A-100

2) Explanation of above selected model.

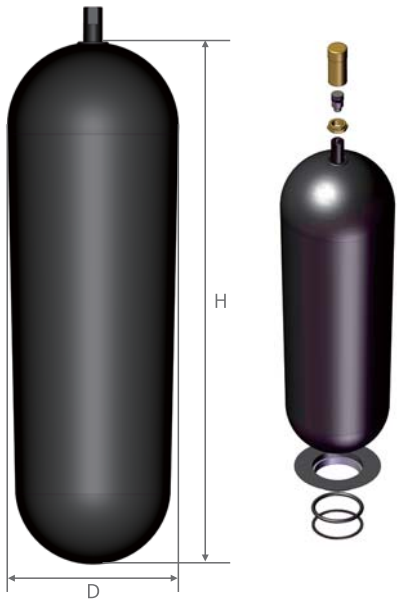
- Type : FB (Bottom Type)
- Rubber Materia : NBR
- Max. Working Pressure : 330bar
- Volume :5G/L (20Liter)
- Gas valve size : A
- Parts for Kit : 100 (Bladder Kit)

3) Part list for Bladder Repair Kit

Acc. Side	Gas Valve Parts	Body(shell)	Fluid Port Parts
Kit Component List	Protection cap, Gas valveadapter	Bladder Ass'y(Stem)	· Anti-Extrusion Ring · O-Ring & Back-up Ring

4) Bladder Standard Size

Volume (Gal/Liter)	Dimension	
	H (mm)	D (mm)
0.25 / 1	149	100
0.7 / 2.5	331	100
1 / 4	208	150
1.5 / 6	326	150
2.5 / 10	286	200
3/12	408	200
5 / 20	590	200
6.5 / 24.5	732	200
10 / 32	1114	200
11 / 42	1250	200
14 / 50	1611	200
15 / 57	1733	200

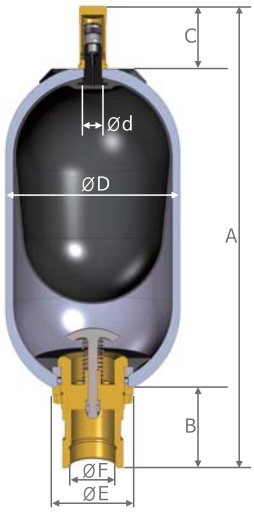


※ Please contact FLOWFORCE for above 60L accumulator.

Code	Bladder Material	Fluid	Working Temperature
N	Buna-n	Petroleum HYD Oil/Water	-15℃ ~ +85℃
L	Low Temperature Nitrile	Petroleum HYD Oil/Water	-28℃ ~ +80℃
H	High Temperature Nitrile	Petroleum HYD Oil/Water	-5℃ ~ +115℃
C	Hydrin (ECO)		-32℃ ~ +115℃
E	EPDM	Phophate Ester Baesd Oil	-40℃ ~ +120℃
B	Butyl	Phophate Ester	-15℃ ~ +120℃
V	Viton (FKM)	Phophate Ester Baesd Oil	-20℃ ~ +130℃

7. Specification of Bladder Type Accumulator

4 FB-Series(Bottom Repairable Type - Standard)



Basic Information

- Max. Working pressure : 330bar(4,800psi), 350bar(5,000psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

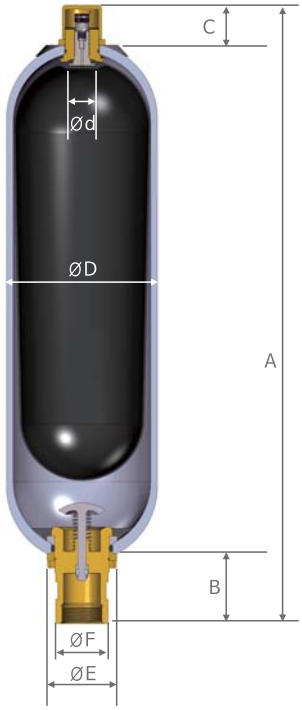
- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.

(Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

Model	Max. Working pressure Bar/psi	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm) ØDmax	Amax	B	C	Ød	ØE	ØF
FBN-210-0.05A	210/3000	0.05/0.2	95	1.6	51	284	40	47	16	26	1"1/16/12UNF
FBN-210-0.13A	210/3000	0.13/0.5	170	3.6	89	265	52	48	16	37	M27x2
FBN-350-0.25A	350/5000	0.25/1	240	5	114	328	54	79	22.5	50	PT3/4"
FBN-350-0.7A	350/000	0.7/2.5	450	10	114	548	66	79	22.5	68	G1"1/4
FBN-350-1A	350/5000	1/4	450	14	168	433	66	79	22.5	68	G1"1/4
FBN-350-1.5A	350/5000	1.5/6	450	20	168	560	66	79	22.5	68	G1"1/4
FBN-330-2.5A	330/4800	2.5/10	STD=900 SH=1200 H=1500	39	219	585	103	79	22.5	101	G2"
			UH=1800	42		620	138			125	G2 1/2
FBN-330-3A	330/4800	3/12	STD=900 SH=1200 H=1500	48	219	685	103	79	22.5	101	G2"
			UH=1800	51		720	138			125	G2 1/2
FBN-330-5A	330/4800	5/20	STD=900 SH=1200 H=1500	58	219	895	103	79	22.5	101	G2"
			UH=1800	61		930	138			125	G2 1/2
FBN-330-6.5A	330/4800	6.5/24.5	STD=900 SH=1200 H=1500	74	219	1030	103	79	22.5	101	G2"
			UH=1800	77		1065	138			125	G2 1/2
FBN-330-10A	330/4800	10/32	STD=900 SH=1200 H=1500	92	219	1420	103	79	22.5	101	G2"
			UH=1800	95		1455	138			125	G2 1/2
FBN-330-11A	330/4800	11/42	STD=900 SH=1200 H=1500	114	219	1557	103	79	22.5	101	G2"
			UH=1800	117		1592	138			125	G2 1/2
FBN-330-14A	330/4800	14/50	STD=900 SH=1200 H=1500	124	219	1943	103	79	22.5	101	G2"
			UH=1800	127		1978	138			125	G2 1/2
FBN-330-15A	330/4800	15/57	STD=900 SH=1200 H=1500	150	219	2027	103	79	22.5	101	G2"
			UH=1800	153		2062	138			125	G2 1/2

[Note] ① Tolerance of "A" is ±10mm. ② Please refer to page 45~47 for bushing and flange.

5 FB-Series(High Pressure-Bottom Repairable Type)



Basic Information

- Max. Working pressure : 690bar(10,800psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.

(Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

CE Approved

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	Amax	B	C	Ød	ØE	ØF
FBN-690-0.25A-01	690/10000	0.25 / 1	240	8	123	364	54	79	22.5	50	PT3/4"
FBN-690-0.7A-01	690/10000	0.7 / 2.5	450	13	123	551	66	79	22.5	68	G1"1/4
FBN-690-1A-01	690/10000	1 / 4	900	19	123	745	66	79	22.5	68	G1"1/4
FBN-690-2.5A-01	690/10000	2.5 / 10	900	48	245	561	103	58	51	101	G2"
FBN-690-5A-01	690/10000	5 / 20	900	83	245	871	103	58	51	101	G2"
FBN-690-10A-01	690/10000	10 / 32	900	143	245	1406	103	58	51	101	G2"
FBN-690-11A-01	690/10000	11 / 42	900	157	245	1536	103	58	51	101	G2"
FBN-690-14A-01	690/10000	14 / 50	900	199	245	1911	103	58	51	101	G2"
FBN-690-15A-01	690/10000	15 / 57	900	208	245	1991	103	58	51	101	G2"

ASME Approved

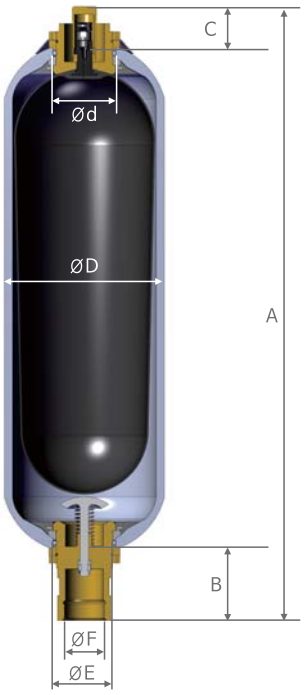
Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	Amax	B	C	Ød	ØE	ØF
FBN-690-2.5A-02	690/10000	2.5 / 10	900	80	267	580	103	58	51	101	G2"
FBN-690-5A-02	690/10000	5 / 20	900	137	267	898	103	58	51	101	G2"
FBN-690-10A-02	690/10000	10 / 32	900	231	267	1422	103	58	51	101	G2"
FBN-690-11A-02	690/10000	11 / 42	900	255	267	1558	103	58	51	101	G2"
FBN-690-14A-02	690/10000	14 / 50	900	323	267	1936	103	58	51	101	G2"
FBN-690-15A-02	690/10000	15 / 57	900	333	267	1991	103	58	51	101	G2"

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

7. Specification of Bladder Type Accumulator

6 FT-Series(Top Repairable Type)



Basic Information

- Max. Working pressure : 207bar(3,000psi), 315bar(4,500psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated / SELO Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.

(Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	A max	B	C	Ød	ØE	ØF
FTN-207-2.5A	207/3000	2.5 / 10	1080	38	228	559	103	62	89	101	G2"
FTN-207-5A	207/3000	5 / 20	1080	60	228	864	103	62	89	101	G2"
FTN-207-10A	207/3000	10 / 32	1080	97	228	1391	103	62	89	101	G2"
FTN-207-11A	207/3000	11 / 42	1080	106	228	1540	103	62	89	101	G2"
FTN-207-15A	207/3000	15 / 57	1080	138	228	1994	103	62	89	101	G2"

SELO Approved

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	A max	B	C	Ød	ØE	ØF
FTN-315-16A	315/4500	16 / 63	1800	175	351	1152	140	62	130	146	G3"
FTN-315-20A	315/4500	20 / 80	1800	206	351	1377	140	62	130	146	G3"
FTN-315-25A	315/4500	25 / 100	1800	250	351	1642	140	62	130	146	G3"
FTN-315-32A	315/4500	32 / 125	1800	304	351	1972	140	62	130	146	G3"
FTN-315-40A	315/4500	40 / 160	1800	378	351	2432	140	62	130	146	G3"
FTN-315-45A	315/4500	45 / 180	1800	420	351	2682	140	62	130	146	G3"
FTN-315-50A	315/4500	50 / 200	1800	460	351	2962	140	62	130	146	G3"

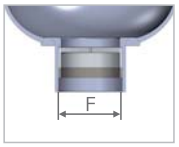
[Note]

① Tolerance of "A" is ±10mm.

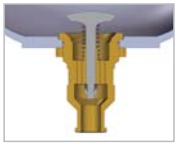
② Please refer to page 45~47 for bushing and flange.

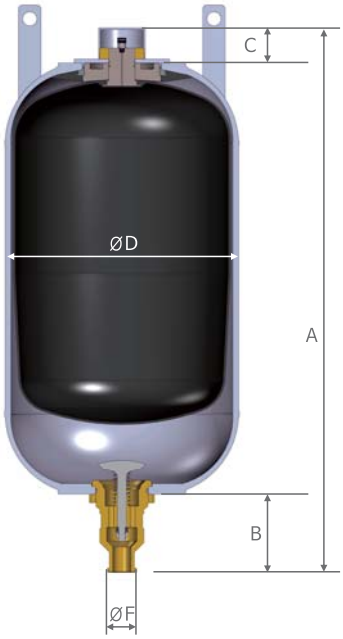
7 FL-Series(Large Volume)

MASH TYPE



SAE FLANGE TYPE





Basic Information

- Max. Working pressure : 50bar(725psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

SAE FLANGE TYPE

Model	Max. Working pressure	Volume Gal / Liter	Effective Gas Volume (Liter)	Weight (kg)	Dimension (mm)				
	Bar/psi				ØDmax	Amax	B	C	ØF
FLN-50-25A-S	50 / 725	25 / 100	93	155	577	852	192	100	SAE 50A 6000psi
FLN-50-40A-S	50 / 725	40 / 150	139	180	577	1055	192	100	SAE 50A 6000psi
FLN-50-50A-S	50 / 725	50 / 200	207	218	577	1354	192	100	SAE 50A 6000psi
FLN-50-80A-S	50 / 725	80 / 300	293	263	577	1730	192	100	SAE 50A 6000psi
FLN-50-100A-S	50 / 725	100 / 375	379	310	577	2111	192	100	SAE 50A 6000psi
FLN-50-125A-S	50 / 725	125 / 475	473	360	577	2525	192	100	SAE 50A 6000psi
FLN-50-140A-S	50 / 725	140 / 530	532	390	577	2784	192	100	SAE 50A 6000psi
FLN-50-150A-S	50 / 725	150 / 575	565	410	577	2933	192	100	SAE 50A 6000psi

MASH TYPE

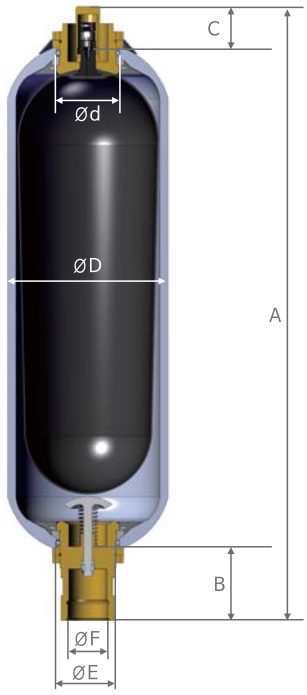
Model	Max. Working pressure	Volume Gal / Liter	Effective Gas Volume (Liter)	Weight (kg)	Dimension (mm)				
	Bar/psi				ØDmax	Amax	B	C	ØF
FLN-50-25A-M	50 / 725	25 / 100	93	165	577	805	192	100	M205x3
FLN-50-40A-M	50 / 725	40 / 150	139	190	577	1008	192	100	M205x3
FLN-50-50A-M	50 / 725	50 / 200	207	228	577	1307	192	100	M205x3
FLN-50-80A-M	50 / 725	80 / 300	293	273	577	1683	192	100	M205x3
FLN-50-100A-M	50 / 725	100 / 375	379	320	577	2064	192	100	M205x3
FLN-50-125A-M	50 / 725	125 / 475	473	370	577	2478	192	100	M205x3
FLN-50-140A-M	50 / 725	140 / 530	532	400	577	2737	192	100	M205x3
FLN-50-150A-M	50 / 725	150 / 575	565	420	577	2886	192	100	M205x3

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 45~47 for bushing and flange.

7. Specification of Bladder Type Accumulator

8 FH-Series(High Flow Type)



Basic Information

- Max. Working pressure : 207bar(3,000psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

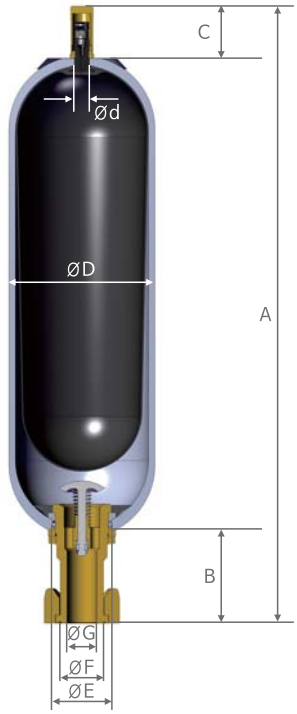
- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	A max	B	C	Ød	ØE	ØF
FHN-207-2.5A	207/3000	2.5 / 10	4800	36	228	596	140	62	89	130	M105x2
FHN-207-5A	207/3000	5 / 20	4800	56	228	901	140	62	89	130	M105x2
FHN-207-10A	207/3000	10 / 32	4800	94	228	1428	140	62	89	130	M105x2
FHN-207-11A	207/3000	11 / 42	4800	105	228	1577	140	62	89	130	M105x2
FHN-207-15A	207/3000	15 / 57	4800	138	228	2031	140	62	89	130	M105x2

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 45~47 for bushing and flange.

9 FF-Series(SAE Flange Type)



Basic Information

- Max. Working pressure : 330bar(4,800psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)
- Models that can be mounted directly on manifold block.

[Note]

- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

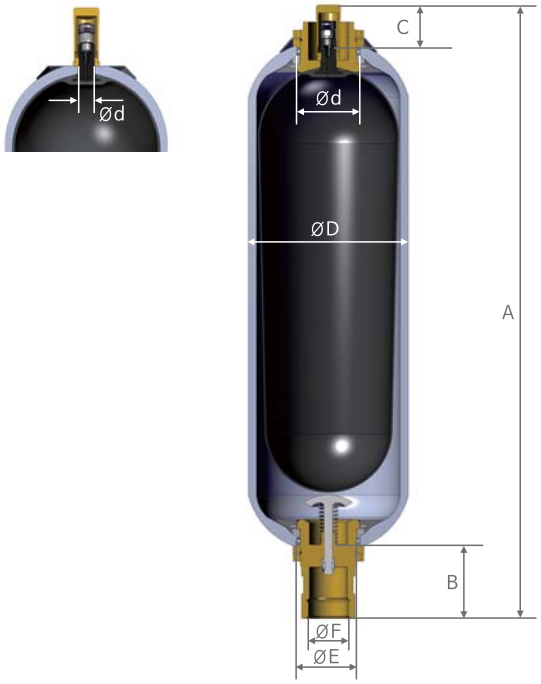
Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)							
	Bar/psi				ØDmax	A max	B	C	Ød	ØG	ØE	ØF
FFN-330-0.7A	350/5000	0.7/2.5	450	11	114	608	111	79	22.5	22	68	1"SAE 6000psi
FFN-330-1A	350/5000	1/4	450	15	168	493	110	79	22.5	22	68	1"SAE 6000psi
FFN-330-1.5A	350/5000	1.5/6	450	20	168	619	110	79	22.5	22	68	1"SAE 6000psi
FFN-330-2.5A	330/4800	2.5/10	STD=900	31	219	625	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	40						45		2"(50A)SAE 6000psi
FFN-330-3A	330/4800	3/12	STD=900	46	219	725	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	49						45		2"(50A)SAE 6000psi
FFN-330-5A	330/4800	5/20	STD=900	56	219	935	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	59						45		2"(50A)SAE 6000psi
FFN-330-6.5A	330/4800	6.5/24.5	STD=900	72	219	1070	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	75						45		2"(50A)SAE 6000psi
FFN-330-10A	330/4800	10/32	STD=900	90	219	1457	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	93						45		2"(50A)SAE 6000psi
FFN-330-11A	330/4800	11/42	STD=900	113	219	1597	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	115						45		2"(50A)SAE 6000psi
FFN-330-14A	330/4800	14/50	STD=900	122	219	1983	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	125						45		2"(50A)SAE 6000psi
FFN-330-15A	330/4800	15/57	STD=900	148	219	2067	143	79	22.5	34	101	1 1/2"SAE 6000psi
			H=1500 UH=1800	151						45		2"(50A)SAE 6000psi

[Note]

① Tolerance of "A" is ±10mm. ② Please refer to page 45~47 for bushing and flange.

7. Specification of Bladder Type Accumulator

10 FS-Series(Stainless Steel Type)



Basic Information

- Max. Working pressure : 100bar(1,500psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Stainless Steel/SUS316L
  - Fluid port : Stainless Steel/SUS316
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18, page 56~59 for more information of N_2 gas charging and control vale
- Please refer to page 19 for how to order for bladder repair kit.

(Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +130℃)

Model	Max. Working pressure	Volume Gal/ / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				ØDmax	Amax	B	C	Ød	ØE	ØF
FSN-100-2.5A	100/1500	2.5 / 10	900	39	229	562	103	62	89	101	G2"
FSN-100-5A	100/1500	5 / 20	900	61	229	873	103	62	89	101	G2"
FSN-100-10A	100/1500	10 / 32	900	99	229	1410	103	62	89	101	G2"
FSN-100-11A	100/1500	11 / 42	900	108	229	1540	103	62	89	101	G2"
FSN-100-15A	100/1500	15 / 57	900	140	229	1994	103	62	89	101	G2"

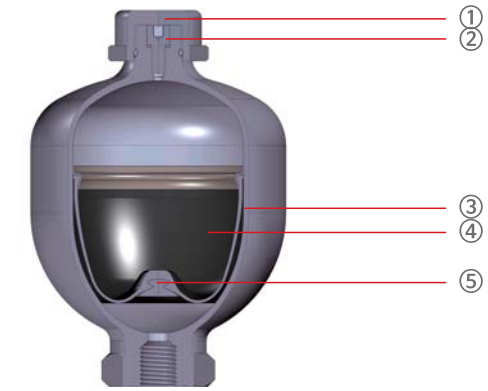
[Note]

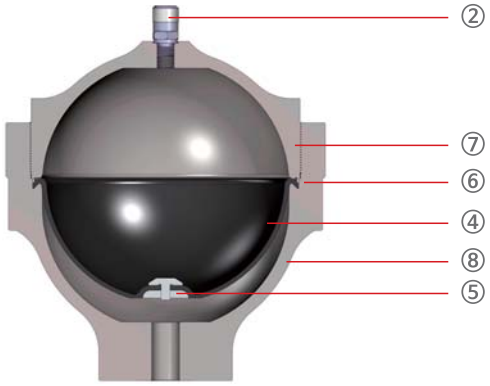
① Tolerance of "A" is ±10mm.
② Please refer to page 45~47 for bushing and flange.

8. Specification of Diaphragm/Membrane Accumulator

1 Basic information

Type/Series	FLM/FLO	FLMS
Max. Working pressure	250bar	400bar
Volume	0.07~3.5ℓ	0.2ℓ, 2.5ℓ, 4ℓ, 10ℓ
Material	Steel, Special Material	
Fluids	HFC, HLP, HFD	
Working temperature	-40℃ ~ +135℃	
Max. Flow rate	750, 1250ℓ/min	
Installation	Vertical / Horizontal / Diagonal	
Shell	· Carbon Steel · Stainless Steel	
Oil / Gas Valve	· Carbon Steel · Stainless Steel	
Fluid Port Size	· Standard(PF) · Flange(SAE) · Special Connection Option	
Diaphragm material	· NBR · Butyl · EPDM · Viton (FKM) · ECO Bladder	
Certification	· PED 97/23 EC · CRN · All Class	





No.	Part List	Material
1	Protection cap	PLASTIC
2	GAS VALVE	STEEL
3	BODY	STEEL/SCM
4	DIAPHRAGM	NBR(Standard)
5	BUTTON	PLA / AL
6	BACK-UP RING	TEFLON
7	Upper SHELL	SCM
8	Upper SHELL	SCM

8. Specification of Diaphragm/Membrane Accumulator

2 Ordering Model Code for All type of Diaphragm Accumulators

FLM	-	1.5	-	N	-	200	-	C	-	F	-	S	-	50	-	01
01		02		03		04		05		06		07		08		09

01 Type (Series)

FLM	Welding type Diaphragm Accumulator
FLMS	Threaded Membrane Accumulator
FLO	Welding type Diaphragm Accumulator (New Version)

02 Volume (Liter)

0.07	0.07Liter
0.16	0.16Liter
0.2	0.2Liter
0.32	0.32Liter
0.5	0.5Liter
0.6	0.6Liter
0.75	0.75Liter
1	1.0Liter
1.4	1.4Liter
2	2.0Liter
2.5	2.5Liter
2.8	2.8Liter
3.5	3.5Liter
4	4.0Liter
10	10Liter

03 Diaphragm Material

Blank	NBR
C	ECO
V	Viton(FPM)
B	Butyl
H	HNBR
L	IIR
E	EPDM

*See table below on page 19.

04 Max. Working Pressure

140	140bar
160	160bar
210	210bar
250	250bar
330	330bar
350	350bar
400	400bar

05 Shell Material

C	Carbon Steel
S	Stainless Steel

06 Oil Connection Type

F	Female Type
M	Male Type

*Refer to pages 29~31.

07 Air Charging Type

Blank	Welded type-Standard
S	Set Pressure Type

* Except, FLMS Accumulator

08 Charging pressure

50	50Charging at 50bar

* Charging pressure is based on the ambient temperature at 20℃

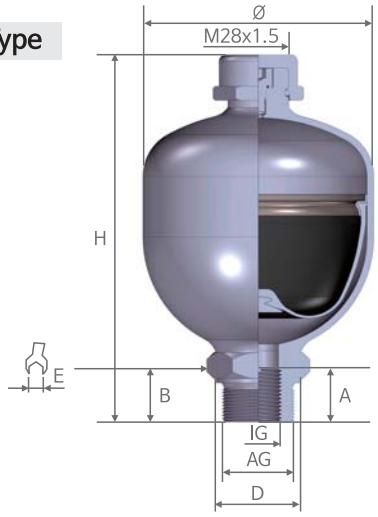
09 Class/Certification

Blank	None(Not Applied)
01	PED 2014/68/EU
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO
11	Other

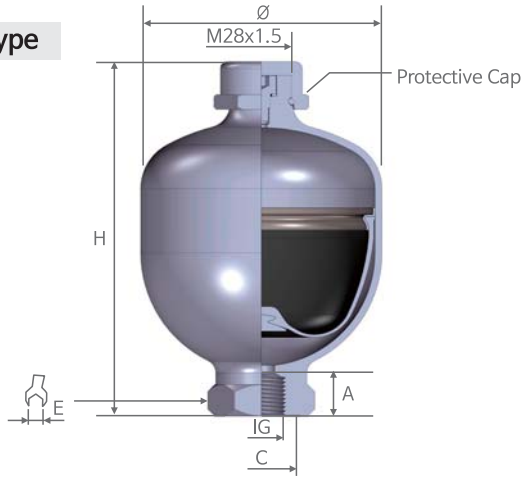
* Please cotact FLOWFORCE for the special material of diaphragm.

3 FLM-Series (Standard Type)

Male Type



Female Type

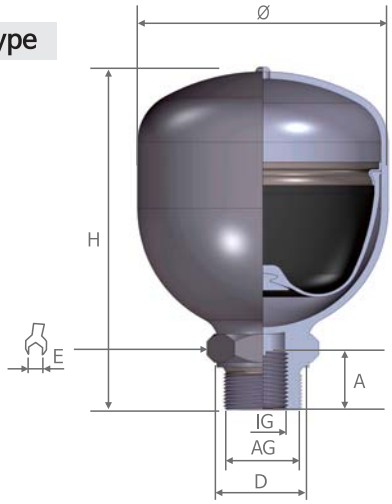


Model	Volume (ℓ)	Max. Working Pressure (bar)	Ratio (P2:P1)	A	B	C	D	E	Ø	H	Inner Thread IG	External Thread AG	Fluid Type
FLM 0.075-250-F	0.075	250	8:1	14	-	29	-	32	64	118	G1/2	-	Female
FLM 0.16-250-F	0.16	250	6:1	14	-	29	-	32	75	126	G1/2	-	Female
FLM 0.32-210-F	0.32	210	8:1	14	-	29	-	32	92	141	G1/2	-	Female
FLM 0.5-210-F	0.5	210	8:1	17	-	34	-	41	107	159	G1/2	-	Female
FLM 0.5-210-M	0.5	210	8:1	24	18	-	39	41	107	170	G1/2	M33X1.5	Male
FLM 0.75-210-F	0.75	210	8:1	17	-	34	-	41	122	173	G1/2	-	Female
FLM 0.75-210-M	0.75	210	8:1	24	18	-	39	41	122	184	G1/2	M33X1.5	Male
FLM 0.75-350-F	0.75	350	8:1	17	-	34	-	41	129	180	G1/2	-	Female
FLM 0.75-350-M	0.75	350	8:1	24	18	-	39	41	129	191	G1/2	M33X1.5	Male
FLM 1.0-210-F	1.0	210	8:1	17	-	34	-	41	136	187	G1/2	-	Female
FLM 1.0-210-M	1.0	210	8:1	24	18	-	39	41	136	198	G1/2	M33X1.5	Male
FLM 1.4-140-F	1.4	140	8:1	17	-	34	-	41	147	191	G1/2	-	Female
FLM 1.4-250-F	1.4	250	8:1	17	-	34	-	41	152	202	G1/2	-	Female
FLM 1.4-250-M	1.4	250	8:1	24	18	-	39	41	152	213	G1/2	M33X1.5	Male
FLM 1.4-350-F	1.4	350	8:1	17	-	34	-	41	156	201	G1/2	-	Female
FLM 1.4-350-M	1.4	350	8:1	24	18	-	39	41	156	212	G1/2	M33X1.5	Male
FLM 2.0-250-F	2.0	250	6:1	17	-	34	-	41	156	255	G1/2	-	Female
FLM 2.0-350-F	2.0	350	6:1	17	-	34	-	41	156	255	G3/4	-	Female
FLM 2.8-250-F	2.8	250	6:1	16	-	33	-	41	169	270	G3/4	-	Female
FLM 3.5-250-F	3.5	250	4:1	16	20	34	49	50	169	304	G3/4	-	Female

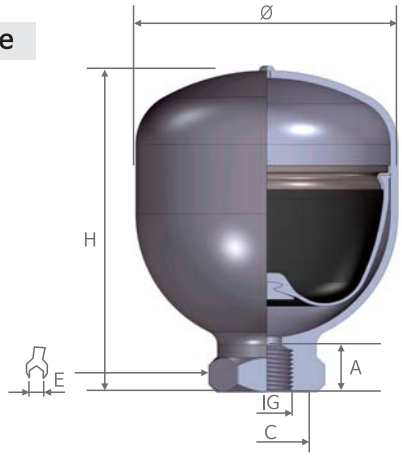
8. Specification of Diaphragm/Membrane Accumulator

4 FLM-Series (Set-Pressure Type)

Male Type



Female Type

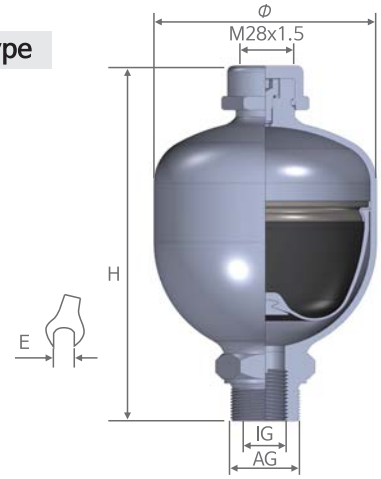


Model	Volume (ℓ)	Max. Working Pressure	Ratio (P2:P0)	Pressure Difference	A	B	C	D	E	Ø	H	Inner Thread IG	External Thread AG	Fluid Type
FLM 0.075-250-F-S	0.075	250	8:1	210	14	-	29	-	32	64	91	G1/2	-	Female
FLM 0.16-250-F-S	0.16	250	6:1	180	14	-	29	-	32	75	99.5	G1/2	-	Female
FLM 0.16-250-M-S	0.16	250	6:1	180	-	12	-	22	27	75	104.5	G1/2	M16x1.5	Male
FLM 0.32-250-F-S	0.32	250	8:1	210	14	-	29	-	32	95	120	G1/2	-	Female
FLM 0.32-250-M-S	0.32	250	8:1	210	24	18	-	39	41	95	133	G1/2	-	Male
FLM 0.5-210-F-S	0.5	210	8:1	175	17	-	34	-	41	106.7	132	G1/2	-	Female
FLM 0.5-210-M-S	0.5	210	8:1	175	24	18	-	39	41	106.7	143	G1/2	M33x1.5	Male
FLM 0.5-250-F-S	0.5	250	8:1	175	17	-	34	-	41	106.7	132	G1/2	-	Female
FLM 0.5-250-M-S	0.5	250	8:1	175	24	18	-	39	41	106.7	143	G1/2	M33x1.5	Male
FLM 0.75-210-F-S	0.75	210	8:1	155	17	-	34	-	41	121.5	146	G1/2	-	Female
FLM 0.75-210-M-S	0.75	210	8:1	155	24	18	-	39	41	121.5	157	G1/2	M33x1.5	Male
FLM 0.75-250-F-S	0.75	250	8:1	155	17	-	34	-	41	123.6	149	G1/2	-	Female
FLM 0.75-250-M-S	0.75	250	8:1	155	24	18	-	39	41	123.6	160	G1/2	M33x1.5	Male
FLM 1.0-210-F-S	1.0	210	8:1	175	17	-	34	-	41	136.2	160	G1/2	-	Female
FLM 1.0-210-M-S	1.0	210	8:1	175	24	18	-	39	41	136.2	171	G1/2	M33x1.5	Male
FLM 1.0-350-F-S	1.0	350	4:1	-	17	-	34	-	41	129	205	G1/2	-	Female
FLM 1.0-350-M-S	1.0	350	4:1	-	24	18	-	39	41	129	217	G1/2	M33X1.5	Male
FLM 1.4-140-F-S	1.4	140	8:1	-	17	-	34	-	41	147	198	G1/2	-	Female
FLM 1.4-140-M-S	1.4	140	8:1	-	24	18	-	39	41	147	209	G1/2	M33X1.5	Male
FLM 1.4-210-F-S	1.4	210	8:1	-	17	-	34	-	41	147	198	G1/2	-	Female
FLM 1.4-210-M-S	1.4	210	8:1	-	24	18	-	39	41	147	209	G1/2	M33X1.5	Male

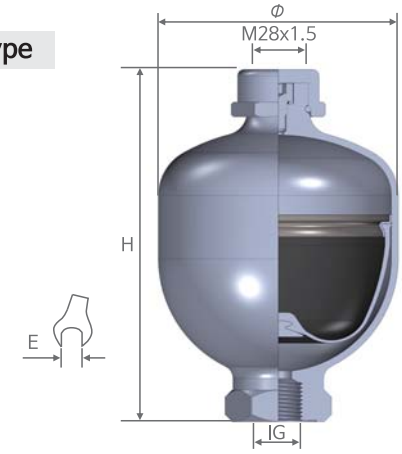
5 FLO-Series

[A Brand New Standard Version with HNBR for High Durability (Max. Working Temperature : -40 to +135℃)]

Male Type



Female Type

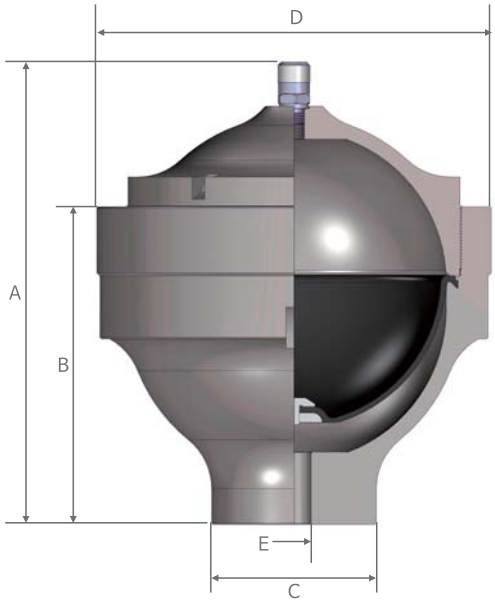


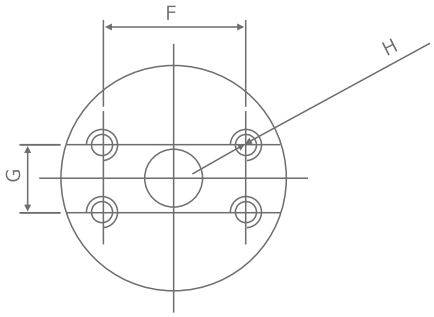
Model	Volume (ℓ)	Max. Working Pressure	Ratio (P2:P0)	(Φ)	E	H	Inner Thread IG	External Thread AG	Max. Flow rate (LPM)	Weight (kg)
FLO 0.075-H-250-C-F	0.075	250	8:1	66	32	123±2.0	G1/2		10	0.9
* FLO 0.16-H-250-C-F	0.16	250	8:1	76	32	130±2.0	G1/2			1.1
* FLO 0.32-H-250-C-F	0.32	250	8:1	95	32	149±2.0	G1/2		25	1.8
* FLO 0.5-H-210-C-F	0.5	210	8:1	103	32	155±2.0	G1/2			2
FLO 0.5-H-330-C-F	0.5	330	8:1	112	32	166±2.0	G1/2			3.2
* FLO 0.75-H-210-C-F	0.75	210	8:1	122	32	175±2.0	G1/2			3.5
FLO 0.75-H-210-C-M	0.75	210	8:1	122	41	191±2.0	G1/2	M33x1.5		3.5
FLO 0.75-H-330-C-F	0.75	330	8:1	126	32	184±2.0	G1/2			4.3
* FLO 1.0-H-210-C-F	1.0	210	8:1	136	32	185±2.0	G1/2			4.1
FLO 1.0-H-210-C-M	1.0	210	8:1	136	41	201±2.0	G1/2	M33x1.5		4.1
FLO 1.0-H-330-C-F	1.0	330	8:1	140	32	189±2.0	G1/2			5
* FLO 1.4-H-210-C-F	1.4	210	8:1	150	41	212±2.0	G1/2			5.2
FLO 1.4-H-210-C-M	1.4	210	8:1	150	41	228±2.0	G1/2	M33x1.5		5.2
FLO 1.4-H-330-C-F	1.4	330	8:1	158	41	220±2.0	G1/2			7.7
FLO 2.0-H-210-C-F	2.0	210	4:1	168	41	237±2.0	G1/2		40	8
* FLO 2.0-H-210-C-M	2.0	210	4:1	168	41	253±2.0	G1/2	M33x1.5		8
FLO 2.0-H-330-C-F	2.0	330	4:1	172	41	241±2.0	G3/4			9.4
FLO 2.5-H-250-C-F	2.5	250	4:1	172	41	258±2.0	G3/4			10
* FLO 2.8-H-250-C-F	2.8	250	4:1	172	41	278±2.0	G3/4			10.6
FLO 2.8-H-250-C-M	2.8	250	4:1	172	46	295±2.0	G3/4	M45x1.5		10.6
* FLO 3.5-H-250-C-F	3.5	250	4:1	172	41	326±2.0	G3/4			12.8

* Marks are standard products.

8. Specification of Diaphragm/Membrane Accumulator

6 FLMS-Series (Thread type)





Basic Information

- Max. Working pressure : 400bar(5,800psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page #18 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : Most of classification certifications are available
- Material
  - Shell : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Membrane accumulator(thread type) consists of upper and bottom shells that can be replaced diaphragm repair kit.
- Special thread used for high temperature and pressure.

Model	Max. Working pressure	Gas volume Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)							
	Bar/psi				A max	B	C	D	E	F	G	H
FLMS-0.2-400	400/5800	0.2	-	3.7	175	116	56	84.5	Ø12	18.2	40.5	M8x1.25
FLMS-2.5-400	400/5800	2.5	-	14	249	161	50	213.5	M33x2	-	-	-
FLMS-4.0-400	400/5800	4.0	750	22	302	202	105	251	Ø22	31.7	66.7	M14x2
FLMS-10-400	400/5800	10	1250	53	390	268	105	339	Ø28	31.7	66.7	M14x2

9. Piston Accumulator / FP Series-(1)

1 Product Overview

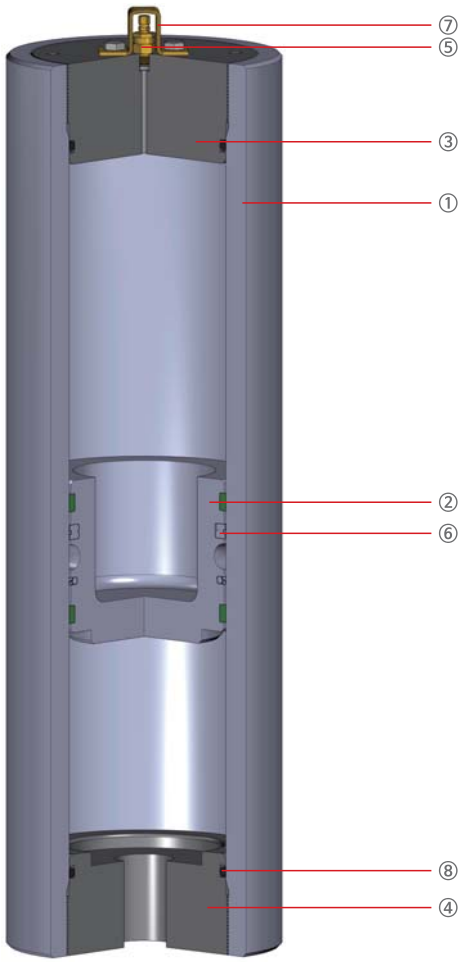
The FP series of piston accumulators are manufactured in Carbon & Stainless Steel and are available with a wide range of bore sizes to CE + ASME.
It can be used for Industrial, Marine, Oil, Mobile equipment, Gas & Energy applications (250 & 350 bar/ up to 50~420mm bore as standard) and they are also specially suitable for use in extreme climatic conditions, confined spaces and allow for careful use of resources

2 Product Features/Utilities

- Max. working pressure - 350bar(Bespoke range: up to 1500bar)
- Max. capacity - up to 500 liter(Standard)
  (Contact us for custom-made specifications)
- Economic solution utilizing back-up gas bottles for low pressure
- Maximize operating pressure ratio between pre-charge pressure and max. working pressure(9:1)
- Energy and power saving
- High flow rates possible - limitation: max. piston velocity
- Gas-tight and leakage free
- Fast and frequent cycle speeds and high flow rates
- No sudden discharge when seals are worn
- Enables monitoring of the volume across the entire piston stroke or electrical limit switch.
- Further main advantages of using the low-friction sealing design kit:

- Minimize friction and no start-up friction
- No stick-slip by based on avoidance design technology
- High piston velocity up to 5m/sec(Standard: 3m/sec)
- low noise, no vibration
- Good life expectancy of seals because of low wear
- Suitable for large operating/ambient temperature fluctuations
- Long durability design and low maintenance requirement

3 Basic Construction



Parts List(Standard)

No	Parts	Material
1	CYLINDER	Carbon Steel (SUS 선택)
2	PISTON	AL
3	GAS END CAP	SCM
4	OIL END CAP	SCM
5	GAS VALVE	SUS
6	PISTON WITH SEAL	PTFE
7	CAP	AL
8	O-RING	NBR

[Note]

① A special patterned cylinder with very finely machined internal surface.
② External O-ring sealed to the end caps on the gas side and the fluid side.
③ To use with certain aggressive or corrosive fluids, the parts coming into contact with the fluid can be nickel plated for protection, or made entirely from corrosion-resistant material.
④ A aluminum piston floating which can easily be accelerated due to its low weight.
⑤ The piston floats by two guide ring which prevent metal-to-metal contact between the piston and the inside cylinder.

9. Piston Accumulator / FP Series-(2)

4 Product Specification

Type / Series	FP
Max. Working pressure	375bar
Volume	0.1~500 liter
Material	Steel, Stainless Steel, Special material
Fluids	HFC, HLP, HFD
Working temperature	-40℃ ~ +150℃
Installation	Vertical / Horizontal
Cylinder(Shell)	· Carbon Steel · Stainless Steel · Nickel Coating(Option) · Other coatings are available
Oil / Gas Valve	· Carbon Steel · Stainless Steel
Fluid port	· PF(Standard) · Flange(SAE) · Special Connections are available.
Seal material	· NBR · Butyl · EPDM · Viton (FKM)
Certification	· PED 97/23 EC · ASME+CRN · SELO · All Class

5 Seals and Fluids, Working Temperature Ranges

Code	Seal Type	Min. Temp	Max. Temp	Fluid Classification	Fluid Type	Maximum Velocity (STD) (m/sec.)
K	"NBR (Nitrile)"	-29℃	74℃	"HFB-HFC HM-HV"	"Mineral Oils& Water Giycols"	4m/s
H	"HNBR (Hydrogenated Nitrile)"	-32℃	150℃	"HFB-HFC HM-HV"	"Mineral Oils& Water Giycols"	4m/s
E	"FPM (Fluorocarbon elastomer)"	-23℃	121℃	"HFB HM-HV"	"Synthetic Oils"	4m/s
D	"EPDM (Ethylene Peopylene)"	-40℃	121℃	HFD	"Ester Fluids"	4m/s
Q	"LT-NBR (Low Temperature Nitrile)"	-45℃	71℃	HM-HV	"Mineral Oils"	4m/s
X	"Low Friction T Seal Consult Parker ACDE"	-43℃	121℃	HM-HV	"Mineral Oils & Water Glycols"	4m/s
S	"Special Consult Parker ACDE"					4m/s

6 Maximum Flow Rates on Actual Bore Sizes

Model	MWP bar	Nominal Bore mm	Max. Recommeded Flow rate ℓ/min.
FP-315-0.1~1-50	315	50	300/380
FP-350-1~6.3-100	350	100	900/1500
FP-350-4~25-140	350	140	1800/2800
FP-350-10~50-180	350	180	3000/5100
FP-350-20~80-210	350	210	3600/5980
FP-350-40~150-250	350	250	5400/7100
FP-350-130~500-420	350	420	-/-

* 3.0/4.0 m/s.Basis

[Technical Note]

① Piston speed: 3.0 m/sec. (standard), optional up to 5.0 m/sec.
② Effective gas volume differ slightly from the nominal volume and form the basis of the calculations of the effective fluid volume.
③ The Effective fluid volume decided between the working pressure P2 and P1.
④ Standard paint specification: Black Primer (Other colors and specifications are optional)
⑤ Piston backup seal washer/bearing ring: PTFE (standard)

9. Piston Accumulator / FP Series-(3)

7 Sealing System Selection Guide

For the most suitable material selection and design of piston seal parts, it is necessary to determine the operating conditions. The correct information below should be checked, example;

- Operating Design Pressure,
- Effective Operating Pressure Difference (Max. to Minimum)
- Operating Temperature Variation Value (Max./Lowest)
- Operating Fluid
- Switching Frequency or Cycles
- Cleanliness of Fluid (Micron Rating of Filter)
- Operation & Maintenance Conditions.
- Other Requirements.

The sealing kits differ according to the type of piston used by the above conditions, each of which has its own type and arrangement of seals.

Choosing the Material

- NBR(Buna-N)
- FKM(Viton, Fluoride Rubber)
- Butyl/EPDM
- PUR (Polyurethane)
- Others on Request.

Type of Piston

(1) Standard Type

- Low Friction Resistance/High Piston Velocity
  (Max. Speed-3.5 m/sec.)

(2) On demand

- Superfast or Slow Piston Velocity
  (From 0.5 m/sec. Up to 5 m/sec.)

* Feature :

- Design structure without sticky-slip, minimum and no start-up Friction
- Good life expectancy of seals because of low wear, also suitable for low pressure differentials.

8 roduct Usage and Precautions

[Permitted Gas Velocities]

When using a piston accumulator of a type connected to a backup gas bottle, the proper flow velocities is recommended as 30m/sec. and should never exceed 50m/sec at all costs.

[Limited Oil Velocities]

In order to limit the pressure losses when the operating fluid is displaced, the flow velocity should not exceed 10m/s in the adapter cross-section.

[Safety & Gas Charging]

Hydraulic accumulators must only be charged with nitrogen(N2).
Danger of Explosion - Never use with Oxygen and other gases.
The permitted types of nitrogen are; type R (99.99% pure); type S (99.8% pure); type U (99.993% pure) ; nitrogen class 4.0, filtered to < 3 μm

[Fluid Cleanliness]

- For maximum component life, the system should be protected from contamination by effective filtration management.
- NAS 1638 - Class 6 or ISO 4406 - Class 17/15/12
- Equivalent to ISO 4572 - 25μ (β10≥75).
  (Exception for type with piston speed of 0.5 m/sec)

[Installation & Mounting]

The optimum mounting orientation is vertical however angled and horizontal mountings are permissible if thehydraulic fluid is kept clean; high levels of contaminants in the fluid can result in uneven or accelerated seal wear.

9. Piston Accumulator / FP Series-(4)

9 Optional Specification and Functional Requirements.

The FP series of piston accumulators can be used in various ways depending on the hydraulic system's application. A wide range of options are available for product, back-up gas bottle, or special installation and operation control.

- Non-standard low, high pressure
- Non-standard capacities
- Stainless steel and special materials
- Threaded (Meter/Inch) and manifold style Port
- Various material for the piston sealing system
- High flow gas port on expanded back-up bottle
- Corrosion such as mixed toxic fluids
- Standard gas valve and safety disc. (pressure and temperature detecting)
- Accumulator station & mounting System
- Piston Position and Velocity Sensors and Switches
- Nitrogen fill pressure monitor
- Extreme Temperatures
- Advanced all of countries certification.

[Fluid = Water Service]

All FP-series piston accumulators are available for use with water as the fluid medium. Modifications include plating of all working surfaces.
Please consult Flowforce for details.

[Gas Valve Adapter and Safety Fuse]

Safety fuses are available on FP Series accumulators to prevent over-pressurization of gas due to external heat or excess hydraulic pressure. They comprise a housing incorporating a disc which is calibrated to rupture at a pre-determined pressure, to be specific by the customer at the time of ordering. Please contact the sales engineering team for further information.

- Standard type:
  Core type Gas valve (Poppet type is optional)
- Optional Specification: Burst disc
- Temperature Sensitive Safety Valve (Other than fire)

[Function Review]

The piston accumulators of FP series enable the storage and release of hydraulic energy. As pressurised hydraulic fluid flows in at the oil port valve, the nitrogen within the accumulator becomes compressed.
Hydraulic energy is stored. When the pressure in the hydraulic system drops, the gas expands, causing the piston to move in the direction of the oil, forcing the liquid out from the piston accumulator into the hydraulic system. Hydraulic energy is released. During this process, the piston also serves as a separator.

[Durable Function Tests]

To be carried out to ensure continuous improvement, Flowforce is responsible for functional and fatigue testing to the Piston Accumulator series.
By subjecting the accumulators to endurance tests under realistic as well as extreme working conditions, important data can be obtained about the long term behaviour of the components. In the case of piston accumulators, important information on gas density and the life expectancy of seals is gained from such tests. In particular, working pressure and switching cycles changes which are vital data for using the capacity determination of the piston accumulator, can also be obtained.

9. Piston Accumulator / FP Series-(5)

10 Ordering Model Code for Piston Accumulators

FP	-	350	-	50	-	210	-	A	-	N	-	C	-	A8	-	A5	-	A	-	01	-	ES
01		02		03		04		05		06		07		08		09		10		11		12

01 Type (Series)

FP	Piston Type

*CE/ASME Regulation
*Refer to page 38~41.

02 Max. Working Perssure

220	220bar
350	350bar
375	375bar

03 Nominal Volume

0.1	0.1Liter
.	
.	
500	500Liter

(Fill in this capacity by referring to the technical specification table for each series on page 38-41.)

04 Bore Size(Piston Diameter)

50	50mm
60	60mm
80	80mm
100	100mm
140	140mm
150	150mm
180	180mm
200	200mm
210	210mm
250	250mm
310	310mm
420	420mm

(Please contact Flowforce separately for other ordering bore size)

05 Gas Valve Size in charging

A	1/2"-20UNF male with 5/16-32UNF
B	1/2"-20UNF male with G1/4 SUS

06 Piston Seal Kit

N	Standard Seal NBR/PTFE
S	NBR/Special material
V	Viton Material
B	Butyl Material

07 Tube Material

C	Carbon Steel(Standard)
S	Stainless Steel

08 오일 Port Size

* Refer to page 38.

09 Gas Port Size

Refer to page 38.

10 Safety Control(Gas)

Blank	Not Applied(Without)
A	Burst Disc (275bar/80℃)
B	Burst Disc (285bar/80℃)
C	Burst Disc (230bar/80℃)
D	Burst Disc (250bar/80℃)
E	Burst Disc (300bar/80℃)
F	Without Burst Disc. Plugged connection
G	Gas Safety valve
T	Temperature Fuse

11 Class/Certification

Blank	Not Applied(Without)
01	CE (2014/68/EU)
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO
11	Other

12 Monitoring of The Piston Position

Blank	Not Applied(Without)
ES	Electrical Limit Switching Device
SV	Electrical Switching Device
SV-M	Visual Monitoring(Magnet-flip-indicators)
SV-B	Analogue Switching Device
SV-GM	Visual Monitoring Bended Design(External Magnet-flip-indicators)
SV-GB	Analogue System Bended Design(External Magnet-flip-indicators)
UPS	Ultrasonic Position Sensor
KME	Electrical Measuring Cable-Sensor
ULM	Ultrasonic Length Measuring System
URM	Ultrasonic Running Time Measuring System

[Note]

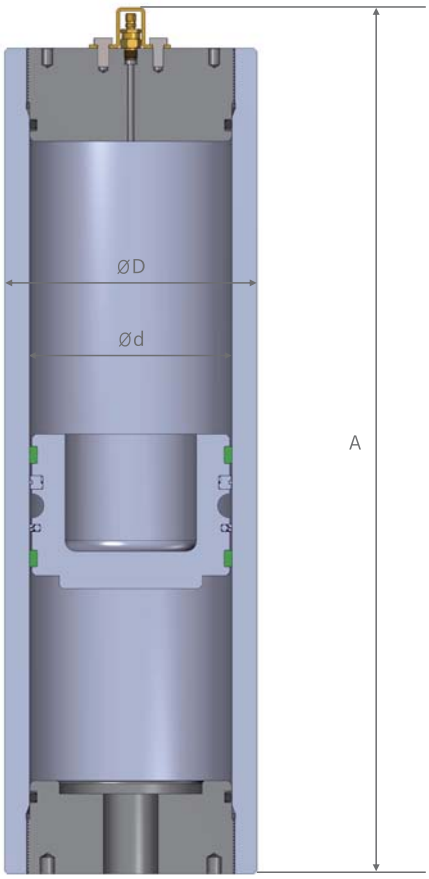
For the maximum piston velocity, refer to the product specification table for each series. And for low speed (0.8 m/s) or high speed (up to 5.0 m/s) specifications, please contact our technical sales team separately.

• Details of sensor option items for monitoring the operating position of the ⑫ piston are provided separately. Please contact the technical sales team.

9. Piston Accumulator / FP Series-(6)

12 Product Specifications/Dimensions

1-1 Based on CE Approval



Basic Information

- Max. Working pressure : 200bar(3,200psi), 375bar(5,400psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
- Cylinder Design Code : CE Approved
- Material
  - Cylinder : Carbon Steel/(Standard)
    Stainless Steel/SUS316L (Option)
  - Piston : Aluminum
  - Seal : PTFE (Polytetrafluoroethylene. Teflon)
    (Please contact FLOWFORCE for the special sealing)

[Note]

- Please contact FLOWFORCE for any other application.
- See the table below for oil port & gas port specifications.

* Oil Port / Gas Port Size

	Code	1	2	3	4	5	6	7	8	9	10	11
Thread to ISO 228-1 (G)	A	G1/8	G1/4	G3/8	G1/2	G5/8	G3/4	G7/8	G1	G1"1/4	G1"½	G2
SAE thread ISO 6162	B	1/2	3/4	1	1"1/4	1"1/2	2	2"1/2	3			
SAE connection (UN)	C	1/2-20	9/16-18	3/4-16	7/8-14	1"1/16-12	1"5/16-12	1'5/8-12	1"7/8-12	2"1/2-12		
Thread to ISO 6149-1 (M)	D	M10x1	M12x1.5	M14x1.5	M18x1.5	M22x1.5	M27x2	M33x2	M42x2	M48x2		
Combined connection	E	SAE2/G1"1/2		G1/G1/2	G1/2/G1/2	G1/2/G1/4						
NPT thread to ANSI B1.20.1	F	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1	1"1/4	1"1/2	2

9. Piston Accumulator / FP Series-(7)

12 Product Specifications/Dimensions

1-2 Based on CE Design Approval

Model	Max. Pressure (bar)	Max. Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-315-0.1-50	315	4,500	0.1	63	50	190	2.8	G3/4	1/2-20UNF
FP-315-0.16-50	315	4,500	0.16	63	50	220	3.1	G3/4	1/2-20UNF
FP-315-0.25-50	315	4,500	0.25	63	50	260	3.5	G3/4	1/2-20UNF
FP-315-0.32-50	315	4,500	0.32	63	50	300	3.8	G3/4	1/2-20UNF
FP-315-0.5-50	315	4,500	0.5	63	50	390	4.6	G3/4	1/2-20UNF
FP-315-0.75-50	315	4,500	0.75	63	50	515	5.7	G3/4	1/2-20UNF
FP-315-1-50	315	4,500	1	63	50	640	6.9	G3/4	1/2-20UNF
FP-350-1-100	350	5,000	1	121	100	306	14.5	G3/4	1/2-20UNF
FP-350-1.6-100	350	5,000	1.6	121	100	385	16.5	G3/4	1/2-20UNF
FP-350-2.5-100	350	5,000	2.5	121	100	500	19.5	G3/4	1/2-20UNF
FP-350-4-100	350	5,000	4	121	100	690	25	G3/4	1/2-20UNF
FP-350-6.3-100	350	5,000	6.3	121	100	985	34	G3/4	1/2-20UNF
FP-350-4-140	350	5,000	4	164	140	485	37	G11/4	1/2-20UNF
FP-350-6.3-140	350	5,000	6.3	164	140	635	44	G11/4	1/2-20UNF
FP-350-10-140	350	5,000	10	164	140	875	55	G11/4	1/2-20UNF
FP-350-16-140	350	5,000	16	164	140	1265	72	G11/4	1/2-20UNF
FP-350-20-140	350	5,000	20	164	140	1525	84	G11/4	1/2-20UNF
FP-350-25-140	350	5,000	25	164	140	1850	98	G11/4	1/2-20UNF
FP-350-32-140	350	5,000	32	164	140	2305	199	G11/4	1/2-20UNF
FP-350-10-180	350	5,000	10	216	180	640	89	G2	1/2-20UNF
FP-350-16-180	350	5,000	16	216	180	875	110	G2	1/2-20UNF
FP-350-20-180	350	5,000	20	216	180	1030	123	G2	1/2-20UNF
FP-350-25-180	350	5,000	25	216	180	1230	141	G2	1/2-20UNF
FP-350-32-180	350	5,000	32	216	180	1505	165	G2	1/2-20UNF
FP-350-40-180	350	5,000	40	216	180	1815	192	G2	1/2-20UNF
FP-350-50-180	350	5,000	50	216	180	2210	227	G2	1/2-20UNF
FP-350-20-210	350	5,000	20	240	210	910	130	G2	1/2-20UNF
FP-350-25-210	350	5,000	25	240	210	1055	142	G2	1/2-20UNF
FP-350-32-210	350	5,000	32	240	210	1255	159	G2	1/2-20UNF
FP-350-40-210	350	5,000	40	240	210	1490	178	G2	1/2-20UNF
FP-350-50-210	350	5,000	50	240	210	1775	202	G2	1/2-20UNF
FP-350-63-210	350	5,000	63	240	210	2150	234	G2	1/2-20UNF
FP-350-80-210	350	5,000	80	240	210	2640	274	G2	1/2-20UNF
FP-350-40-250	350	5,000	40	292	250	1170	255	G2	1/2-20UNF
FP-350-50-250	350	5,000	50	292	250	1380	285	G2	1/2-20UNF
FP-350-63-250	350	5,000	63	292	250	1640	321	G2	1/2-20UNF
FP-350-80-250	350	5,000	80	292	250	1990	371	G2	1/2-20UNF
FP-350-100-250	350	5,000	100	292	250	2390	428	G2	1/2-20UNF
FP-350-125-250	350	5,000	125	292	250	2900	500	G2	1/2-20UNF
FP-350-150-250	350	5,000	150	292	250	3405	570	G2	1/2-20UNF

9. Piston Accumulator / FP Series-(8)

12 Product Specifications/Dimensions

1-3 Based on CE Design Approval (Large Size)

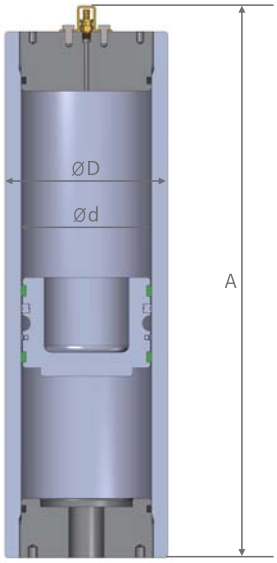
Model	Max. Pressure (bar)	Max. Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-350-100-350	350	5,000	100	400	350	1,560	630	G3	1/2-20UNF
FP-350-130-350	350	5,000	130	400	350	1,870	702	G3	1/2-20UNF
FP-350-150-350	350	5,000	150	400	350	2,080	750	G3	1/2-20UNF
FP-350-180-350	350	5,000	180	400	350	2,390	822	G3	1/2-20UNF
FP-350-200-350	350	5,000	200	400	350	2,600	870	G3	1/2-20UNF
FP-350-225-350	350	5,000	225	400	350	2,860	930	G3	1/2-20UNF
FP-350-250-350	350	5,000	250	400	350	3,120	990	G3	1/2-20UNF
FP-350-275-350	350	5,000	275	400	350	3,380	1050	G3	1/2-20UNF
FP-350-300-350	350	5,000	300	400	350	3,640	1110	G3	1/2-20UNF
FP-350-325-350	350	5,000	325	400	350	3,900	1170	G3	1/2-20UNF
FP-350-350-350	350	5,000	350	400	350	4,160	1230	G3	1/2-20UNF

Model	Max. Pressure (bar)	Max. Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-350-130-420	350	5,000	130	472	420	1,565	891	G3	1/2-20UNF
FP-350-150-420	350	5,000	150	472	420	1,710	933	G3	1/2-20UNF
FP-350-200-420	350	5,000	200	472	420	2,070	1036	G3	1/2-20UNF
FP-350-250-420	350	5,000	250	472	420	2,430	1139	G3	1/2-20UNF
FP-350-275-420	350	5,000	275	472	420	2,600	1188	G3	1/2-20UNF
FP-350-300-420	350	5,000	300	472	420	2,790	1242	G3	1/2-20UNF
FP-350-350-420	350	5,000	350	472	420	3,150	1345	G3	1/2-20UNF
FP-350-390-420	350	5,000	390	472	420	3,510	1448	G3	1/2-20UNF
FP-350-400-420	350	5,000	400	472	420	3,510	1448	G3	1/2-20UNF
FP-350-450-420	350	5,000	450	472	420	3,870	1551	G3	1/2-20UNF
FP-350-500-420	350	5,000	500	472	420	4,230	1654	G3	1/2-20UNF

9. Piston Accumulator / FP Series-(9)

13 Product Specifications/Dimensions

1-1 Based on ASME Approval



Basic Information

- Max. Working pressure : 200bar(3,200psi), 375bar(5,400psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
- Speed of Piston : 3.0m/sec(Standard)
- Cylinder Design Code : CE Approved
- Material
  - Cylinder : Carbon Steel/(Standard)
    Stainless Steel/SUS316L (Option)
  - Piston : Aluminum
  - Seal : PTFE (Polytetrafluoroethylene. Teflon)
    (Please contact FLOWFORCE for the special sealing)

[Note]

- Please contact FLOWFORCE for any other application.
- See the table below on page 38 for oil port & gas port specifications.

Model	Max. Pressure (bar)	Max. Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-010-207-A-A-02	220	3200	10	207	180	720	93	G3/4	1/4
FP-375-010-217-A-A-02	375	5400	10	217	180	755	121	G3/4	1/4
FP-220-020-207-A-A-02	220	3200	20	207	180	1115	119	G1	1/4
FP-375-020-217-A-A-02	375	5400	20	217	180	1145	157	G1	1/4
FP-220-030-207-A-A-02	220	3200	30	207	180	1510	144	G1	1/4
FP-375-030-217-A-A-02	375	5400	30	217	180	1540	193	G1	1/4
FP-220-040-207-A-A-02	220	3200	40	207	180	1900	169	G1	1/4
FP-375-040-217-A-A-02	375	5400	40	217	180	1930	228	G1	1/4

1-2 Based on ASME Approval (AP Series)

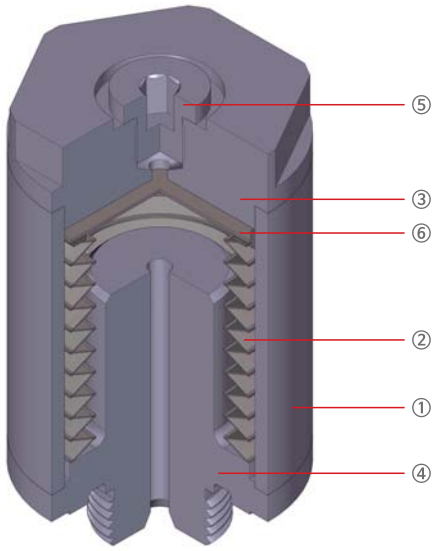
Model	Max. Pressure (bar)	Max. Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-050-207-A-A-02	220	3200	50	207	180	2295	195	G1	1/4
FP-375-050-217-A-A-02	375	5400	50	217	180	2325	264	G1	1/4
FP-220-060-207-A-A-02	220	3200	60	207	180	2690	220	G1"½	1/4
FP-375-060-217-A-A-02	375	5400	60	217	180	2720	300	G1"1/2	1/4
FP-220-080-207-A-A-02	220	3200	80	207	180	3475	271	G1"1/2	1/4
FP-375-080-217-A-A-02	375	5400	80	217	180	3505	371	G1"1/2	1/4
FP-220-100-230-A-A-02	220	3200	100	230	200	3525	338	G1"1/2	1/4
FP-350-100-240-A-A-02	350	5100	100	240	200	3585	462	G1"1/2	1/4
FP-220-150-290-A-A-02	220	3200	150	290	250	3475	618	G1"1/2	1/4
FP-350-150-310-A-A-02	350	5100	150	310	250	3525	918	G1"1/2	1/4
FP-220-350-360-A-A-02	220	3200	350	360	310	5200	1306	G1"1/2	1/4
FP-350-350-370-A-A-02	350	5100	350	370	310	5290	1556	G1"1/2	1/4

Specification of Bellows Accumulator

1 Basic Information

Type / Series	FBL
Max. Working pressure	50bar
Volume	0.043 ℓ (Other capacities can also be custom-made.)
Material	Steel, Stainless Steel, Special material available
Fluids	HFC, HLP, HFD
Working temperature	−65℃ ~ +160℃
Installation	Vertical / Horizontal
Shell (Body)	· Carbon Steel · Stainless Steel
Oil / Gas Valve	· Carbon Steel · Stainless Steel
Fluid Port	· PF(Standard) · Flange(SAE) · Special Connections available
Seal material	· NBR · EPDM · Butyl · Viton (FKM)
Certification	· PED 97/23 EC · SELO · All Class

* Customized orders are available.



No.	Part list	Material
1	SHELL	STAINLESS STEEL
2	BELLOWS(SPRING)	STAINLESS STEEL
3	FILLING FLANGE	STAINLESS STEEL
4	FLUID PORT FLANGE	STAINLESS STEEL
5	GAS CAP	STAINLESS STEEL
6	SEAL	-

10. Specification of Bellows Accumulator

2 Ordering code for Bellows Accumulator

FBL	-	0.043	-	A	-	1	-	C	-	M	-	1	-	01
01		02		03		04		05		06		07		08

01 Type (Series)

FBL	Metal Bellows Type

*Refer to page 41.

02 Volume(Liter)

0.043	0.043 Liter

(기타 용량은 맞춤형 주문 제작 표기)

03 Thread Type

A	Screw Type
B	Weld Type

*Refer to page 29.

04 Oil Port Size

1	M20X1.5
2	Others (mark)

05 Gas Valve Size in charging

C	1/4'BSP(Standard)
B	5/16"

06 Oil Port Size

C	Car1/4'BSP(Standard)
B	5/16"
M	M20x1.5

07 Seal Material

1	NBR
2	Low temperature NBR
3	Viton (FKM)

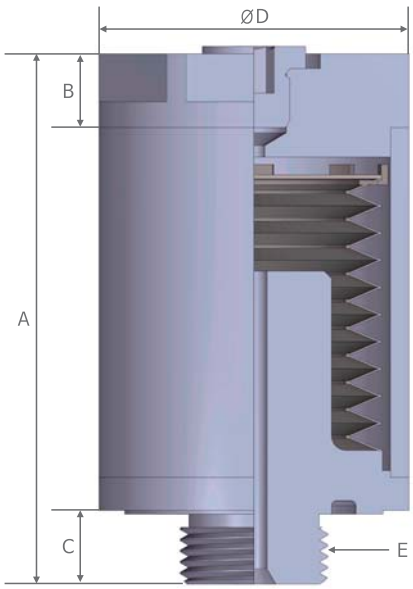
08 Class/Certification

Blank	NONE
01	CE(97/23/EC)
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO

10. Specification of Bellows Accumulator

3 FBL-Series

This FBL Series is 100% custom-made Product and please contact (FLOWFORCE before placing the order.)



Summary

Metal Bellows Element is specially designed to separate N_2 gas and fluid from the accumulator.

Basic Information

- Working pressure : 16bar(Standard)
  (Max. Working pressure up to 210bar as per customer request)
- Working temperature : -65℃ ~ +160℃(-85℉ ~ +320℉)
- Zero pressure loss for N_2 gas
- Maintenance - Free type
- Basically same function and feature with other types(Bladder, Piston, Diaphragm) of accumulator

Summary

- Energy accumulation / Thermal expansion compensation
- Pulse absorption
  (Vessel Diesel Engine, Mobile Suspension / Transmission, Wind mill, Aircraft, Chemical plant, etc)

Basic structure

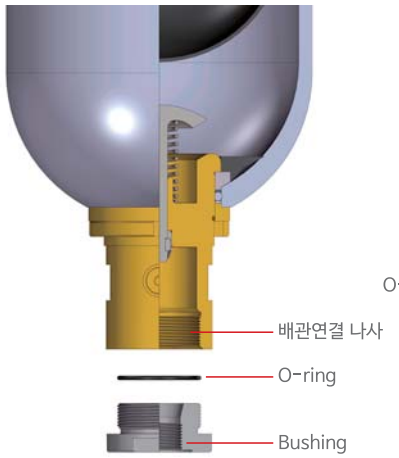
Pressure	Low pressure	High pressure
Type	Standard type(Formed)	Welded type(Bellow)
Feature	· Pulse absorption · Resistance to contamination	· Good to be used for energy accumulation and discharge a large volume
Photo		

Model	Max.Working Pressure	Gas volume cc / Liter	Weight (kg)	Dimension (mm)				
	bar/psi			ØDmax	Amax	B	C	ØE
FBL-16-0.043	16 / 232	43 / 0.043	5	42	72	6.5	9.5	M20 X 1.5

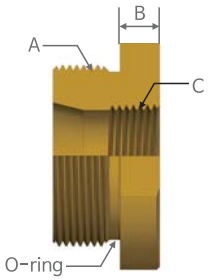
11. Bushing & Flange

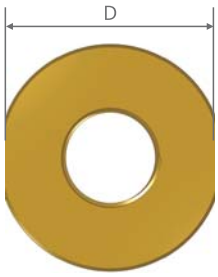
1 Bushing

Bushing

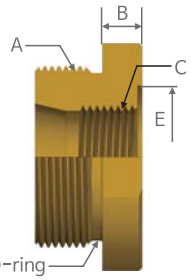


PT-Type





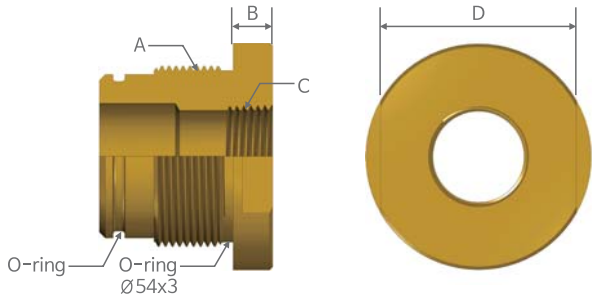
PF-Type



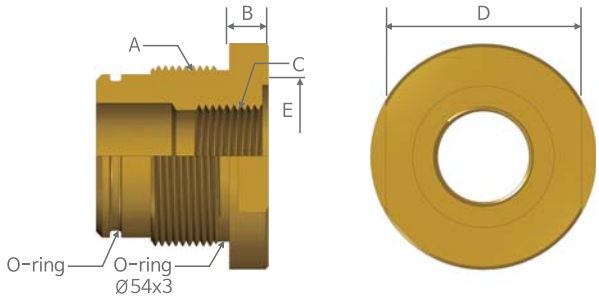
Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B01	2.5~6L (G"1/4)	Ø36.2X3.0	G1"1/4	15	PT1"	50	-
B02			G1"1/4	15	PT3/4	50	-
B03			G1"1/4	15	PT1/2	50	-
B04			G1"1/4	15	PT3/8	50	-
B05			G1"1/4	28	PF1"	50	44
B06			G1"1/4	15	PF3/4	50	42
B07			G1"1/4	15	PF1/2	50	34
B08			G1"1/4	15	PF3/8	50	28
B09	10~57L (G2")	Ø54.0X3.0	G2"	15	PT1"	70	-
B10			G2"	15	PT3/4	70	-
B11			G2"	15	PT1/2	70	-
B12			G2"	15	PT3/8	70	-
B13			G2"	15	PF1"	70	47
B14			G2"	15	PF3/4	70	42
B15			G2"	15	PF1/2	70	34
B16			G2"	15	PF3/8	70	28

11. Bushing & Flange

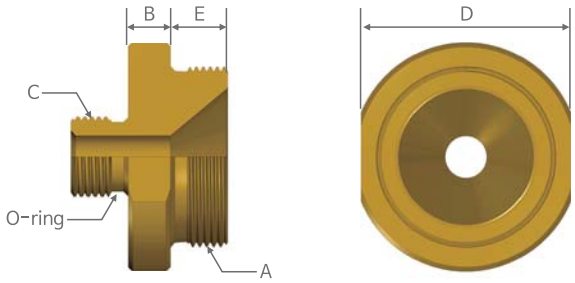
PT-Type



PF-Type



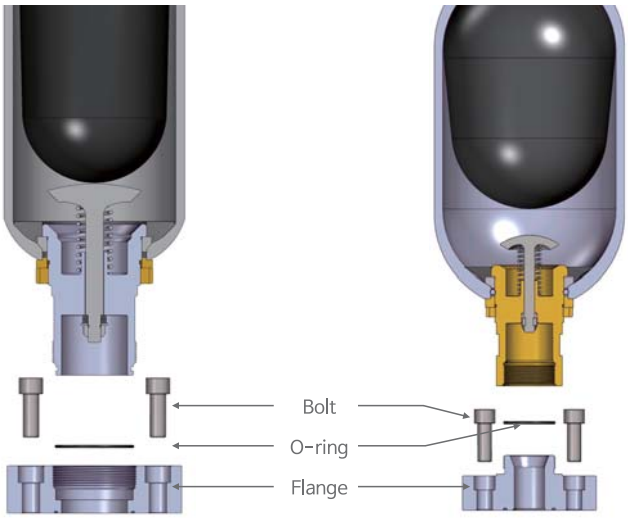
Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B17	10~57L (G2")	O-RING : Ø43.82X5.33 Back-up Ring : 45X54X0.85	G2"	13	PT1"	70	-
B18			G2"	13	PT3/4	70	-
B19			G2"	13	PT1/2	70	-
B20			G2"	13	PT3/8	70	-
B21			G2"	13	PF1"	70	47
B22			G2"	13	PF3/4	70	42
B23			G2"	13	PF1/2	70	34
B24			G2"	13	PF3/8	70	28



Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B25	2.5~6L	Ø36.2x3.0	G1"1/4	15	PF1/2"	52	20
B26	2.5~6L	Ø36.2x3.0	G1"1/4	15	PF3/4"	52	20
B27	10~57L	Ø54.0x3.0	G2"	15	PF3/4"	52	20
B28	10~57L	Ø54.0x3.0	G2"	15	PF1"1/4	52	20

11. Bushing & Flange

2 Flange



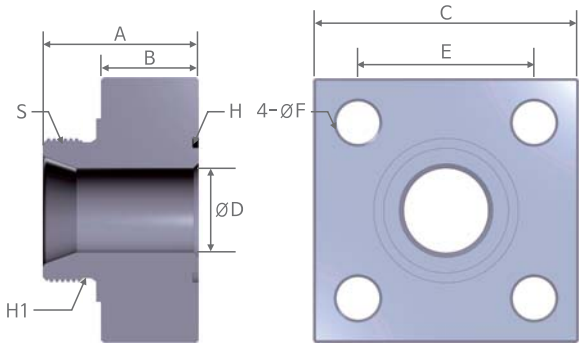


Fig 1

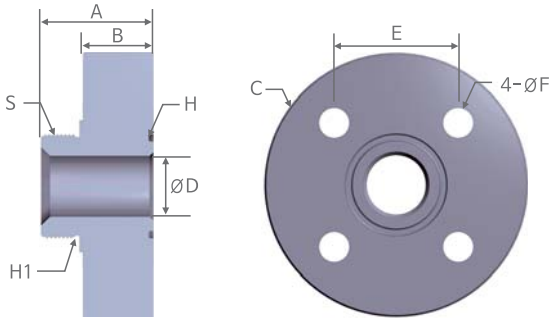


Fig 2

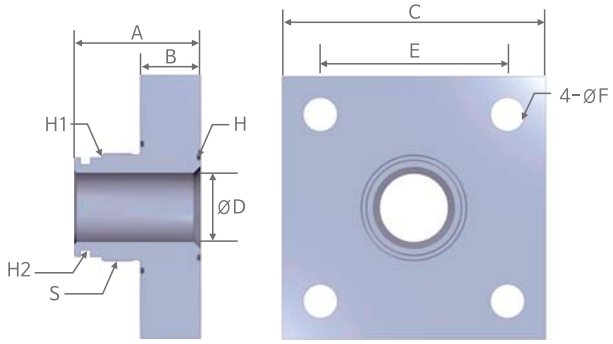


Fig 3

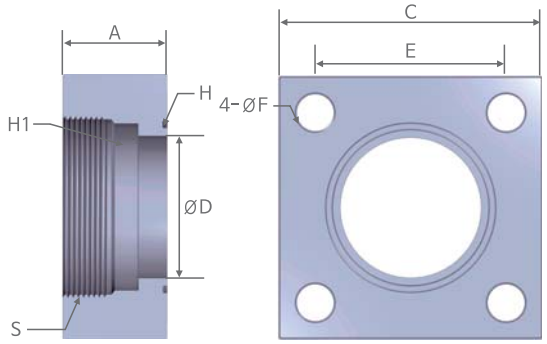


Fig 4

Code	Volume Category	Figure	Dimension (mm)						O-Ring Size			Thread size
			A	B	C	D	E	F	H	H1	H2	S
F01	4L~6L	Fig1	64	40	110	29	73	18	G55	G95		G1"1/4
F02	10~57L	Fig1	64	40	110	35	73	18	G55			G2"
F03		Fig2	64	40	155	35	73	18	G55			G2"
F04		Fig3	40	45	200	52	142	32	G75		P65	M82x3.0
F05		Fig4	50	-	155	82	112	22	G90		-	M105x2.0
F06	63~200L	Fig3	95	45	200	66	142	32	G75	G100	P70	G3"

12. Safety & Shut-off Block(1)

1 FSV/FSAF Series

General Description/Specification

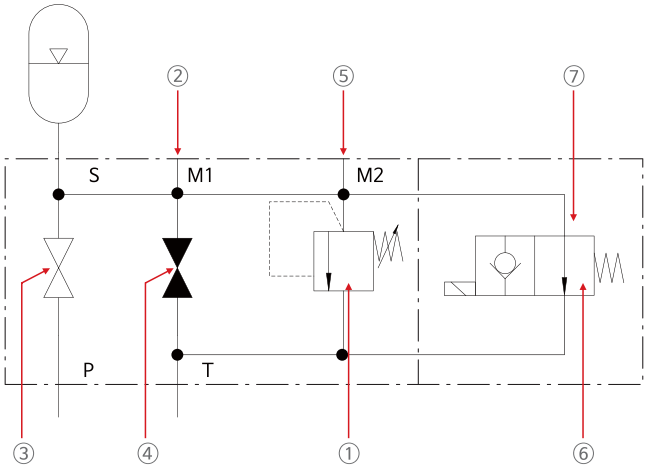
FSAF Safety & Shut-off Block is used between accumulator and hydraulic system to control oil break of accumulator, over pressure protection and oil release. It is mainly composed of a main stop valve, a built-in overflow valve and a manual pressure relief valve. The valve block with electromagnetic reversing valve is used for automatic unloading of hydraulic system and accumulator.

- Max. operating pressure
  - 360/400 bar
- Materials
  - Body : Carbon Steel.
  - Sealing : NBR - Standard(FKM, EPDM as option)
- Operating fluids
  - Mineral oil to DIN 51524 Part 1 and Part 2(other fluids on request)
- Viscosity range
  - Min. 10 mm^2/s ~ Max. 380 mm^2/s
- Filtration
  - Max. permitted contamination level of the operating fluid to ISO 4406 Class 21/19/16 or SAE AS 4059 Class 11.
  - Filter with a minimum retention rate of β 20 ≥ 100.
- Permitted operating temperature
  - 10 ˚C ... +80 ˚C (ambient temperature on E version limited to -10 ˚C ... +60 ˚C)
- Electric data
  (Model with solenoid-operated pressure release)
  - DC : 24V, AC : 110V or 230V-50/60Hz.
  - Type of current
    DC solenoid
    When connected to AC voltage, the necessary DC voltage is produced by means of a bridge rectifier connector.
    voltage tolerance : ± 15 % of the nominal voltage
  - Nominal current
    Dependent on the nominal voltage
    24 V DC 0.80 A
    230 V AC 0.11 A
  - Power consumption
    p20 = 18 W
    DUTY: Continuous
  - Switching time
    Depending on symbol, pressure across the individual ports and flow rate:
    on: 50 ms/off: 35 ms
    on: 35 ms/off: 50 ms

Product benefits

· Minimum of space and maintenance and installation required. As all the individual units are combined in one block, considerably fewer pipe fittings are necessary for installation.
· Considerable reduction in installation time.
· All types of connections for various accumulator designs and manufacturers are available - imperial and metric connections as well as manifold mounted and weld nipple
· Additional valves such as pilot-operated check valves, flow control valves and combined flow control and check valves can be fitted to the system connection P

Key to the circuit diagram



Name of each parts

① Safety valve to prevent excessive pressure to PED 97/23/EC
② Pressure gauge
③ Shut-off valve
④ Pressure release valve
⑤ Connection for test gauge
⑥ Solenoid-operated pressure release valve
⑦ Throttle

Ports

The safety and shut-off block has the following ports:
S - Accumulator port
P - Inline port
connects SAF to the system (pump)
T - Tank port

[Note] The connection to the tank must be piped separately.
This will ensure that when the pressure relief valve opens, flow can drain unpressurised to tank.

M1	- Test gauge port	G 1/2-ISO 228(G 1/4 at SAF 10)
M2	- Gauge connection	G 1/4-ISO 228

12. Safety & Shut-off Block(2)

2 FSAF Series(1)

Ordering Model Code for a Safety & Shut-off Block

FSAF	-	20	-	M	-	1	-	2	-	Y	-	1	-	N	-	210	-	A	-	S13
01		02		03		04		05		06		07		08		09		10		11

01 Safety and shut off block
FSAF Series

02 Size of main shut-off valve
10mm, 20mm, 32mm

03 Type of discharge(Unloading way)

M	manual discharge
E	solenoid-operated and manual discharge

04 Block material

1	Carbon steel(Standard)
	Other materials on request.

05 Material of seals (elastomer)

2	NBR(Perbunan)
5	EPDM
6	FKM(Viton)
7	Others

06 Type of Solenoid valve acting (Directional poppet valve)

Y	open when de-energised (Unloading)
Z	closed when de-energised (Unloading)

07 Type of voltage (directional poppet valve)

1	24V DC
2	115V AC
3	230V AC
7	Others

08 Pressure relief valve

T	pressure-set and lead-sealed by inspector
N	pressure-set adjustable by wrench

09 Pressure setting value
e.g. 210 bar
(adjustable up to 315bar)

10 Standard threaded connection to

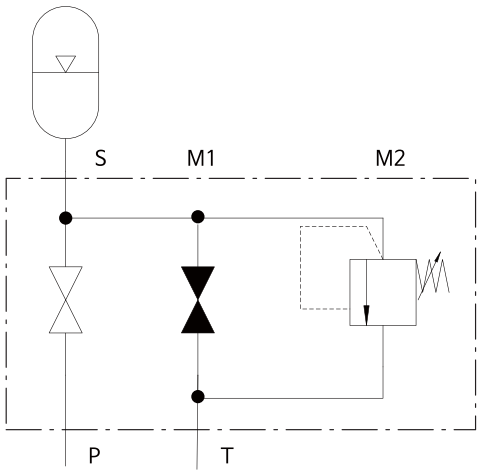
A	ISO 228(BSP)

11 Adapter to accumulator
e.g. such as B27 or F02

(see page 45 to 47)

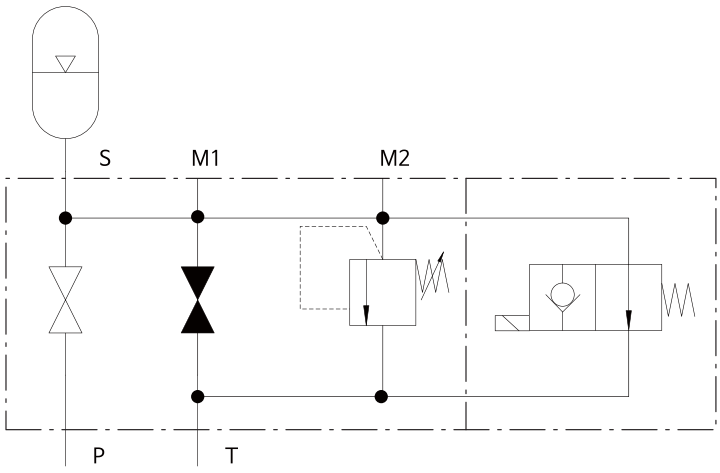
Circuit Diagram for Standard Types

Model with manually operated pressure release valve



Type of discharge/Unloading way : M version
- Sizes : FSAF10M, FSAF20M, FSAF32M

Model with solenoid-operated pressure release



Type of discharge/Unloading way : E version
Sizes : FSAF10E, FSAF20E, FSAF32E

12. Safety & Shut-off Block(2)

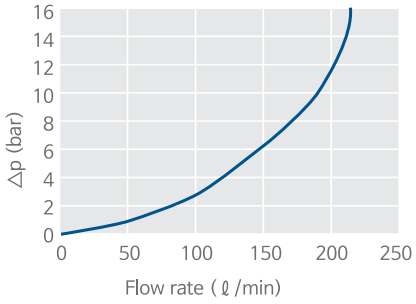
3 FSAF Series (2)

GRAPHS FOR FSAF(△P-Q)

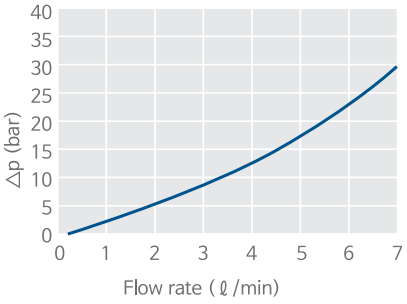
* Measured at: ν = 32 mm²/s, t oil = 40 °C, Operating pressure = 360 bar with pressure relief valve

Flow from the pump ▼ Accumulator	Flow from the accumulator ▼ Solenoid-operated release valve ▼ Tank	Flow from the accumulator ▼ Release valve ▼ Tank

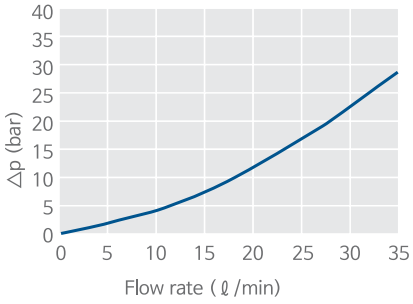
FSAF10M/E



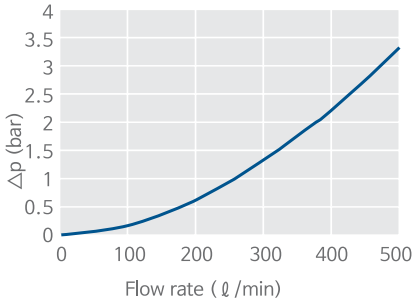
FSAF10E



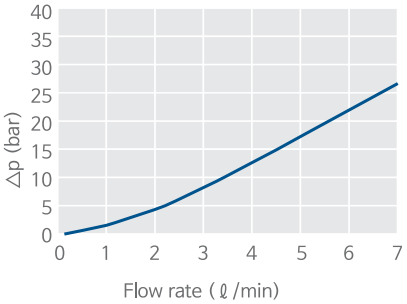
FSAF10M/E



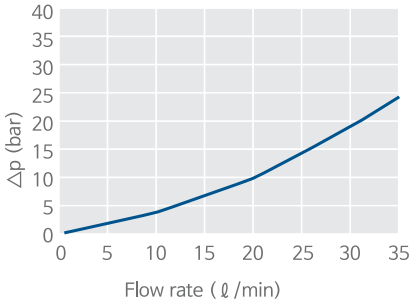
FSAF20M/E



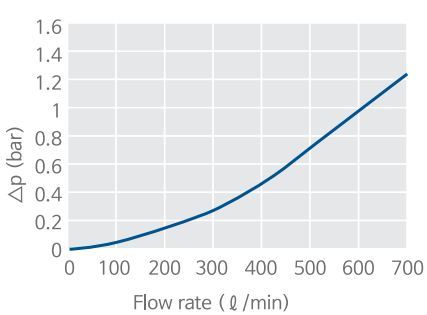
FSAF20E



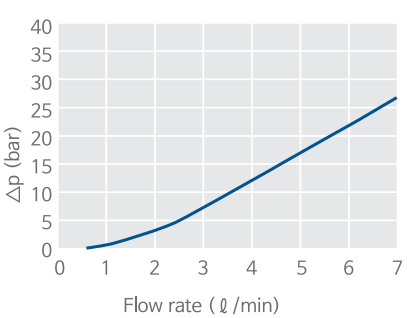
FSAF20M/E



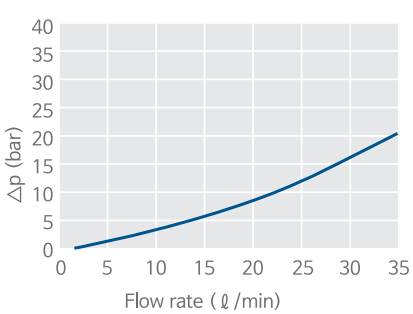
FSAF32M/E



FSAF32E



FSAF32M/E

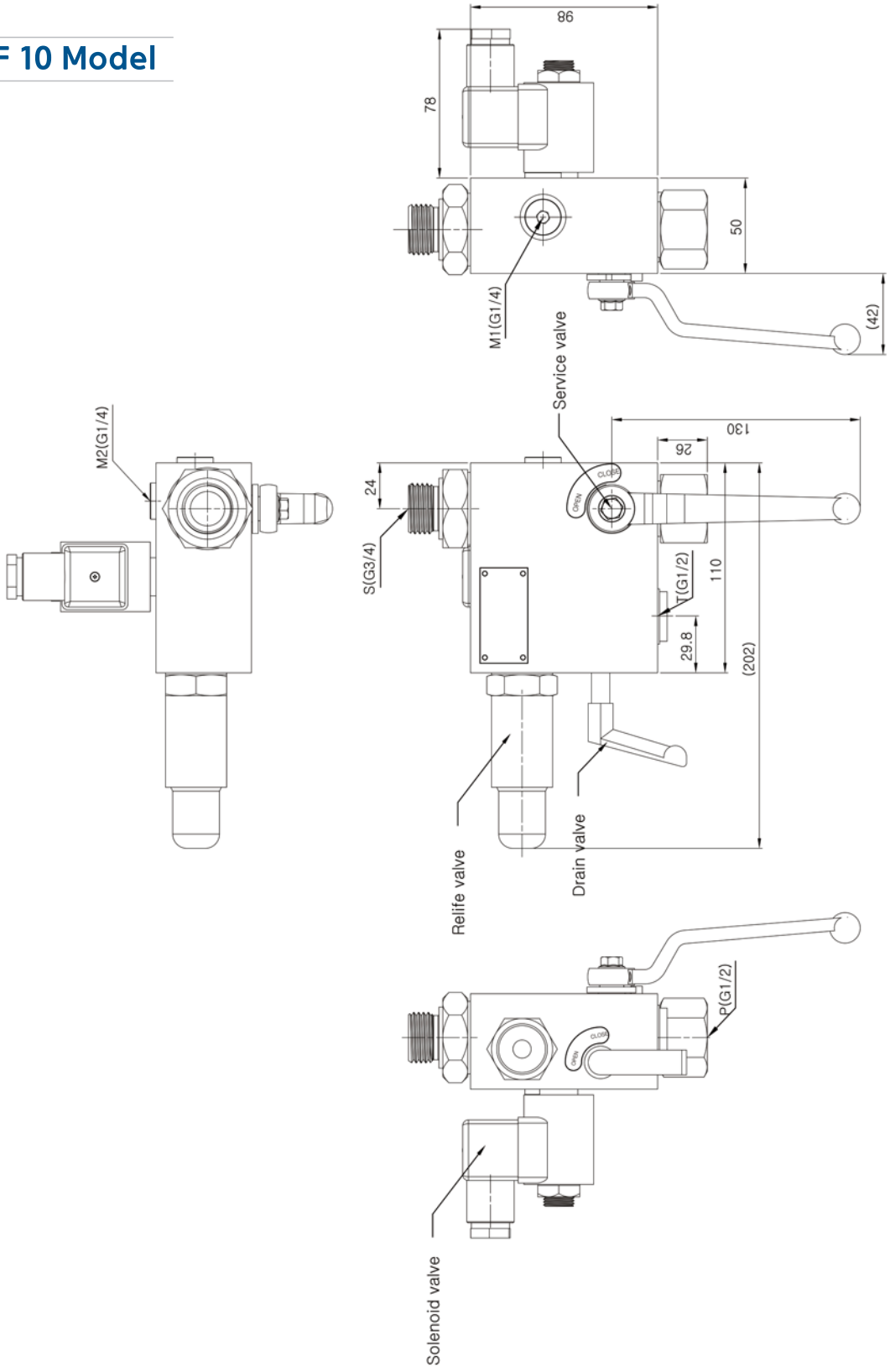


12. Safety & Shut-off Block(2)

4 FSAF Series (3)

The Exterior Demensions

FSAF 10 Model

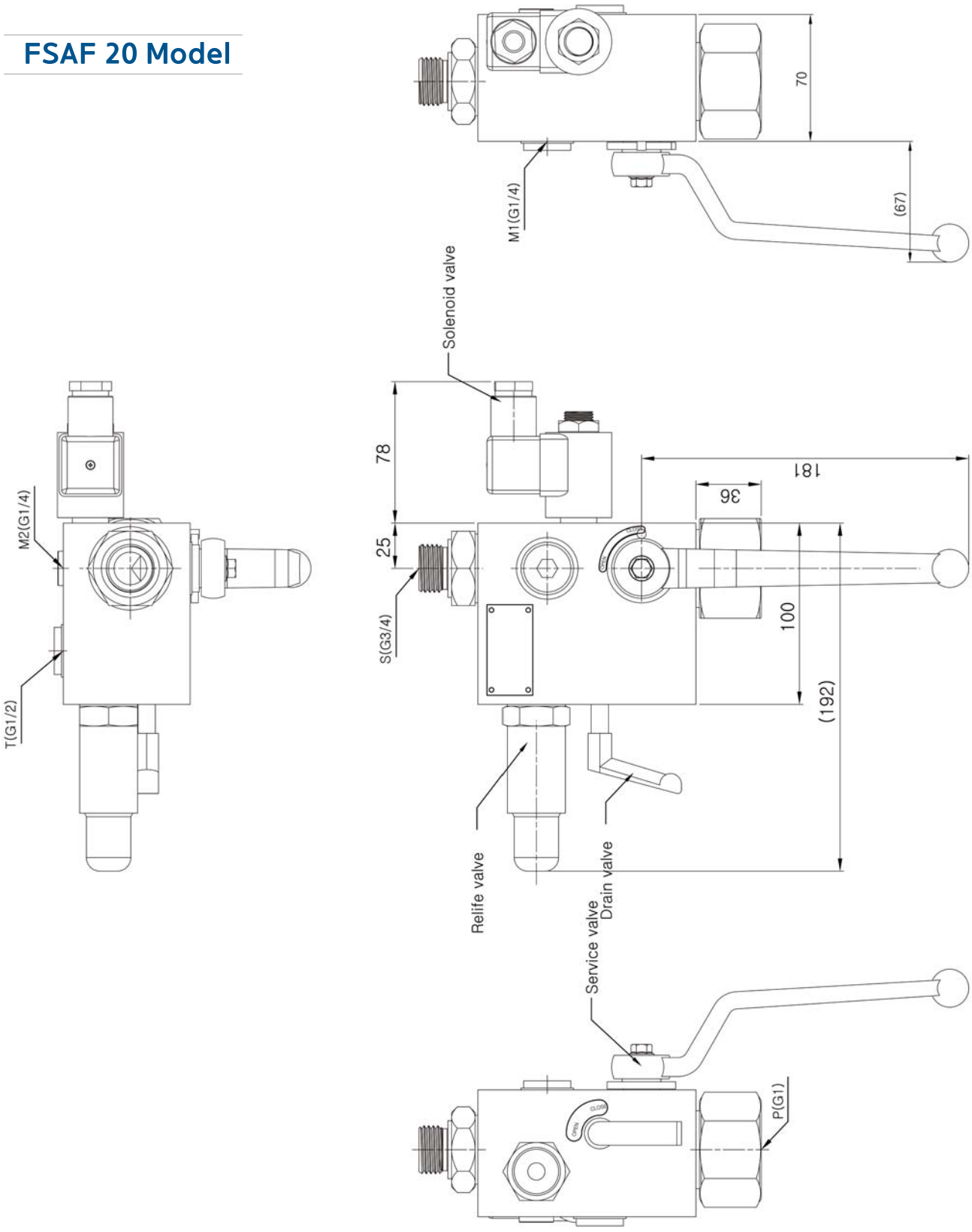


12. Safety & Shut-off Block(2)

4 FSAF Series (4)

The Exterior Demensions

FSAF 20 Model

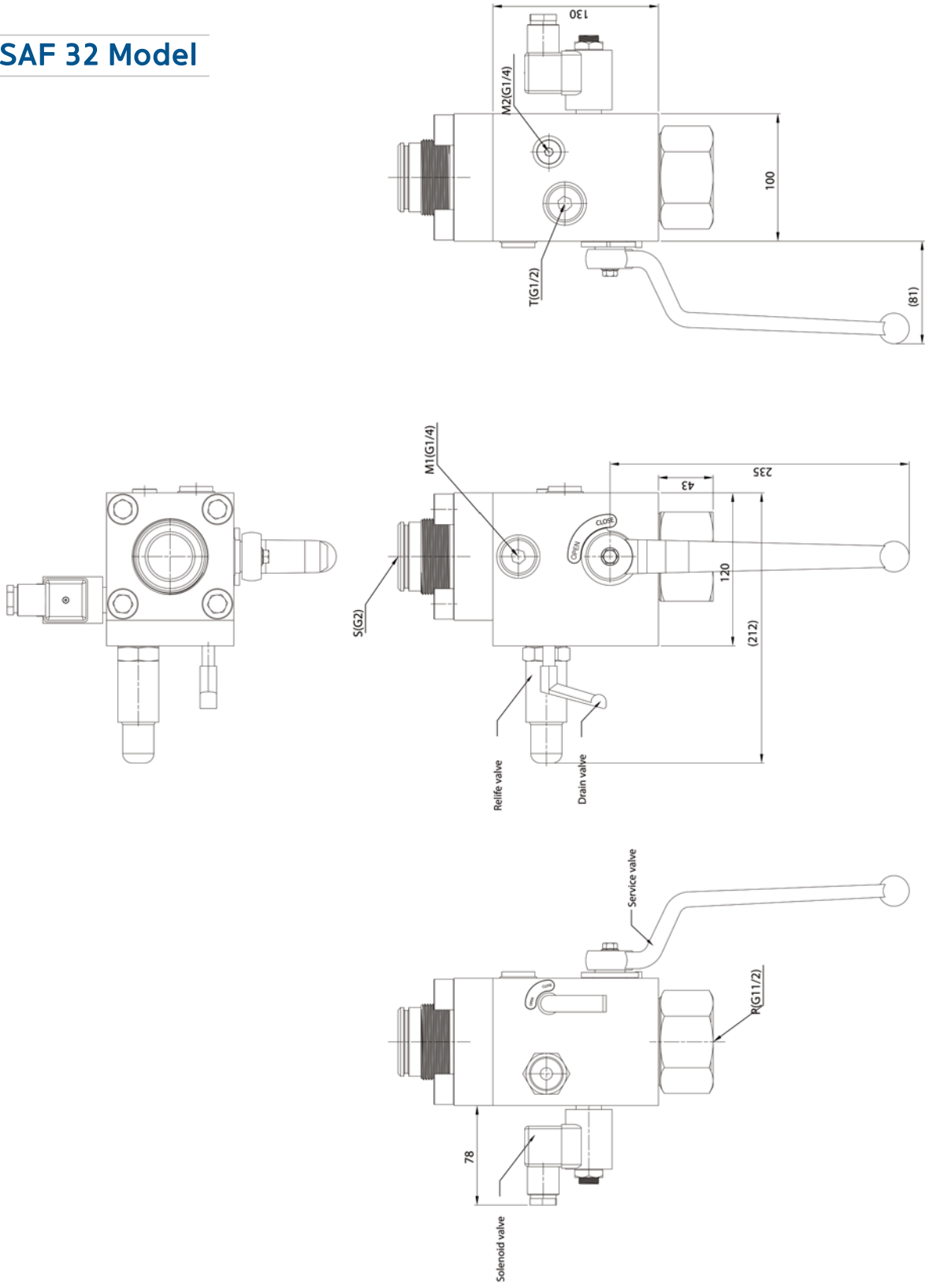


12. Safety & Shut-off Block(2)

4 FSAF Series (5)

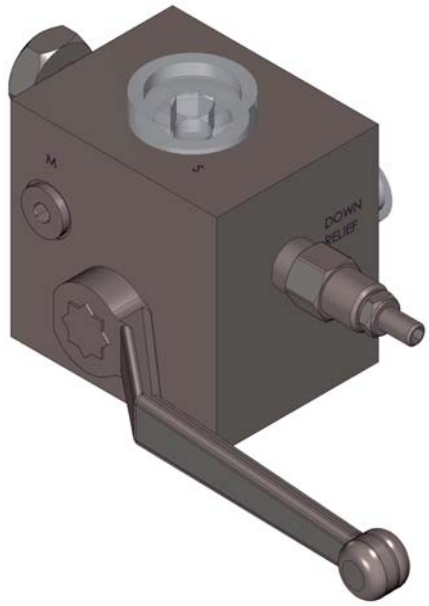
The Exterior Demensions

FSAF 32 Model



12. Safety & Shut-off Block(2)

1 FSV Series(1)



Basic Specification

- Working Pressure: 360bar(5,221psi)
- Temperature Range
  - Manual drain : -10℃ ~ +80℃
  - Electrical drain : -10℃ ~ +60℃
- Material
  - Body : Carbon Steel.
  - Sealing : Nitrile(Option - Viton)
- Electrical data
  DC : 24V
  AC : 110V or 220v, 50~60Hz

- Safety block comes with manual and electrical type.
- Please ensure to check the connecting size when assembling with accumulators.

2 Ordering Code for Safety Block

① FSV - ② 12 - ③ 01 - ④ L - ⑤ N

① Type (Series)	
FSV	Safety Block

*Refer to page 46.

② Model/Size	
12	G1/2"
20	G3/4"
30	G1"1/4

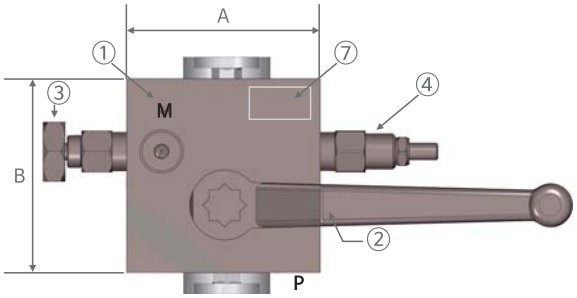
③ Relief Valve Type	
01	Manual
02	Manual & Electrical

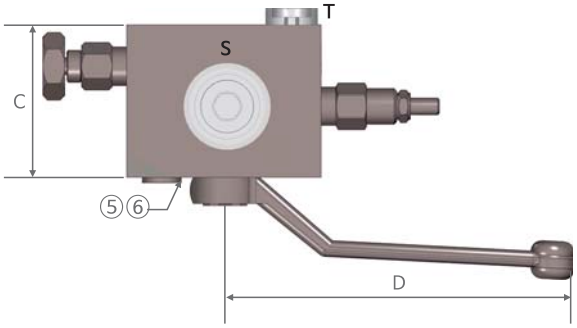
④ Seal Material	
L	Nitrile
V	Fluorocarbon

⑤ Voltage	
N	None
G	DC 24V
A	AC 110V
B	AC 220V

12. Safety & Shut-off Block(2)

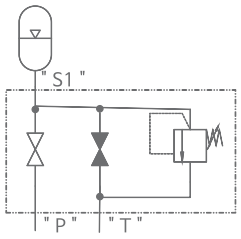
3 FSV Series(2)



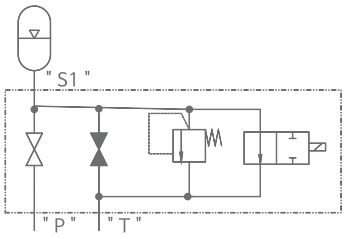


Part List

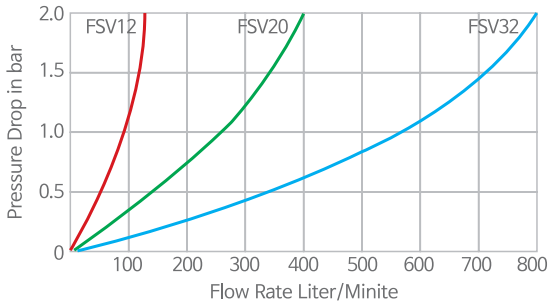
1	Safety Block Housing FSV Valve Assy Kit
2	Ball Valve Kit
3	Manual Pump Valve
4	Spring Relief Valve
5	Blanking Plug 1/4" BSP
6	Bonded Seal 1/4" BSP
7	Label



Type 1



Type 2



Pressure Drop / Flow Rate through Safety Block

Code	"S" port Accmulator	"P" port process	"T" port gauge	"M" port gauge	Dimension (mm)			
					A	B	C	D
FSV12	G1/2"	G1/2"	G1/4"	G1/4"	76	94	66	115
FSV20	G3/4"	G3/4"	G3/8"	G1/4"	89	89	70	160
FSV32	G1"1/4	G1"1/4	G3/8"	G1/4"	89	129	88	300

13. N_2 Gas Charging Kit 1 Universal Type

1 Ordering Code for N_2 Charging Kit

FCU	-	250	-	1	-	1	-	1	-	R	-	K
01		02		03		04		05		06		07

01 Type (Series)

FCU	Charging Kit

*Refer to page 57.

02 Gauge Pressure

25	25bar
250	250bar
25/250	25/250bar

03 Charging Adapter

1	G1/4
2	5/8-18UNF
3	5/16-24UNF
4	7/8-14UNF(Short)
5	7/8-14UNF(Long)
6	1번+2번+3번+4번+5번 일체형
7	1번+2번+3번 일체형
8	2번+3번 일체형

04 Hose

0	None
1	2.8m(Standard), 200bar
2	2.8m, 400bar

05 Charging Case

1	With Charging Box Set(Type A)
2	With Charging Box Set(Type P)

06 Regulator

O	None
R	Regulator

07 N_2 Bottle Valve

K	Korea Standard

*FCU Charging kit is a universal type that covers most types of accumulators for N_2 gas charging.

1-1 FCU consists of

FCU charging kit has a variety of adapters available to cover all the different connections of accumulators.

- Charging Unit Body
- Gas valve
- Pressure gauge 25 bar
- Pressure gauge 250 bar
- High Pressure Hose(2.8M, 200bar)
- Charging Adapter
- Spare parts(sealing)
- Regulator

※. Pressure ranges and length of charging hose are available as per requirements.

A Type-Aluminum Case

P Type-Plastic Case

13. N_2 Gas Charging Kit

1 Universal Type

2 Detailed outline drawing

Charging Adapter

Code	규격
2E114-101-00	G1/4
2E114-103-00	5/8-18UNF
2E114-104-00	7/8-14UNF(S)
2E114-105-00	7/8-14UNF(L)
2E114-106-00	5/16-24UNF
2E114-107-00	M14x1.5

Size	Applicable brand
G1/4	FLOWFORCE, SGPT
7/8-14UNF	OLAER
5/8-18 UNF	EPE, NOK, OLAER
5/16-24 UNF	Nakamura, Greer, Bosch

Charging Hose

(200 bar, 2.8M) Connecting to N_2 Bottle Valve

Code	Size
CH028	W22-14

13. N_2 Gas Charging Kit 2 Standard Type

1 Ordering Code for N2 Charging Kit

BCG	-	250	-	1	-	1	-	1	-	R	-	K
01		02		03		04		05		06		07

01 Type (Series)

BCG	Charging Kit(Use only Bladder Type.)

02 Gauge Pressure

25	25bar
250	250bar
25/250	25/250bar

03 Charging Adapter Connection

1	5/8-18UNF
2	7/8-14UNF(Short)
3	5/16-24UNF
4	1+2+3

04 Hose

0	None
1	STD. 2.8m(200bar)
2	2.8m, 400bar

05 Charging Case

1	None
2	With Charging Box Set(Type A)
3	With Charging Box Set(Type P)

06 Regulator

O	None
R	Regulator

07 N2 Bottle Valve

K	Korea Standaed

*BCG Charging kit is only for the bladder type accumulators.

1-1 Main parts of BCG Charging kit

BCG charging kit has a variety of adapters available to cover all the different connections of accumulators.

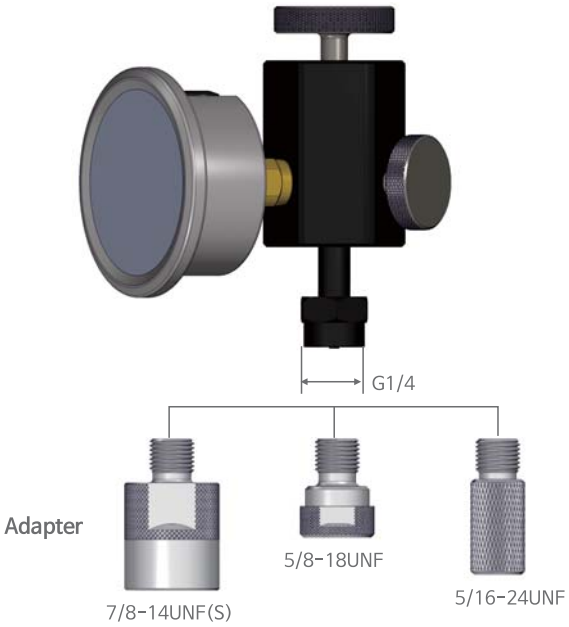
- Charging Unit Body
- Gas valve
- Pressure gauge 25 bar
- Pressure gauge 250 bar
- High Pressure Hose(2.8M, 200bar)
- Charging Adapter
- Spare parts(sealing)
- Ragulator

A Type-Aluminum Case

P Type-Plastic Case

13. N_2 Gas Charging Kit 2 Standard Type

2 Detailed outline drawing



Charging Adapter

Code	Size
1E114-103-00	5/8-18UNF
1E114-104-00	7/8-14UNF
1E114-106-00	5/16-24UNF

Size	Applicable Brand
7/8-14UNF	OLAER, Hyundai Olaer
5/8-18 UNF	EPE, NOK, OLAER, Hyundai olaer
5/16-24 UNF	Nakamura, Greer, Bosch, Hydac

Charging Hose

(200 bar, 2.8M) Connecting to N_2 Bottle Valve

Code	Size
CH028	W22-14

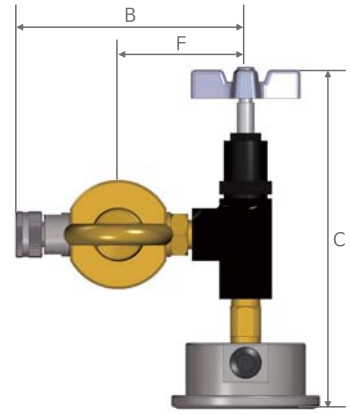
14. N_2 Gas Port Gauging & Control Valve

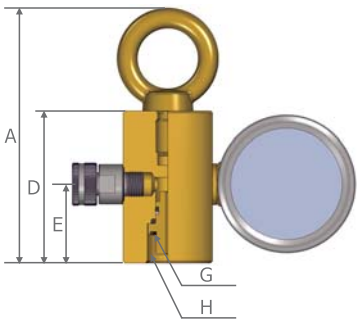
1 CPG (Charging & Permanent Gauge) Series

CPG - I - 250 - D
(01) (02) (03) (04)

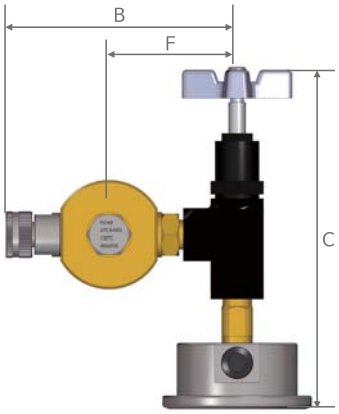
01 Type (Series)		02 Safety Valve		03 Pressure Gauge		04 Gauge Type	
CPG		Bank	Without Eyebolt	250	250bar(Standard)	D	Horizontal Type (Standard)
		I	With Eyebolt			A	Vertical Type
		B	Pressure Burst Disc				

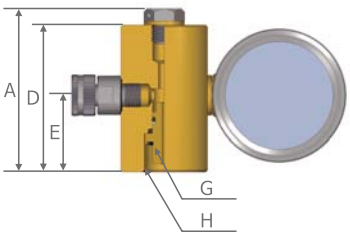
CPGI-Type
(With Eyebolt)

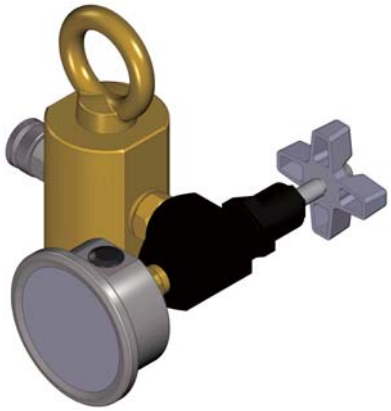




CPGB-Type
(With Pressure Burst Disc)





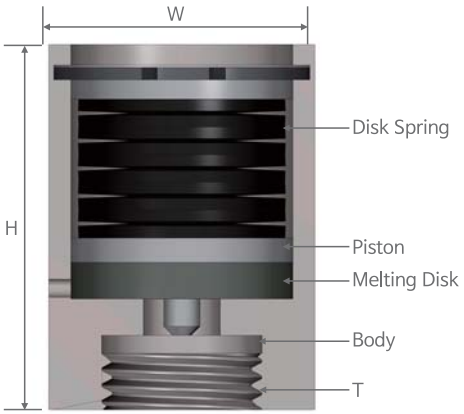


D-Type

Code	Model No	kg	Dimension (mm)							
			A	B	C	D	E	F	G	H
CPG01	CPG-250-D	1.82	75	109	148	75	39	60	1/2-20UNF	7/8-14UNF
CPG02	CPGI-250-D	1.94	126	109	148	75	39	60	1/2-20UNF	7/8-14UNF
CPG03	CPGB-250-D	1.84	83	109	148	75	39	60	1/2-20UNF	7/8-14UNF

14. N_2 Gas Port Gauging & Control Valve

2 TR Cap (Fusible-plug Safety Valve)



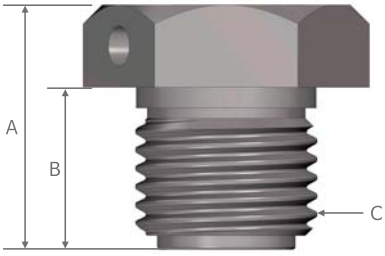
Before

After
(Press the valve stem and released the seal)

Code	Working temperature	Dimension (mm)		
		W	H	T
TRC1-150	150℃	22	30	5/8-18UNF
TRC2-150	150℃	22	30	1/4 BSP

※ Please ensure the code when placing TR Cap separately.

3 Pressure Burst Disc

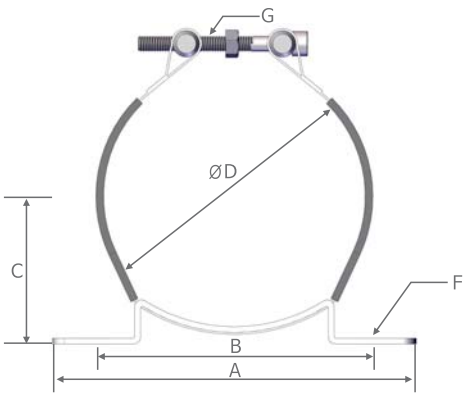


Code	Working temperature	Dimension (mm)		
		A	B	C
PBD-270	270bar/120℃	17.7	11.7	1/4 BSP

※ Pressure / Temperature : 270bar / 120℃
※ Please ensure the code when placing Pressure Burst Disc separately.

15. Clamp Band

1 Diaphragm Type (Stainless Steel)



Code	Volume Category	Dimension (mm)						
		A	B	C	Ø D	E	F	G
C091	0.32ℓ	140	110	59.5	91	25	9X150	M8X80
C105	0.5ℓ	140	110	66.5	105	25	9X150	M8X80
C120	0.75ℓ	140	110	74	120	25	9X150	M8X80
C136	1.0ℓ	189	149	77	136	25	11X20	M8X80
C155	1.4~2.0ℓ	189	149	86.5	155	25	11X20	M8X80
C168	2.8~3.5ℓ	189	149	93	168	25	11X20	M8X80
C179	2.8~3.5ℓ	189	149	98.5	179	25	11X20	M8X80

15. Clamp Band

2 Bladder Type (Stainless Steel)

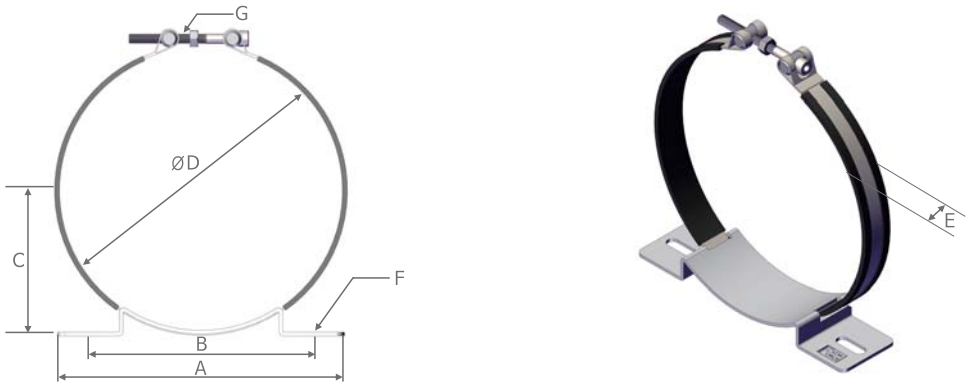


Fig 1

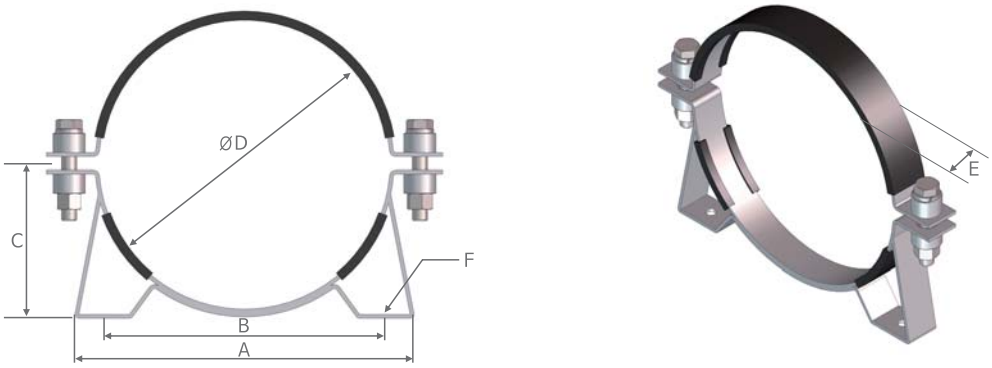


Fig 2

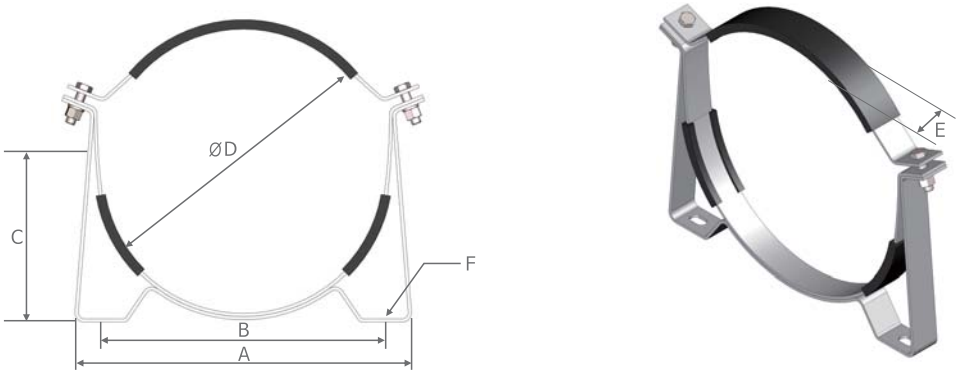
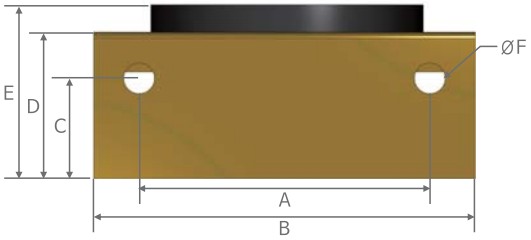


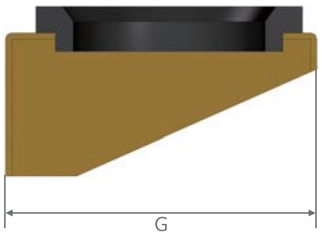
Fig 3

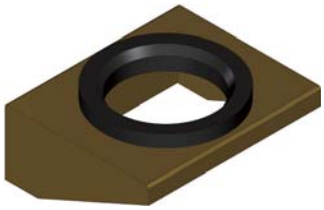
Code	Volume Category	Figure	Dimension (mm)						
			A	B	C	ØD	E	F	G
A119	1~2.5ℓ	Fig1	140	110	72	119	25	9X15	M8X90
A177	4~6ℓ	Fig1	189	149	96	177	25	11X20	M8X90
A232	10~57ℓ	Fig1	235	193	119	232	25	11X30	M8X90
C220	10~57ℓ	Fig2	261	216	119	220	30		Φ9
C351	63~200ℓ	Fig3	422	360	190	351	40		Φ15

16. Support Bracket / Cushion Ring

1 Support Bracket

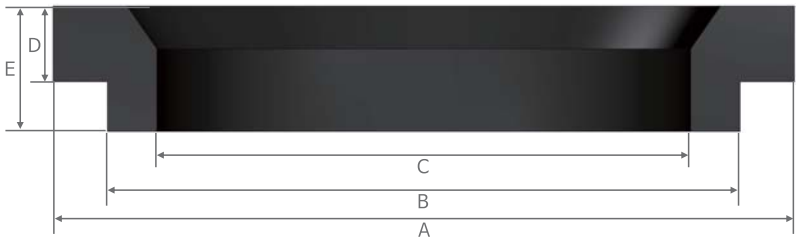






Code	Volume Category	Weight	Dimension (mm)						
			A	B	C	D	E	ØF	G
SB01	1.0~2.5ℓ	0.8	75	130	35	60	75	13	140
SB02	4~6ℓ	1.5	160	210	55	80	95	17	175
SB03	10~57ℓ	3.8	200	260	75	100	120	17	235

2 Cushion Ring



Code	Volume Category	Dimension (mm)				
		A	B	C	D	E
CR01	1.0~2.5ℓ	125	109	89	15	25
CR02	4~6ℓ	150	128	108	15	25
CR03	10~57ℓ	206	165	150	20	30

*Please contact FLOWFORCE for more information of the cushion rings for large size and piston accumulators.

17. Nitrogen Booster (FKAG Series) - (1)

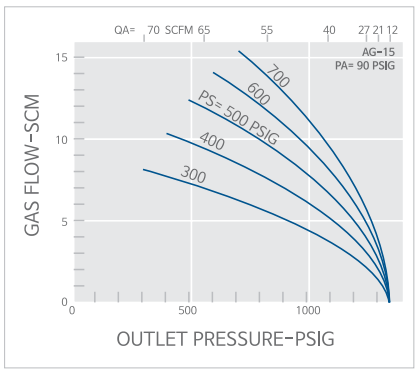
Main Feature

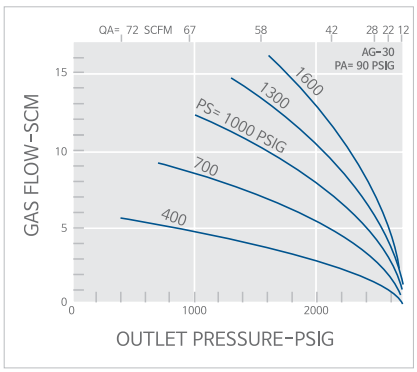
- Maximum In/Outlet Pressure : 700bar.
- Approximate practical pressures based on 6.5 Bar drive and 35 Bar efficiency with nitrogen gas
- ATEX Certified Products with Lightweight Structure

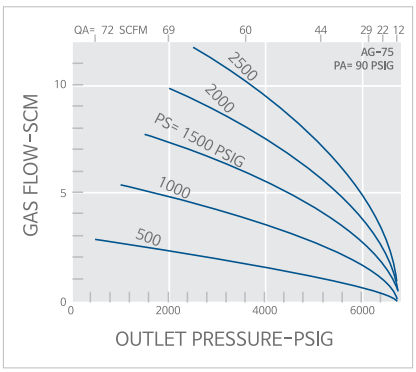
1 Basic Technical Specification by Model

Model	Type	Specification		Gas Supply Pressure (kg/㎠)	Driven Air Pressure (kg/㎠)
		Working Pressure (kg/㎠)	Max. Flow (l/min)		
FKAG-15H-SS	H : Standard type HC : Movable wheel mounted (Caster)	10~100	400	10~120	1~10.3
FKAG-30H-SS		10~210	300	10~120	
FKAG-75H-SS		10~420	150	10~120	
FKAG-152H-SS		10~700	90	10~120	
FKAG-7/15H-SS		10~100	300	10~30	
FKAG-15/30H-SS		10~210	300	10~70	
FKAG-32/62H-SS		10~420	350	10~120	
FKAG-62/152H-SS		10~700	200	10~120	

2 Performance Curve





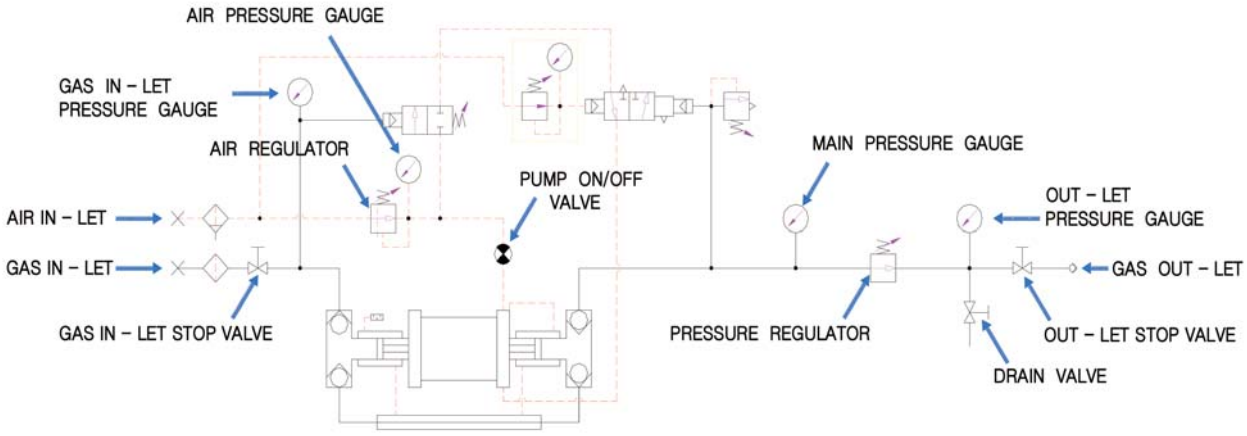


[Note] · For other model's performance curves, please contact FLOWFORCE.

17. Nitrogen Booster (FKAG Series) - (2)

3 Structural and Circuit Diagram

① Air Pressure Gauge
② Gas In-Let Pressure Gauge
③ Main Pressure Gauge
④ Out-Let Pressure Gauge
⑤ Drain Valve
⑥ Out-Let Stop Valve
⑦ Pressure Regulator
⑧ Gas In-Let Stop Valve
⑨ Pump ON/OFF Valve
⑩ Gas In-Let
⑪ Air In-Let
⑫ Gas Out-Let
⑬ Air Regulator



4 Setting pressure table

Model	FKAG-30H-SS	FKAGT-32/62H-SS
DRIVEN AIR PRESSURE (kg/㎠)	1~7	1~7
GAS SUPPLY PRESSURE (kg/㎠)	10~120	10~120
WORKING PRESSURE (kg/㎠)	10~210	10~420

17. Nitrogen Booster (FKAG Series) - (3)

5 Use and Handling Manual

[5-1] Preparations before use

1) Turn the air regulator counterclockwise and release it completely. (Air supply pressure is "0")
2) Lock the pump on/off valve.
3) Lock the gas in-let stop valve.
4) Lock the out-let stop valve and the drain valve.
5) Turn the pressure regulator counterclockwise to release it completely.
6) Connect the nitrogen bottle to the gas in-let port.
7) Connect the air hose to the air in-let port.
(Do not increase the supply air pressure by more than 7㎏/㎠)
8) Connect the applied goods to the gas out-let port.

[5-2] How to operate the pump

1) Slowly rotate the air regulator clockwise to set the air supply pressure to 6㎏/㎠. And the air supply pressure can be verified through the air pressure gauge.
2) Open the gas in-let stop valve to supply nitrogen.
The pressure of the supplied gas can be determined by the in-let pressure gauge. However, if the pressure of the nitrogen bottle falls below 20㎏/㎠, it must be replaced.
3) Slowly open the pump on/off valve to drive the pump.
The pressure to be increased can be determined by the main pressure gauge.
The pump stops automatically at the set pressure.
(Refer to setting pressure table by model)
4) When the pump stops at the set pressure, open the out-let stop valve.
5) Gradually rotate the pressure regulator clockwise to supply pressure to the applied goods. The pressure can be found through the out-let pressure gauge.
If the main pressure drops due to reached pressure at the applied goods, the pump will automatically operate.
Top up to the set pressure.

[5-3] Pressure exhaustion method

1) Lock the pump on/off valve(No. 9) to block the supply of pump-driven air.
2) Lock the gas in-let stop valve(No. 10) to cut off the nitrogen supply.
3) Open the drain valve(No. 11-2) to exhaust pressure.

*Caution: Ensure that pressure is exhausted through all gauge in the equipment.

[5-4] Precautions for Handling

1) Do not move or impact the equipment/device while it is in use.
2) Make sure that the pressure is exhausted after completion of the work or when replacing the test piece.
3) Do not dismantle any pipes or fittings under pressure.
4) Do not use any gas other than nitrogen.
5) Only personnel who are fully familiar with the functions of the equipment should operate this equipment.
6) Always keep the equipment clean.

18. Accumulator Station Stand-(1)

1 Overview

There are many advantages to use the accumulator station stand when a large volume of the accumulators is required in the hydraulic system, which are ready for operation, complete with all the necessary valve controls, 3 way ball valves and safety equipment. Flowforce specializes in supplying this system to customers to apply it to all types of accumulators along with engineering services in

a custom-made format.

[Supply Type]

- Bladder accumulator alone or with the back-up nitrogen bottle.
- Piston accumulator alone or with the Back-up nitrogen Bottle.
- Nitrogen bottle alone.

[Main Advantage]

Bladder Accumulator

- Maintain minimal operating conditions in the event of some internal bladders damaged
- Maximize the maximum discharge flow of the accumulators

Piston Accumulator + Gas Bottle

- The smaller the operating pressure difference between maximum and minimum, it can be used more economically.
- Maximize the total effective volume and discharge flow of the accumulator

2 Ordering Model Code

FAS	-	330	-	PN	-	1	x	50	+	6	x	50	-	CE
01		02		03		04		05		06		07		08

01 Type(Series)

FAS	Flowforce Acc. Stand

02 Max. Operating Pressure(bar)

330	330bar

(Please indicate the maximum working pressure of use of the corresponding directly)

03 Series(Supply Type)

B	Bladder Accumulator Alone
BN	Bladder Accumulator + Nitrogen Bottle
P	Piston Accumulator Alone
PN	Piston Accumulator + Nitrogen Bottle
N	Back-up Nitrogen Bottle Alone

04 Number of Accumulators

(Please indicate the installation quantities of the corresponding accumulators directly)

05 Nominal Volume(liter) of The Accumulators

(Please indicate the norminal volume of the appropriate accumulators directly)

06 Number of Nitrogen Bottles

0	Accumulator Alone

(Please indicate the installation quantities of the corresponding gas bottle directly)

07 Individual Nominal volume(liter) of Nitrogen Bottles

08 Certification Code(Directly specified)

0	No Certificate
Ex	CE, ASME, KGS, Class...

[Note]

All type of the accumulators and nitrogen bottles are connected up via a manifold block or pipework.

18. Accumulator Station Stand-(2)

3 Example of Bladder Accumulator Stations(Special & Large Size)

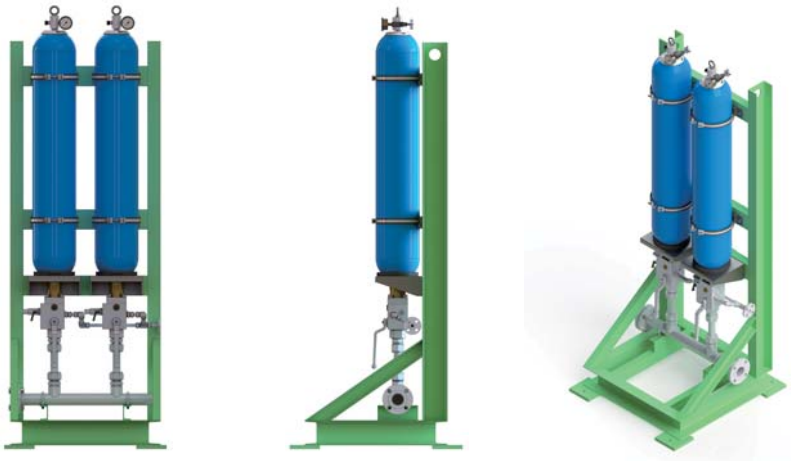
Basic Specifications		
Volume	Quantity	Max. Working Pressure
530Liter	3	20bar

Basic Dimensions		
Length	Width	Height
2700	208	3300

4 Example of Bladder Accumulator Stations(Standard)

Basic Specifications		
Volume	Quantity	Max. Working Pressure
50Liter	2	330bar

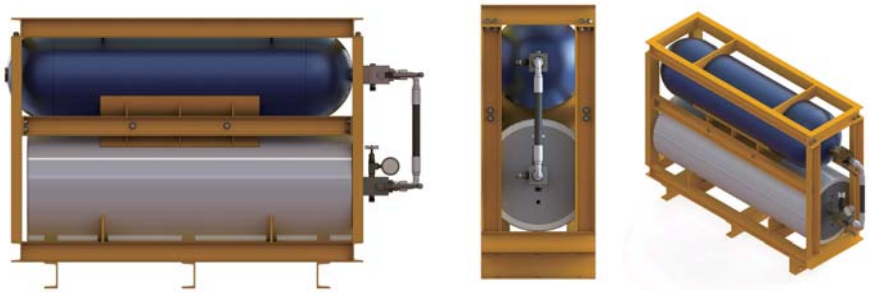
Basic Dimensions		
Length	Width	Height
810	862	2200



5 Example of Piston Accumulator + Back-up Nitrogen Bottle Stations

Basic Specifications		
Volume	Quantity	Max. Working Pressure
70Liter	1	350bar

Basic Dimensions		
Length	Width	Height
1500	420	920

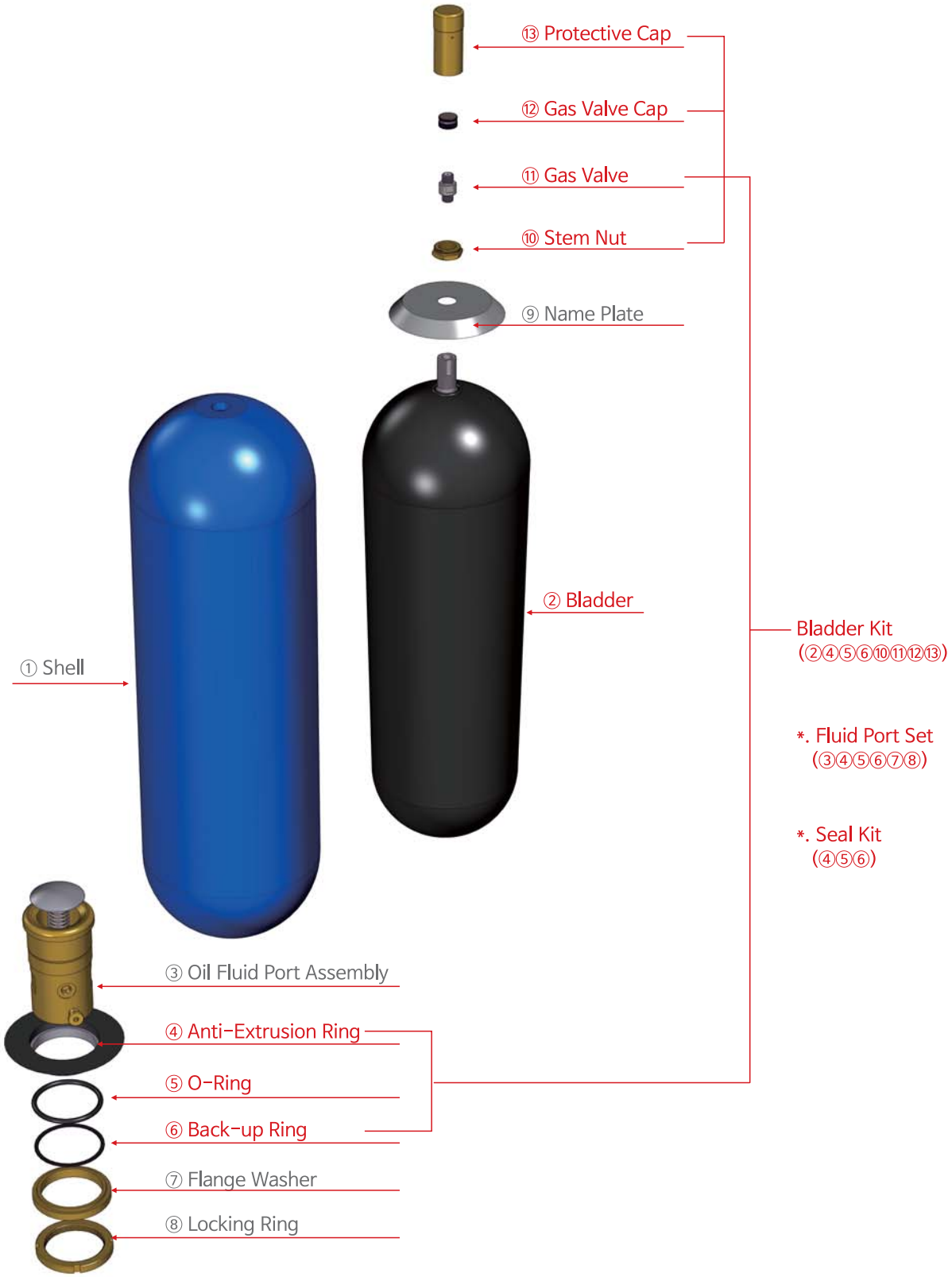


[Note]

If you need detailed installation and production drawings, estimates at your site, please contact our technical sales team.

19. Accumulator Repair Kit

1 Bladder Type

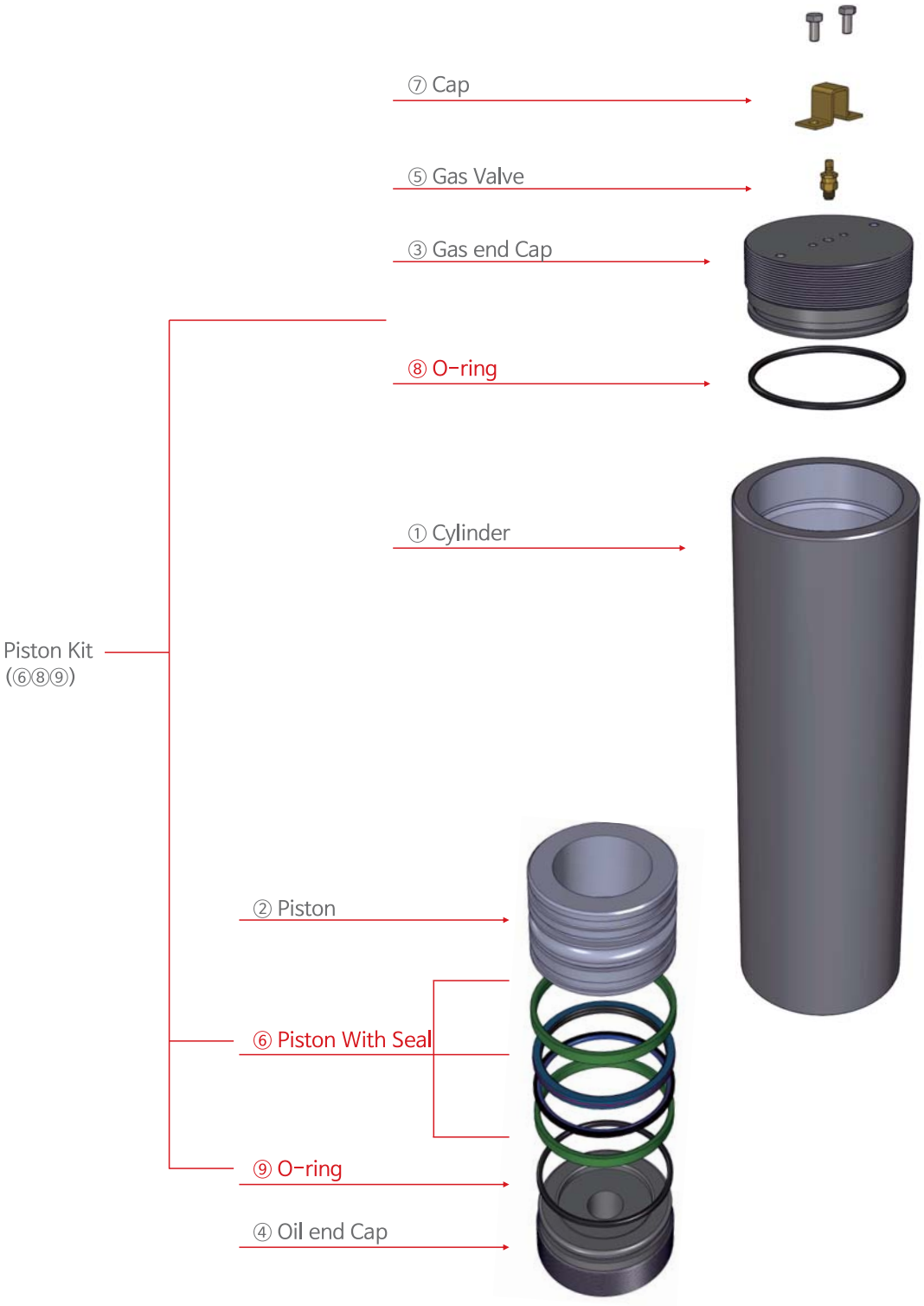


19. Accumulator Repair Kit

2 Diaphragm (Thread) Type

19. Accumulator Repair Kit

3 Piston Type



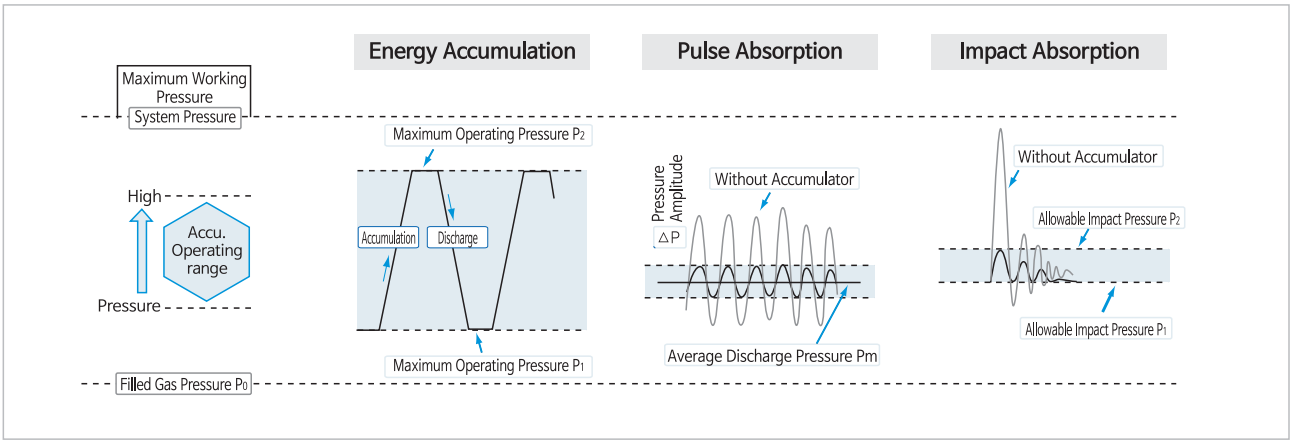
20. Accumulator Volume Calculation

1 Method of calculation used by applications and examples

Accumulator volume is basically calculated on the basis of $P_0V_0 = P_1V_1 = P_2V_2 = C$ although this formula can be varied by applications.

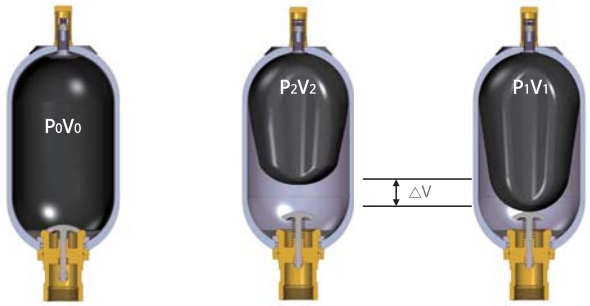
Examples

Terms related to Accumulator pressure



- Max. Working pressure : This pressure is referred to as the maximum working pressure.
- System pressure : The maximum possible pressure of a circuit and generally used to refer to the release pressure of a relief valve mounted on the equipment or machinery.
- Max. Operating pressure (P_2) :Max. applicable pressure at witch gas can be compressed.
- Min. operating pressure (P_1) : The Min. pressure when fluid is discharged from the accumulator.
- Filled Gas pressure (P_0) : Seal pressure of N_2 Gas
- Average discharge pressure (P_m) : The average pressure of fluid discharged from the pump, etc.
- Normal pressure (P_2) : The pressure within a pipe with no impact pressure.
- Allowable impact pressure (P_2) : Maximum allowable impact pressure.

Operating Condition of Accumulator



Filled with N_2 gas
Bladder expands and poppet closes

Fluid flow in
When the fluid pressure reaches the filled gas pressure, the poppet opens and accumulation takes place until the pressure reaches the maximum operating pressure

Fluid discharged
Fluid discharges until the minimum operating pressure is reached

Accumulator Volume

P_0	Filled Gas Pressure	V_0	Gas Volume at P_0
P_1	Min. operating pressure	V_1	Gas Volume at P_1
P_2	Max. Operating pressure	V_2	Gas Volume at P_2
n	Polytropic Index (Index determined by temperature and pressure of the gas		

20. Accumulator Volume Calculation

1 Energy Storage & Save

1 Applicable Basic Formula

3 types of following formulas based on the system condition are generally used to calculate for energy accumulation (system pressure / flow compensation).

Calculate the required gas volume (Vo)

① In case of isothermal change, slow accumulation and slow discharge

$$V_0 = \frac{dV \times \frac{P_1}{P_0}}{1 \times \frac{P_1}{P_2}}$$ ▶ Formula ①

② In case of polytropic change (1), quick accumulation and quick discharge

$$V_0 = \frac{dV \times \frac{P_1}{P_0}}{1 - (\frac{P_1}{P_2})^{1/n}}$$ ▶ Formula ②

※ This formular is the most commonly used.

③ In case of polytropic change (2), slow accumulation and quick discharge

$$V_0 = \frac{dV \times \frac{P_2}{P_0}}{(\frac{P_2}{P_0})^{1/n} - 1}$$ ▶ Formula ③

※ Isothermal ≥ 90 seconds of operating time ≥ Polytropic

Basic terms

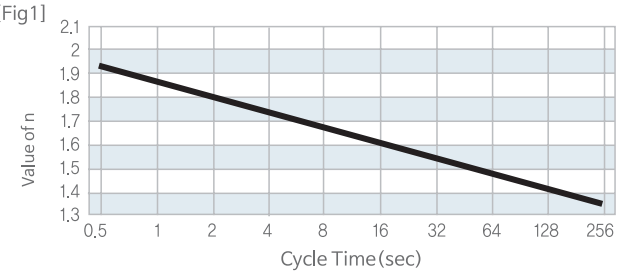
V_0	Accumulator Gas Volume – (ℓ)
dV	Accumulator Necessary Discharge Flow – (ℓ)
P_0	N2 Filled Gas Pressure – (kg/㎠)
P_1	Min. Operating Pressure – (kg/㎠)
P_2	Max. Operating Pressure – (kg/㎠)
n	Polytropic Index

Select the polytropic index (n)

Please refer to the tables below to calculate n of the N_2 gas which are varied to operating time (cycle time), average working pressure and temperature of N_2 gas and ambient.

① Value of n according to the operating time

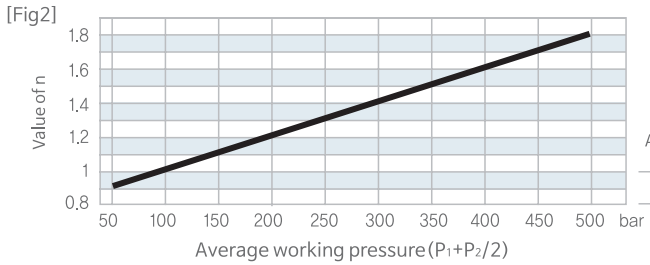
[Fig1]



Operating Time	0.5	1	2	4	8	16	32	64	128	256
Value of n	1.93	1.87	1.8	1.73	1.68	1.62	1.55	1.49	1.42	1.35

② Value of n according to the average working pressure

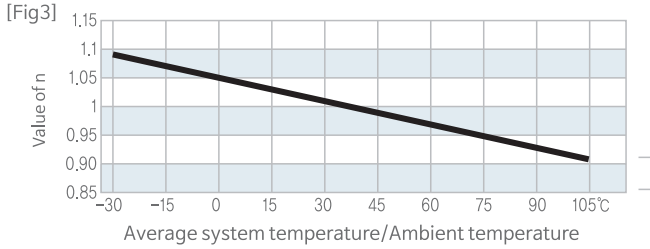
[Fig2]



Average working pressure	10	50	100	150	200	250	300	350	400	450	500
Value of n	0.85	0.92	1.02	1.11	1.21	1.31	1.40	1.50	1.60	1.70	1.79

③ Value of n according to the ambient temperature or average working temperature

[Fig3]



Ambient temperature	−30	−15	0	15	30	45	60	75	90	105
Value of n	1.08	1.07	1.05	1.03	1.01	0.99	0.97	0.95	0.93	0.91

2 Calculation and select the model

[Working Condition & System Specification]

Working Condition & System Specifl cation

P_2 : Max. Operating Pressure = 180kg/㎠ · G

P_1 : Min. Operating Pressure = 120kg/㎠ · G

P_0 : N2 Filled Gas Pressure (at Tmax 50℃) = 102kg/㎠ · G

$$P_1 \times (0.9) \times \frac{Tmin+273}{Tmax+273} = 120 \times 0.9 \times \frac{32+273}{50+273}$$

Q : Discharge per Pump Rotation = 110Liter/min

D : Cylinder Inside Diameter = 280mm

S : Cylinder Stroke = 360mm

V : Cylinder working speed 0.53m/sec.

Fluid = Petroleum-based hydraulic fluids

Working temperature = Tmin 32℃~Tmax 50℃

[Question]

※ What is the appropriate model of accumulator for operating the cylinder under the above working condition?

Solution

1) Find the value of Accumulator Necessary Discharge Flow (dV) firstly based on the above working condition.

$$dV = \frac{\pi XD^2}{4} \times S \times 10^{-6}$$

$$= \frac{\pi X280^2}{4} \times 360 \times 10^{-6}$$

$$= 22.16 \text{ Liter}$$

20. Accumulator Volume Calculation

2) Calculate the value of n since it is a polytropic change.

Time of working cycle (accumulation & discharge) : 12.08 + 0.68 = 12.76 sec

Average operating pressure (Pm) $= \frac{P_2 + P_1}{2} = \frac{180+120}{2} = 150 kg/cm^2$

Average working temperature : (Tmin + Tmax)/2 = (32+50)/2 = 41℃

※ The final value of n is verified according to the Fig.1, 2, 3 on page 60~61.
n=1.65 x 1.11 x 1.00 = 1.83

3) Calculate the total volume of the accumulator

$V0 = \frac{dV(P_1/P_0)}{[1-(P_1/P_2)^{n/1}}$ Formula 2 on page 4.

$= \frac{22.16x(120/102)}{[1-(120/180)^{1/1.83}]} = 131.3 Liter$

4) Find the number of unit according to the above necessary total volume.

131.3 Liter = 131.3 / 50Liter = one of 3 units or 150 Liter accumulator.

5) Verify the Max. Accumulator Discharge Flow whether it is appropriate.

- Time for oil accumulation $(T_1) = \frac{dV}{Q} = \frac{22.16}{110/60} = 12.08 sec$
- Time for oil discharge $(T_0) = \frac{S}{A} \cdot 10^{-3} = \frac{360}{0.53} \cdot 10^{-3} = 0.68 sec$
- $\frac{dV}{Q} = \frac{22.16}{0.68} \fallingdotseq 32.58 \ell / sec$

According to the above 4), FB 330-14A (3 x 13.5Liter/sec) is enough for the cylinder operation.

6) Select the bladder material: Please see page 19 for detailed material of bladder based on the working temperature.

N : NBR : Buna-n : -15℃~85℃

7) Select the final accumulator model which is suitable for the above conditions from 1) to 6) Refe to page 20, FBN 330-14A is selected.

8) Consider installation and maintenance cost.

※ Technical Note

: How to calculate N_2 Gas filling pressure at ambient temperature (at 20℃)

$P_0(at\ 20℃) = P_0(at\ Tmax) \times \frac{T_0+273}{Tmax+273}$

$= 102 \times \frac{20+273}{50+273} = 92.5 kg/cm^2$

When the oil temperature increases in hydraulic system, the pressure increases based on the temperature due to increased molecular activity of N_2 gas.
This example is based on the ambient temperature at 20℃ that automatically maintenance the pressure at 102kg/㎠ at 50℃ of the system temperature when filling N_2 gas pressure at 92.5kg/㎠.

Sizing chart & Calculation for Accumulator Gas Volume

In case of energy storage, the below table which is the pressure ratio between Max. operating pressure and Average operating pressure is much convenience to select the appropriate accumulator model(accumulator gas volume) than using the formulars on page 74.

[Fig. 4]

Pressure Ratio P_2/P_1>4	Accumulators Size																	
	Standard Bladder Accumulators												Transfer Barrier with 50L Gas Back-Up Bottle Fitted					
P_2/P_1	0.16	0.6	1	3	4	10	20	32	50	57	100	150	28X1	37X1	37X2	54X1	54X2	P_2/P_1
1.05 1.10	0.005 0.010	0.018 0.035	0.035 0.066	0.08 0.14	0.12 0.22	0.29 0.34	0.57 1.09	1.07 2.03	1.49 2.84	1.67 3.17	2.99 5.77	4.80 9.22	2.20 4.18	2.46 4.69	3.87 7.37	2.87 5.49	4.28 8.16	1.05 1.10
1.15 1.20	0.015 0.019	0.049 0.063	0.094 0.120	0.21 0.26	0.31 0.39	0.78 0.98	1.55 1.97	2.90 3.68	4.04 5.13	4.51 5.73	8.32 10.70	13.32 17.14	5.96 7.58	6.73 8.60	10.56	7.88 10.06	11.73 14.97	1.15 1.20
1.25 1.30	0.022 0.026	0.074 0.086	0.143 0.149	0.31 0.36	0.47 0.54	1.17 1.35	2.35 2.69	4.39 5.03	6.12 7.02	6.84 7.85	12.91 14.99	20.68 23.99	9.06	10.20 11.91		11.94 13.94	17.76	1.25 1.30
1.35 1.40	0.029 0.032	0.096 0.104	0.183 0.201	0.40 0.44	0.60 0.66	1.80 1.65	3.01 3.29	5.62 6.16	7.84 8.60	8.76 9.61	16.93 18.73	27.09 29.98		13.11		15.35 16.77		1.35 1.40
1.45 1.50	0.034 0.036	0.113 0.121	0.217 0.231	0.47 0.50	0.71 0.76	1.78 1.90	3.56 3.80	6.65 7.11	9.28 9.98	10.37 11.15	20.45 22.06	32.72 35.29				18.09 19.33		
1.55 1.60	0.038 0.041	0.128 0.135	0.245 0.258	0.53 0.56	0.81 0.85	2.01 2.12	4.03 4.23	7.53 7.89	10.50 11.04	11.74 12.34	23.58 25.02	37.72 40.03						
1.65 1.70	0.042 0.044	0.141 0.146	0.270 0.280	0.59 0.61	0.89 0.92	2.21 2.30	4.43 4.60	8.27 8.60	11.54 12.01	12.90 13.43	26.38 27.67	42.21 44.27						
1.75 1.80	0.046 0.047	0.152 0.157	0.290 0.300	0.63 0.65	0.95 0.98	2.38 2.46	4.77 4.92	8.91 9.20	12.44 12.84	13.91 14.35	28.90 30.07	46.24 48.12						
1.85 1.90	0.048 0.049	0.161 0.165	0.310 0.320	0.67 0.69	1.00 1.04	2.53 2.60	5.06 5.20	9.47 9.71	13.210 13.56	14.77 15.16	31.2 32.26	49.91 51.61						
1.95 2.00	0.051 0.052	0.169 0.173	0.325 0.331	0.71 0.72	1.06 1.09	2.66 2.72	5.32 5.44	9.95 10.17	13.88 14.19	15.51 15.86	33.28 34.26	53.25 54.81						
2.10 2.20	0.054 0.056	0.179 0.186	0.344 0.355	0.75 0.77	1.13 1.17	2.83 2.92	5.56 5.84	10.56 10.91	14.74 15.23	16.47 17.02	36.08 37.77	57.74 60.45						
2.30 2.40	0.057 0.059	0.191 0.195	0.365 0.374	0.80 0.82	1.20 1.23	3.00 3.07	6.00 6.18	11.22 11.49	15.66 16.04	17.51 17.93	39.34 40.78	62.94 65.27						
2.50 2.60	0.060 0.061	0.200 0.203	0.382 0.389	0.83 0.85	1.26 1.28	3.14 3.20	6.28 6.39	11.74 11.95	16.38 16.68	18.31 18.64	42.13 43.39	67.43 69.44						
2.70 2.80	0.062 0.063	0.207 0.210	0.395 0.401	0.86 0.87	1.30 1.32	3.25 3.29	6.50 6.59	12.15 12.32	16.95 17.19	18.95 19.21	44.57 45.68	71.33 73.10						
2.90 3.00	0.064 0.065	0.212 0.215	0.406 0.411	0.88 0.89	1.34 1.35	3.34 3.37	6.67 6.75	12.42 12.61	17.41 17.60	19.46 19.67	46.71 47.70	74.77 76.33						
3.20 3.40	0.066 0.067	0.219 0.222	0.419 0.425	0.91 0.92	1.38 1.40	3.44 3.49	6.88 6.98	12.85 13.04	17.94 18.20	20.05 20.35	49.93 51.52	79.9 82.42						
3.60 3.80	0.068 0.069	0.224 0.227	0.430 0.434	0.94 0.95	1.41 1.43	3.53 3.57	7.06 7.13	13.20 13.33	18.42 18.60	20.59 20.80	52.95 54.24	84.72 86.80						
4.00 4.50	0.070 0.075	0.228 0.231	0.437 0.443	0.96 0.97	1.44 1.46	3.59 3.64	7.18 7.28	13.43 13.61	18.98 18.98	20.95 21.22	55.44	88.70						

Example 1

What size of accumulator will discharge 1.4L of liquid between the Max. working pressure at 140kg/㎠ and Min. working pressure at 120kg/㎠?

SOL

① $P_2/P_1 = \frac{140}{120} = 1.17$

② Find the value of P_2/P_1 which is equal to or next lowest to 1.17. In this case the value is 1.15.

③ Select accumulator reference equal to or next greater to 1.4 from the values located in the row 1.15.
Thus, total necessary volume of accumulator is 20 ℓ.

④ Select the accumulator model by FBN 330-5A.

※ Accumulator Necessary Discharge Flow is according to the pressure ratio of P_1/P_2 ($P_0=P_1 \times 0.9$)

[Note]

① The above table is based on the following formulars.
- P_2 = Max. System Pressure
- P_1 = Min. System Pressure
- $P_0 = 90\% \times P_1$
- $P_0V_0 = P_2V_2$ = Isothermal compression
- $P_2V_2^n = P_1V_1^n$ = Adiabatic expansion
- n = 1.4

② Ensure to use the above table, when the value of V_0-V_2 is within 80%.

20. Accumulator Volume Calculation

2 Pulsation Dampener

1 Applicable Basic Formula

There is a pulse from the pump when the pressurized fluid discharged. Pulse produces noise and vibrations that make the system as instability and the components are being damaged. Following formular is to minimize the vibration for the double acting that the pressure pulsation is varied by the number of piston and RPM.

$$\therefore V_0 = \frac{AKL(P_1/P_0)^{1/n}}{1-(P_1/P_2)^{1/n}}$$

Basic terms

V_0	Accumulator Gas Volume
P_0	N_2 Filled Gas Pressure
P_1	Average Pump Discharge Pressure
P_2	Max. Pump Working Pressure (Max. Allowable Pressure Pulsation)
A	Pump Cylinder Area
L	Pump Stroke
K	Value of Constant (K) based on Pump type
n	Polytropic Index 1.4 (N_2 Gas)

Constant (K) for Pump Type

Number	Type of Pump	K
1	Single-acting	0.60
	Double-acting	0.25
2	Single-acting	0.25
	Double-acting	0.15
3	Single-acting	0.13
	Double-acting	0.06
4	Single-acting	0.10
	Double-acting	0.06
5	Single-acting	0.06
	Double-acting	0.02
6	(Gear Pump)	0.06
7	(Vane Pump)	0.02

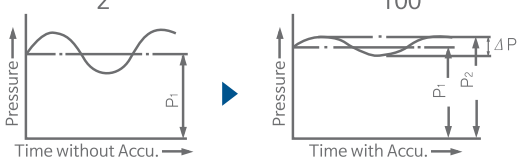
In case of Gear Pump

$$K = 0.6 \cdot A \cdot L \frac{\text{Pump Discharge (cc/min)}}{\text{(RPM) x No. of Gear}}$$

$$\text{Ripple Factor} = \frac{P_2-P_1}{P_1} \times 100\%$$

Calculation for Max. Allowable Pressure Pulsation

$$P_2 = P_1 + \frac{\Delta P}{2} \quad \text{or} \quad P_2 = \left(1+\frac{\text{Target Ripple Factor (\%)}}{100}\right) \times P_1$$



2 Calculation and select the model

What is the appropriate accumulator volume to reduce the pulsation from the pump under the working condition below?

Pump Type	: Triple Double-acting Plunger Pump
Inside Diameter of Plunger	: 100mm(10cm)
Average Discharge Pressure	: 170kg/㎠
Plunger Stroke	: 180mm
Target Ripple Factor	: ±3%
System Temperature	: Tmin = 10℃
	Tmax = 50℃,

$$(P_1 \times (0.65 \sim 0.75) \times \frac{Tmin+273}{Tmax+273}$$

$$\fallingdotseq 170 \times 0.7 \times \frac{10+273}{50+273} \fallingdotseq 105 kg/㎠$$

Solution

① P_0 = 105kg/㎠(P_1 x 0.6~0.75)
P_1 = 170kg/㎠
P_2 = 170+(170x0.03)=175.1kg/㎠
K = 0.06(64page)

$$A = \frac{\pi D2}{4} = \frac{3.14+10^2}{4} = 78.5㎠$$

L = 180mm(18cm)
n = 1.4

② Accoring to the calculation of accumulator,

$$V_0 = \frac{AKL(P_1/P_0)^{1/n}}{1-(P_1/P_2)^{1/n}}$$

$$= \frac{78.5 \times 18 \times 0.06 \times (170/105)^{1/1.4}}{1-(170/175.1)^{1/1.4}}$$

$$= 5.727㎥$$

$$\fallingdotseq 5.8\,ℓ$$

③ Set the Bladder volume based on applicable fluid
Nominal capacity of the accumulator that the gas volume is 6ℓ and it goes to the model of **FLOWFORCE** Accumulator as FBN330-1.5A with N_2 Gas filling pressure at 105kg/㎠

20. Accumulator Volume Calculation

3 Surge Pressure

1 Applicable Basic Formula

① **Determine the surge pressure**

When rapid closure of valve or sudden load changes in hydraulic system, there is an impact pressure in pipe lines which can lead to noise or damages to pipes or internal parts.

Surge pressure is generated when the speed of fluid is zero within closing time of valve(T) or the distance between the pipe ends is less than the time it takes to the road speed of sound pressure waves.

$$TC \leq \frac{2L}{\alpha}$$

T : Valve Closing Time(sec)
L : Length of Pipe(m)
α : Speed of the shock wave(m/sec)
TC : Critical Time: Round Trip Time of α

$$\alpha = \sqrt{\frac{k \cdot g}{\gamma} / \left(1+\frac{k \cdot d}{eE}\right)} \times 10^2$$

② **Appropriate accumulator volume is selected by the formular below.**

$$\therefore\ V_a = \frac{W \times V^2 \times (n-1)}{200 \times P_0 \left(\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right)}$$

Working Condition & System Specification

V_0	Accumulator Gas Volume(ℓ)
W	Total weight of fluid(kg)
V	Fluid Velocity(m/sec)
g	Gravitational acceleration(9.8m/sec^2)
L	Pipe Length(m)
P_0	Filled Gas Pressure(kg/㎠), P_1=(0.6~0.8xP_2)
P_1	Max. Allowable Impact Pressure(kg/㎠)
P_2	Normal Pressure or Initail System Pressure(kg/㎠)
n	Polytropic Index, 1.4

2 Calculation and select the model

What is the appropriate accumulator volume for following working condition(T=0.1 sec)?
Pipe Length = 120m
Pipe Size = 6B, SCH 40
Line Pressure before closing = 14kg/㎠·g
Flow = 3200 ℓ /min
Water Temperature = 15 ~ 20℃(Tmin: 15℃ ~ Tmax: 20℃)

[Solution]

① · Specific weight of water(γ) = 1000kg/㎥
· Pipe Length(L) = 120M
· Pipe Size(d) = 151.0mm(6B. SCH40 Copper)
· Flow(Q) = 3200 ℓ /min
· Fluid Velocity(V) = $21.23 \cdot Q/d^2 = 21.23 \times 3200/151^2$
= 2.98m/sec
· Total weight of fluid(W) = $\frac{\pi \cdot d^2}{4} \cdot L \cdot \gamma 10^{-6}$
= $\frac{\pi \cdot 151^2}{4} \times 120 \times 1{,}000 \times 10^{-6}$
= 2148kg
· Normal Pressure(P_1) = 14kg/㎠

② Check the possibility of the surge pressure in pipelines

· Speed of the shock wave(α) = $\sqrt{\frac{k \cdot g}{\gamma} / (1+\frac{k \cdot d}{eE})} \times 10^2$

여기서,

· Bulk modulus of water(k)=2.083×10^4 kg/㎠
· The modulus of longitudinal elasticity of the pipe material(E)=2.1×10^6kg/㎠
· Pipe thickness(e)=7.1mm

※Thus,

· $\alpha = \sqrt{\frac{2.083 \times 10^4 \times 9.8}{10^3}} / (1+\frac{2.083 \times 10^4 \times 151}{2.1 \times 10^6 \times 7.1}) \times 10^2$

≒ 1302m/sec

Critical Time(TC) = $\frac{2xL}{\alpha} = \frac{2 \times 120}{1302} = 0.18$sec

So, there is surge pressure occurred because T(0.1 sec) is less than TC(0.18 sec)

③ Max. Allowable Surge Pressure goes to $P_2 < 1.1 \cdot P_1$

$P_2 = 14 \times 1.1 \fallingdotseq 16$kg /㎠.a

$P_0 = P_1 \times (0.6 \sim 0.75) \times \frac{T_{min}+273}{T_{max}+273}$

= $16 \times 0.67 \times \frac{15+273}{20+273}$

= 10.5kg/㎠·abs(N2 Gas filling pressure)

④ The necessary gas volume of accumulator is,

$\therefore\ V_a = \frac{W \times V^2 \times (n-1)}{200 \times P_0((\frac{P_2}{P_1})^{\frac{n-1}{n}} - 1)}$

= $\frac{2148 \times 2.98^2 \times (1.4-1)}{200 \times 10.5 \times P_0((\frac{16}{14})^{\frac{1.4-1}{1.4}} - 1)}$

⑤ $V_o = V_a \times \frac{P_1}{P_0}$

$V_o = 95 \times (\frac{14}{10.5}) = 126\ \ell$

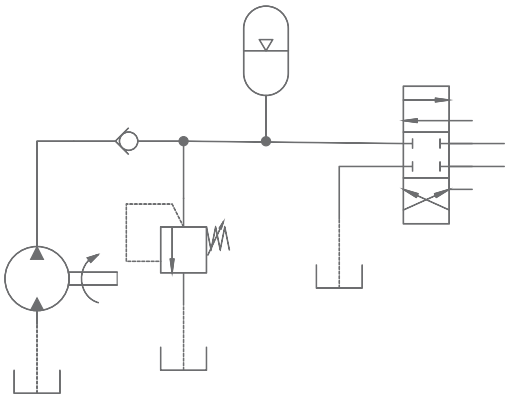
⑥ Select the appropriate model

Set the bladder material: Refer to page 23. for bladder material based on fluid and working temperature.
Model Code of selected accumulator: FLN-50-40A, 1EA
(Gas volume 50x3-150 ℓ > 126 ℓ)
The calculation of N_2 gas filling pressure is the surge pressure under ambient temperature.

20. Accumulator Volume Calculation

Question (1)

There might be shocks generated when the direction of the flow is changed using a solenoid valve on a hydraulic line. What is the appropriate model of accumulator for the surge pressure concerning below hydraulic circuit?



- Pipe Diameter (d) = 3/4"B SCH 160 (I.D : 16.2mm)
- Pipe Length (L) = 16M
- Flow Rate (Q) = 240 ℓ /Min
- Normal Pressure (P_1) = 150kg/㎠
- Max. Allowable Impact Pressure (P_2) = 150 × 1.1 ≒ 165kg/㎠
- N_2 Gas filling pressure (P_0) $= P_1 \times (0.6 \sim 0.75) \times \frac{T_{min}+273}{T_{max}+273}$

  $= 165 \times (0.65) \times \frac{40+273}{50+273}$

  = 105kg/㎠.g
- Specific weight of fluid (γ) = 900kg/㎥

  (Hydraulic oil type: Phosphate ester hydraulic fluid, Working Temperature at Tmin: 40 ~ Tmax: 50℃)

[Solution]

(1) $W = \frac{\pi d^2}{4} \cdot L \cdot \gamma \cdot 10^{-6}$

$= \frac{\pi \times 16.2^2}{4} \times 16 \times 900 \times 10^{-6}$

= 2.96kg

(2) According to the accumulation calculation,

$V_0 = Va \frac{P_1}{P_0}$

$V_0 = \frac{W \cdot V^2 \cdot (n-1)}{200 \cdot P_0 \cdot [(P_2/P_1)^{n-1/n} - 1]}$

$= \frac{2.96 \times 19.42^2 \times (1.4-1)}{200 \times 105 \times [(165/150)^{1.4-1/1.4} - 1]}$

≒ 0.8 ℓ

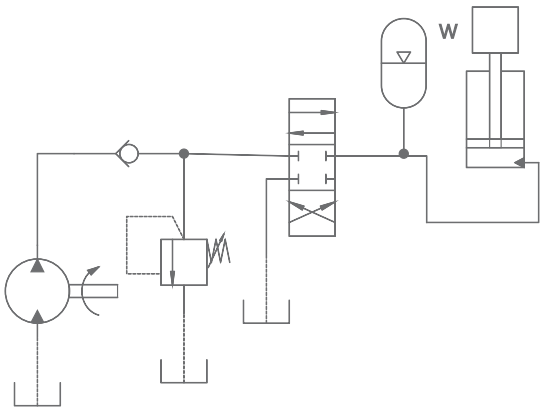
$V_0 = 0.8 \times \frac{150}{105} = 1.1$ ℓ

(3) Select the appropriate model

- Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
- Model Code of selected accumulator FBN 350-0.7A, 1EA (Gas volume 2.5 ℓ > 1.1 ℓ) (*Refer to page 20.)

Question (2)

There might be shocks generated by sudden stop or descent of Ram from the constant speed and pressure.
What is the accumulator volume to abosrb this impact pressure?



- Ram Weight (Load, W) = 800ton
- Normal Pressure (P_1) = 120kg/㎠
- Ram Rate Descent (V) = 0.12sec
  (Hydraulic oil type: Phosphate ester hydraulic fluid, Working Temperature at Tmin: 40 ~ Tmax: 50℃)

[Solution]

(1) Max. Allowable Impact Pressure (P_2) = 120 x 1.1 = 132kg/㎠

- N_2 Gas filling pressure (P_0)

$$= P_1 \times (0.75) \times \frac{T_{min}+273}{T_{max}+273}$$

$$= 120 \times 0.72 \times \frac{40+273}{50+273}$$

$$= 84 kg/㎠.g$$

- Flow Rate (Q) = It can safely be ignored because the flow rate is very small.

(2) According to the accumulation calculation,

$$Va = \frac{W \times V^2 \times (n-1)}{200 \times P_0 \left(\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right)}$$

$$= \frac{800 \times 10^3 \times 0.12^2 \times (1.4-1)}{200 \times 84 \left(\left(\frac{132}{120} \right)^{\frac{1.4-1}{1.4}} - 1 \right)}$$

$$= 8\,\ell$$

$$V_0 = Va \cdot \frac{P_1}{P_0} = 8 \times \frac{120}{84} = 9.1\,\ell$$

(3) Select the appropriate model

- Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
- Model Code of selected accumulator : FBV 330-2.5A 1EA (Gas volume 10 ℓ〉9.1 ℓ) (*Refer to page 20.)

20. Accumulator Volume Calculation

4 Thermal Expansion Compensator

1 Applicable Basic Formula

Both the fluid and the pipes will expand in volume when the fluid is heated up in the pipes of the closed circuit.
The coefficient of thermal expansion of the fluid which is unstable condition is greater than the coefficient of thermal expansion of the piping material.
Morevoer, thermal expansion of the fluid increases all the pressure in the whole system.
This pressure which is instability increasing is unnecessary and damages on the expensive hydraulic components.
Increase or decrease of the internal pressure occurs due to the temperature changes in a closed circuit. It is also one of the accumulator functions that reduce the fluctuations in the pressure.

$$\therefore V_0 = \frac{V_1 (T_2 - T_1)(\beta - 3\alpha)(P_1/P_0)}{1 - (P_1/P_2)}$$

Basic terms

V_0	Accumulator Gas Volume (ℓ)
P_0	N2 Gas Filled Gas Pressure (P1X 0.7 ~ 0.8) (kg/㎠·abs)
P_1	Min. System Pressure at T_1 (kg/㎠·abs)
P_2	Max. System Pressure at T_2 (kg/㎠·abs)
V_1	Total Amount of Fluid in Pipes at T_1 (Pipe Cross-sectional Area x Pipe Length) ℓ
T_1	Initial System Temperature (℃) : Absolute Pressure (abs) (273+℃) = Tmin
T_2	Increased System Temperature (℃) : Absolute Pressure (abs) (273+℃) = Tmax
α	Coefficient of Linear Expansion Piping (1/℃)
β	Coefficient of Volume Expansion of Fluid (1/℃)
n	Polytropic Index, 1.4

2 Calculation and select the model

[Question] What is the appropriate accumulator volume based on the working condition below?

- Pipe Length : 15M
- Bore Area of Pipe : Φ125(SCH40)
- Material : Steel
- Specific weight of fluid(γ) : 0.75(at 20℃)
- Fluid : Gasoline

[Solution]

(1) · V_0 : Accumulator Gas Volume

· $P_0 = P_1 \times (0.8 \sim 0.9) \times \frac{T_{min}+273}{T_{max}+273}$

$= 1.73 \times 0.9 \times \frac{293}{328}$

$= 1.4kg/cm2 \cdot abs$

· P_1 : 0.7+1.033=1.73kg/㎠·abs

· P_2 : 4+1.033=5.03kg/㎠·abs

· $T_2 - T_1$: 328−293=35℃

· Φ125(SCH40) Total volume of Φ125(SCH40) pipe

O.D(Outside of Diameter) of Steel Pipe: 139.8mm, Thickness of Steel Pipe: 6.6mm

$Vt = \frac{\pi(139.8-2\times0.66)^2}{4} \times 1{,}500cm$

$= 188.725㎤$

$= 189Liter$

· α: 10×10^{-6} 1/℃ (from Engineering Hand Book)

· β: 13.5×10^{-4} 1/℃ (Gasoline)

(2) Thus, necessary gas volume is,

· $V_0 = \frac{V_t(T_2-T_1)(\beta-3\alpha)(P_1/P_0)}{1-(P_1/P_2)}$

· $V_0 = \frac{189 \times (35) \times (13.5\times10^{-4}-3\times10^{-6}) \times (1.73/1.4)}{1-(1.73/5.03)}$

$\fallingdotseq 15.3Liter$

(3) Select the appropriate model

· Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.

· Model Code of selected accumulator FBN 330−5A, 1EA

※ Note : Please see example on page 61 for the calculation of N_2 gas filling pressure at ambient temperature.

21. Accumulator Selection Questionnaire

Please fill in the blank and send it by email(master@flowforce.co.kr) or fax(+82-31-499-9886). Date: / /

Company / Dept.		/		
Contact Information	Person		Tel	
	e-mail		Fax	
System Information	Name of system			
	Location			
Application		Ex. Energy accumulation / Pulse absorption / Impact absorption / Others		
Type of Accu.	☐ Bladder Type ☐ Diaphragm Type ☐ Piston Type			

1. Working Condition

Location	☐ Indoor ☐ Outdoor	Operating time required of system	___Hour/Day	Installation	☐ Vertical ☐ Horizontal ☐ Other
Temperature Condition	Fluid Temp : ~ ℃ Normal Temp : ℃		Applicable Fluid	☐ Common Mineral Oil	
	Ambient Temp : ~ ℃ Normal Temp : ℃			☐ Others	
Material	**Shell** ☐ Carbon Steel(standard) ☐ SUS ☐ Other( ) **Bladder** ☐ NBR(standard) ☐ Viton ☐ EPDM ☐ Other( )				
	Any other specific required( )				

2. Operating Condition

☐ Energy Accumulation

Max. Operating Pressure	P_2	bar
Min. Operating Pressure	P_1	bar
Necessary Discharge Flow	△V	ℓ
Charge/Discharge Period		sec
Required Discharge Flow	q	ℓ/min

"※. System Pressure = Max. Working Pressure(P_2) = Relief Valve Opening Pressure"

☐ Pulse Absorption

Average Discharge Pressure(pump)		P_1	bar
Target Ripple Factor		-	%
Pump Specification	Discharge	Q	ℓ/min
	Rotations	N	rpm
Type of Pump		☐ Plunger ☐ Cylinder	
		☐ Diaphran ☐ Single	
		☐ Double	
		☐ Vane ☐ Gear	

☐ Impact Absorption

Normal Pressure	P_1	bar
Allowable Impact Pressure	P_2	bar
Fluid Density	ρ	kg/㎥
Inside Pipe Diameter	d	mm
Pipe Length	L	m
Flow Rate	Q	ℓ/min
Flow Velocity	V	m/s

※ Other application	☐ Thermal Expansion Compensation ☐ Leak Compensation ☐ Gas Spring ☐ Transfer Barrier
	☐ Equilibrium Action ☐ Other

3. Option

Fluid Port Connection		Gas Port Connection	
☐ Unnecessary		Permanent Gauge	☐ Unnecessary
☐ Bushing	Size:		☐ Necessary
☐ Flange	Connection Diameter: A		☐ Fuse Met
	☐ A ____ Type	TR Cap (Temp. sensing type)	☐ Unnecessary
	☐ B ____ Type		☐ Necessary
	☐ C ____ Type	Pressure Guage	☐ b
	☐ Other		☐ Other
Regulation	☐ CE MArk ☐ ASME		
	☐ China Requlation(SELO) ☐ Other		

4. Additional Specification

Nameplate	☐ Standard	Manufacturer Specification
	☐ Customized	Other:
Paint	☐ Manufacturer Standard (· Coat : · Topcoat : · Color :)	
	Designated	
Internal Cleanliness	☐ Manufacturer Standard	Nas 10 Class
	☐ Designated	Nas____Class
Filled N_2 Gas Pressure	☐ Standard	20bar
	☐ Designated	____bar at ____℃
Other		

Result of Selection	Type		Model / code	
	Quantity	EA	Filled N_2 Gas Pressure	____bar at ____℃

22. Accumulator Calculation Sheet

1 Energy Storage & Save

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	- ℃	Fluid Type	☐ Fluid :
	Ambient Temp.	- ℃		☐ Other :

Max. Operating Pressure	P_2	bar	Max. pressure of accumulated fluid in the accumulator
Min. Operating Pressure	P_1	bar	Min. pressure when fluid is discharged from the accumulator
Average Operating Pressure	Pm	bar	Pm = $(P_2+P_1) / 2$
Necessary Discharge Flow	dV	ℓ	Total amount of fluid required for piston(actuator) operation
Accumulation/Discharge Cycle Time	Tc	sec	Tc = △tm(Accumulation time) + △tn(Discharging time)

Calculate necessary gas volume(V_0)

Less than the pressure at 10bar is calculated as an absolute pressure(Absolute Pressure=Pg + 1.0339)

☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.8\sim0.9)xP_1$	0.85x( ) = ____ bar
	☐ If the temperature changes : $P_0=\frac{273+T\ min}{273+T\ max} x\ (0.8\sim0.9)xP_1$	$\frac{273+(\ )}{273+(\ )}$ x 0.85=____bar
	Max. N_2 Gas Charging ($\alpha = P_0/P_2$)	• Vertical mounting : 1/4($P_0 \geq P_2$ x 0.25) • Horizontal mounting : 1/3($P_0 \geq P_2$ x 0.33)
☐ Set Polytropic Indices(n)	① Cycle Time x ② Average Operating Pressure x ③ Average ambient temperature = n	
	n = ( ) Cycle Time x ( )Average Operating Pressure x ( )Average ambient temperature = _____	※ Please refer to the graph for the curve 1, 2 and 3 on page 60~61.

☐ Calculate Necessary Gas Volume for Accumulator(Vo)

$$\therefore V0 = \frac{dV \times (P_1/P_0)}{1-(P_1/P_2)^{1/n}} = \frac{(\ ) \times (\ /\ )}{1-(\ /\ )^{1/(\ )}} = \_\_\_\_ \text{ Liter}$$

Verify Necessary Discharge Flow Q max Qmax = dV x 60 ÷ △tn = ( ) x 60 ÷ ( ) = _____ ℓ/min

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0)

- Select the model according to P_2, Qmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts(shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ /(Accumulator Gas Volume)/ _____ ℓ /unit

Verify the discharge flow(△V) of the selected accumulator

$$\therefore \triangle V = V_0(\text{Gas Volume}) \times \frac{1-(P_1/P_2)^{1/n}}{P_2/P_0} = (\ ) \times \frac{1-(\ /\ )^{1/(\ )}}{(\ /\ )} = \frac{(\ )}{(\triangle V \geq dV)} \text{ Liter}$$

22. Accumulator Calculation Sheet

2 Pulsation Dampener

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature		Fluid Temp.	- ℃	Fluid Type	☐ Fluid :
		Ambient Temp.	- ℃		☐ Other :
System Pressure	P max	bar	Max. possible pressure applied to the accumulator in the circuit. (Release pressure of the relief valve)		
Average Discharge Pressure	P_1	bar	Average pressure of fluid dischargeed from the pump		
Target Ripple Factor		%			
Type of Pump: ☐ Plunger / ☐ Diaphragm / ☐ Gear / ☐ Vane / ☐ Other	Number		☐ Single-acting ☐ Double-acting		
Pump Specification	Discharge	ℓ /min			
	Rotation	rpm			

K - Pump Type

Type of Pump	No.	K: Single-acting	K: Double-acting
Plunger	1	0.60	0.25
	2	0.25	0.15
	3	0.13	0.06
	4	0.1	0.06
	5	0.06	0.02
	6	0.06	
	7 or more	0.02	
Gear / Vane		0.06	

Calculate Necessary Gas Volume (V_1)

Less than the pressure at 10bar is calculated as an absolute pressure (Absolute Pressure=PG + 1.0339)

☐ Set Constant (k)	Refer to the above table, K-Pump Type	
☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.6\sim0.75)\times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0=\frac{273+T\,min}{273+T\,max}\times(0.6\sim0.75)\times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha=P_0/P_2$)	· Vertical mounting : $1/4(P_0 \geq P_2 \times 0.25)$ · Horizontal mounting : $1/3(P_0 \geq P_2 \times 0.33)$
☐ Calculate Discharge per Pump Rotation (Q)	☐ Q = Discharge ÷ Rotation =	( ) ÷ ( ) = _____ ℓ /Rotation
☐ Set Polytropic Indices (n)	n = 1.40	(N_2 Gas)
☐ Max. Operating Pressure (P_2)	P_2 = (1+Target Ripple Factor/100) x P_1	= 1 + ( )/100 = ( )bar

☐ Calculate Necessary Gas Volume for Accumulator (V_0)

$$\therefore V_0 = \frac{Q \times K \times (P_1/P_0)^{1/n}}{1-(P_1/P_2)^{1/n}} = \frac{Q \times K \times (\quad/\quad)^{1/1.4}}{1-(\quad/\quad)^{1/1.4}} = \_\_\_\_\_\ \text{Liter}$$

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0).

- Select the model according to V_0, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts (shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ / (Accumulator Gas Volume) / _____ ℓ /unit

3 Surge Pressure Absorption

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	- ℃	Fluid Type	☐ Fluid :
	Ambient Temp.	- ℃		☐ Other :

System Pressure	P max	bar	Max. possible pressure applied to the accumulator in the circuit (Release pressure of the relief valve).
Allowable Impact Pressure	P_2	bar	$P_2 = P_1 + \alpha(110\% \times P_1)$ / Generallt set to be 110% of the normal pressure
Normal Pressure	P_1	bar	The pressure within a pipe with no impact pressure.
Fluid Density	γ	kg/㎥	Water: 1,000kg/㎥ (Petroleum based hydraulic oil: 900kg/㎥, Phosphate ester: 1,100kg/㎥)
Inside Pipe Diameter	d	mm	
Pipe Length	L	m	
Flow Rate	Q	ℓ/min	
Flow Velocity	v	m/s	Flow rate = Pipe diameter

Calculate necessary gas volume (V_1)

Less than the pressure at 10bar is calculated as an absolute pressure (Absolute Pressure=PG + 1.0339)

☐ Calculate Fluid Mass within the Line (W)	$W = \pi/4 \times d^2 \times L \times \gamma \times 10^{-6}$	$= \pi/4 \times (\quad)^2 \times (\quad) \times (\quad) \times 10^{-6} =$ ___ kg
☐ Calculate Flow Velocity (v)	$v = 21.33 \times Q/d^2$	$= 21.33 \times (\quad)/(\quad)^2 =$ ___ m/s
☐ Set Filled Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.6\sim0.8)\times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0=\frac{273+T\,min}{273+T\,max}\times(0.6\sim0.8)\times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha=P_0/P_2$)	· Vertical mounting : $1/4(P_0 \geq P_2 \times 0.25)$
		· Horizontal mounting : $1/3(P_0 \geq P_2 \times 0.33)$
☐ Set Polytropic Indices (n)	n = 1.40	(Nitrogen Gas)
☐ Allowable Impact Pressure (P_2)	$P_2 = 1.1 \times P_1$	$= 1.1 \times (\quad) =$ _____ bar

☐ Calculate Accumulator Gas Volume (V_A) when Pressure is (P_1)

$$\therefore V_A = \frac{W \times V^2 \times (n-1)}{200 \times P_0 \times (P_2/P_1)^{n-1/n} - 1} = \frac{(\quad) \times (\quad)^2 \times (1.4-1)}{200 \times (\quad) \times (\quad)/(\quad)^{1.4-1/1.4} - 1} = \_\_\_\_\_ \text{ Liter}$$

☐ Calculate Necessary Gas Volume for Accumulator (V_0)

$$\therefore V_0 = V_A \times \frac{P_1}{P_0} = (\quad) \times \frac{(\quad)}{(\quad)} = \_\_\_\_\_ \text{ Liter}$$

Select Accumualtor Model

※ Please refer to the specification on page 20 for the accumulator gas volume (V_0).

- Select the model according to V_1, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts (shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ / (Accumulator Gas Volume) / _____ ℓ /unit

22. Accumulator Calculation Sheet

4 Thermal Expansion Compensation

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	-	℃	Fluid Type	☐ Fluid :
	Ambient Temp.	-	℃		☐ Other :

System Operating Condition				
	Max. Operating Pressure	P_2	bar	Pressure at Temperature T_2
	Normal Pressure	P_1	bar	Pressure at Temperature T_1
	Filled N_2 Gas Pressure	P_0	bar	
	Initial System Temperature	t_1	℃	
	Increased System Temperature	t_2	℃	
	The coefficient of thermal expansion based on the pipe material	α	1/℃	$\alpha = 10 \times 10^{-6}$ 1/℃ (Steel)
	Fluid volume expansion coefficient	β	1/℃	Refer to Fluid volume expansion coefficient below.
	Necessary Gas Volume	V_1	ℓ	Volume at T_1

Calculate necessary gas volume (V_0)

Less than the pressure at 10bar is calculated as an absolute pressure (Absolute Pressure=Pg + 1.1013)

☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.6\sim0.8)\times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0=\frac{273+T\,min}{273+T\,max}\times(0.6\sim0.8)\times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha=P_0/P_2$)	· Vertical mounting : $1/4(P_0 \geq P_2 \times 0.25)$
		· Horizontal mounting : $1/3(P_0 \geq P_2 \times 0.33)$

☐ Calculate Necessary Gas Volume for Accumulator (V_0)

$$\therefore V_0 = \frac{V_1 \times (T_1-T_2)\times(\beta-3\alpha)\times(P_1/P_0)}{1-(P_1/P_2)} = \frac{(\quad)\times(\quad)-(\quad)\times(\quad)-3(\quad)\times(\quad)/(\quad)}{1-(\quad)/(\quad)} = \_\_\_\_\_ \text{ Liter}$$

※ Fluid volume expansion coefficient

Fluid Density	0.86~0.87	0.87~0.88	0.88~0.89	0.89~0.90	0.90~0.91	0.91~0.92	0.92~0.93	0.93~0.95	0.95~0.96	0.96~0.97
① Cubic expansion coefficient	0.00077	0.00076	0.00075	0.00074	0.00073	0.00072	0.00071	0.0007	0.00069	0.00068
② Fluid ensity	0.97~0.98	0.98~1.00	1.001~1.075							
③ Cubic expansion coefficient	0.00067	0.00066	0.00063							

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0)

- Select the model according to V_1, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts (shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	

※ No. of necessary accumulators
= V_1_____ ℓ / (Accumulator Gas Volume) / _____ ℓ /unit

23. Accumulator Handling & Precaution

Before installation

1. Please ensure to check the nameplate of the accumulators whether they match to your order.
2. Never use the accumulators at pressure above its maximum working pressure.
3. Please do not use any other types of fluids than the selected fluids.
   (It will be caused deterioration of the product life-cycle)
4. The accumulators are not filled with N_2 gas when they are shipped to customers and ensure to fill N_2 gas before using the accumulators.
   (Pre-filling at 2 bar only, but N_2 gas filled as per customer request when placing the order)

Installation & N_2 Gas Charging

5. Before installation of accumulators, please ensure to use clamp band to fix the accumulators.
6. Ensure not to operate accumulators prior to filling of N_2 gas. It is caused to damage to bladders.
7. Ensure to fill the accumulators with only N_2 gas.

- **Never use oxygen or inflammable gas.**
- **Ensure not to use air instead of N2 gas that the life-cycle of bladders will be shortened.**

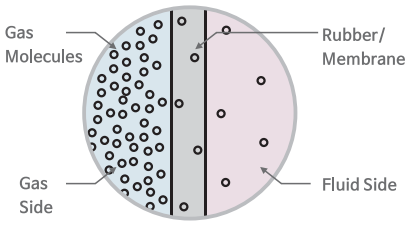
8. Prior to checking N_2 gas pressure, ensure to release the fluid pressure.
9. Before releasing the fluid pressure, please ensure to utilize by-pass or drain positioned between main pipe.

Operation & Maintenance

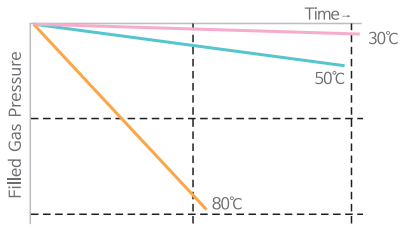
10. Carry out the periodic maintenance and inspections of the accumulators approximately 2 times per year.
    ① Add more N_2 gas if it is insufficient.

※ Note that N_2 gas will typically permeate from the bladders causing the gas pressure to drop
(Please refer to Technical Manual for more information about osmotic pressure and precautions).

Gas Permeation



Relationship between temperature of accumulator and pressure drop in filled gas pressure



② Ensure to check the leakage for any external N_2 gas or fluid.
③ Ensure to check accumulators for any damages, loosened screws or any abnormalities.

11. Ensure to release the pressure in system line prior to disassembling accumulators.
12. Ensure to release all N_2 gas from the accumulators prior to storage.
13. Before disposing of accumulators, please ensure to completely remove N_2 gas first then, remove gas valve and control valve, thereby ensuring not to use again.

※ Please note
- Ensure to adequate ventilation of the room when removing N_2 gas from accumulators
  (The room might become saturated with N_2 gas and will lead to a deficiency of oxygen).
- Welding or any other process of accumulators are strictly prohibited.

Please contact FLOWFORCE or nearest service center regarding any necessary on-site gas filling or replacing parts.

23. Accumulator Handling & Precaution

1 N_2 Gas Charging Kit

- FCU charging kit allows the customers to fill N_2 gas safely and check the gas pressure in accumulators on a regular basis.
- One of the main features of the regulator as an option that controls the supplied pressure of N_2 gas stably and safely.
- This FCU charging kit is durable and easy-to-use structure designed.

1.1 Safety Instruction and Precautions.

1. Before using this FCU charging kit, please ensure to read the safety instructions and precautions.
2. We are not responsible for the product defaults occurred using any other tools and kits during charging N_2 gas.
3. In order to prevent any damages on bladders before N_2 charging, please ensure to release oil pressure first.
4. Purity of the N_2 gas is always more than 99.8%.
5. Please ensure to use the regulator when setting the charging kit for pressure charging.
6. FCU charging kit is a test tool.
7. After using the charging kit, please release the charging kit from the accumulators.

1.2 Application

- Bladder Type Accumulator
- Piston Type Accumulator
- Diaphragm Type Accumulator
- Membrane Type Accumulator
- Others

1.3 Appropriate charging pressure

- Energy accumulation : 80~90% of minimum operating pressure
- Surge absorption : 60~80% of normal pressure
- Thermal expansion compensation : 60~80% of normal pressure
- Pulse absorption : 60~75% of the average operating pressure

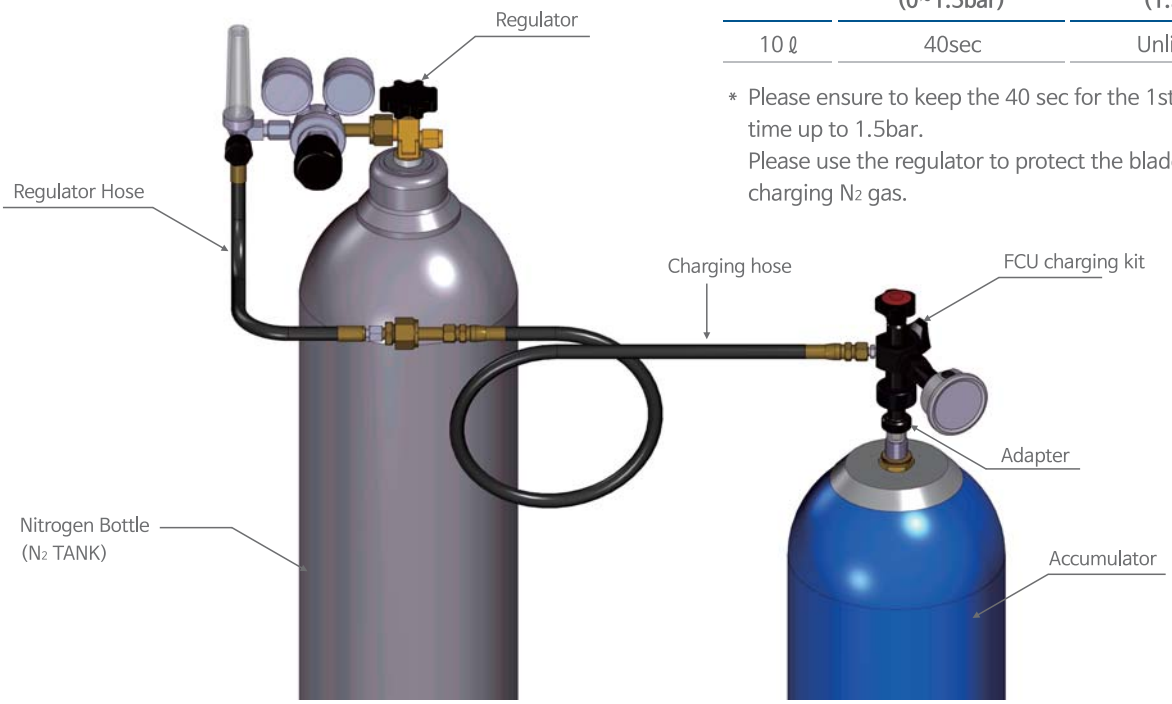
2 Accumulator Handling & Precaution

- Recommendation : Please refer to the instruction manual before proceeding start-up charging process.
- Pressure limitation : Please check the maximum pressure of each accumulator that described on the shell. After filling N_2 gas, please wait for a while until the pressure is stabilized that it needs a certain time of period for N_2 gas pressure to be stabilized.
- Depending on the ambient temperature when filling N_2 gas, it is necessary to control and adjust the amount of N_2 gas.

※. Charging management based on Volume
Ex) Membrane Accu.

Volume	1st Charging Time (0~1.5bar)	2Charging Time (1.5bar)
10ℓ	40sec	Unlimited

* Please ensure to keep the 40 sec for the 1st charging time up to 1.5bar.
Please use the regulator to protect the bladders when charging N_2 gas.



- **Regulator features**
  In case of initial charging, please ensure to use low pressure in a certain time(If the initial charging pressure is high when charging the accumulator might be damaged to the bladders due to the sudden expansion)

At this time, a constant pressure control is necessary during the initial filling of N_2 gas by the regulator.

1. To be filled up to 10bar by using the regulator.
2. Connector the charging hose to N_2 gas tank and fill N_2 gas up to desired pressure.

23. Accumulator Handling & Precaution

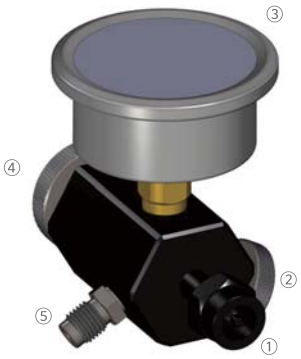
3 N_2 Gas Charging Process

1st step : Be Ready

1. Please ensure to determine the optimal pressure
   (In order to prevent damages on the bladders, bladder type accumulators should be filled with more than 25% and Diaphragm type accumulators should be filled with more than 17%).
2. Connecting Charging hose
   - First, connect the regulator to the N_2 gas tank.
   - In case of using only charging kit, then connect the N_2 gas tank with the charging kit.
3. Connecting charging kit
   Using the adapters to connect between the charging kit and gas valve.

Part list

① Charging Device Nozzle
② Air Vent Valve
③ Pressure Gauge
④ Charging Handle
⑤ Tank Valve Nipple



2nd step: Check N_2 Gas Pressure

4. Open the inlet bolt of gas valve.
   - In case of Diaphragm accumulators, open the inlet bolt a bit.
     (35N 90°: Too much open will be happened leakage)
5. Please ensure to check N_2 gas pressure from the accumulators by turning the knob(④) as counterclockwise.
6. Please check whether N_2 gas supplying to the accumulator turning the knob(②) as clockwise a bit.
7. If see there is the pressure of the accumulator, then filling N_2 gas to the accumulator.

3rd step: N_2 Gas Charging

8. Open the N_2 gas tank.
9. In case of charging N_2 gas pressure by using regulator, please set up the desired pressure first.
10. Please stop charging the pressure by turning the knob(④) as clockwise when the pressure of the gauge is slightly above the desired pressure.
11. Close the valve of N_2 gas tank.
12. Close by turning the knob(②) as clockwise, and release the residual pressure of charging kit.
13. When the pressure is stabilized, please re-check the pressure whether it is pressurized. Then, disassemble the charging kit from the accumulator.

4th step : Final Check-up

14. Please do the leak test by using soapy water on gas valve of the accumulator.
    * If there is no leakage found on Diaphragm type accumulator, close the gas valve by torque wrench.
15. Close the cover after removing the soapy water.

* How to adjust N_2 gas pressure is to connect the charging kit with the accumulator while open the knob(④), check the pressure gauge until desired pressure by turning the knob(②). After disassemble the charging kit, do the leak test by soapy water.

24. Appendix

1. Length

mm	cm	m	in
1	0.1	0.001	0.0394
25.4	2.45	0.0245	0.965

2. Pressure

Mpa	kg/㎠	bar	psi
1	1.01972	10	145.038
0.09807	1	0.98067	14.2233
0.1	10.1972	1	14.5038
0.00689	0.07031	0.06895	1

3. Volume

Liter	IN^3	U.S.gal	U.K.gal
1	61.033	0.264	0.219
0.016	1	0.004	0.003
3.785	231	1	0.833
4.546	277.419	1.2	1

4. Viscosity & Kinematic Viscosity

Pa.S	cp	P
1	$1 X 10^3$	1 X 10
$1 X 10^{-3}$	1	$1 X 10^{-2}$
$1 X 10^{-1}$	$1 X 10^2$	1

m/s	cSt	St
1	$1 X 10^6$	$1 X 10^4$
$1 X 10^{-6}$	1	$10 X 10^{-2}$
$1 X 10^{-4}$	$1 X 10^2$	1

5. Temperature

℃	℉	℃	℉
-40	-40	+80	+176
-20	-4	+100	+212
0	+32	+120	+248
+20	+68	+140	+284
+40	+104	+160	+320
+60	+140	+180	+356

The faith and belief in technology with new CI, FLOWFORCE is a hydraulic system accessory manufacturer with

35 years of business background and experience aiming to be the Global Only 1. Company in the hydraulic accessories and cooling solution technology.

FLOWFORCE also implements energy-saving on its site and lead the market with new technology by supplying the most efficient eco-friendly and next-generation products as its guaranteed, created and shared value for the customers.

By the experience together with next-generation technologies that we, FLOWFORCE will exert efforts to improve customer problems with differentiated engineering solutions and leading the market.

Thank you.

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