New Challenge for creation——NOK-GROUP

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NOK CORPORATION
NOK

NOK EKK

● Cat. No. **239E・10-2015**

Compliant with all major Regulations and Standards

ACCUMULATOR

**CE Mark
(EU)**

**Regulation for
Boiler and Pressure
Vessel Manufacture
Licensing (CHINA)**

**ASME
U Stamp
(USA)**

**High Pressure Gas
Safety Law
Industrial Safety and
Health Law (JAPAN)**

ACCUMULATOR

NOK CORPORATION

EAGLE INDUSTRY CO.,LTD.

NOK

Eagle Industry Co., Ltd.   Printed in Japan

AI Sales Department Marketing & Sales Division

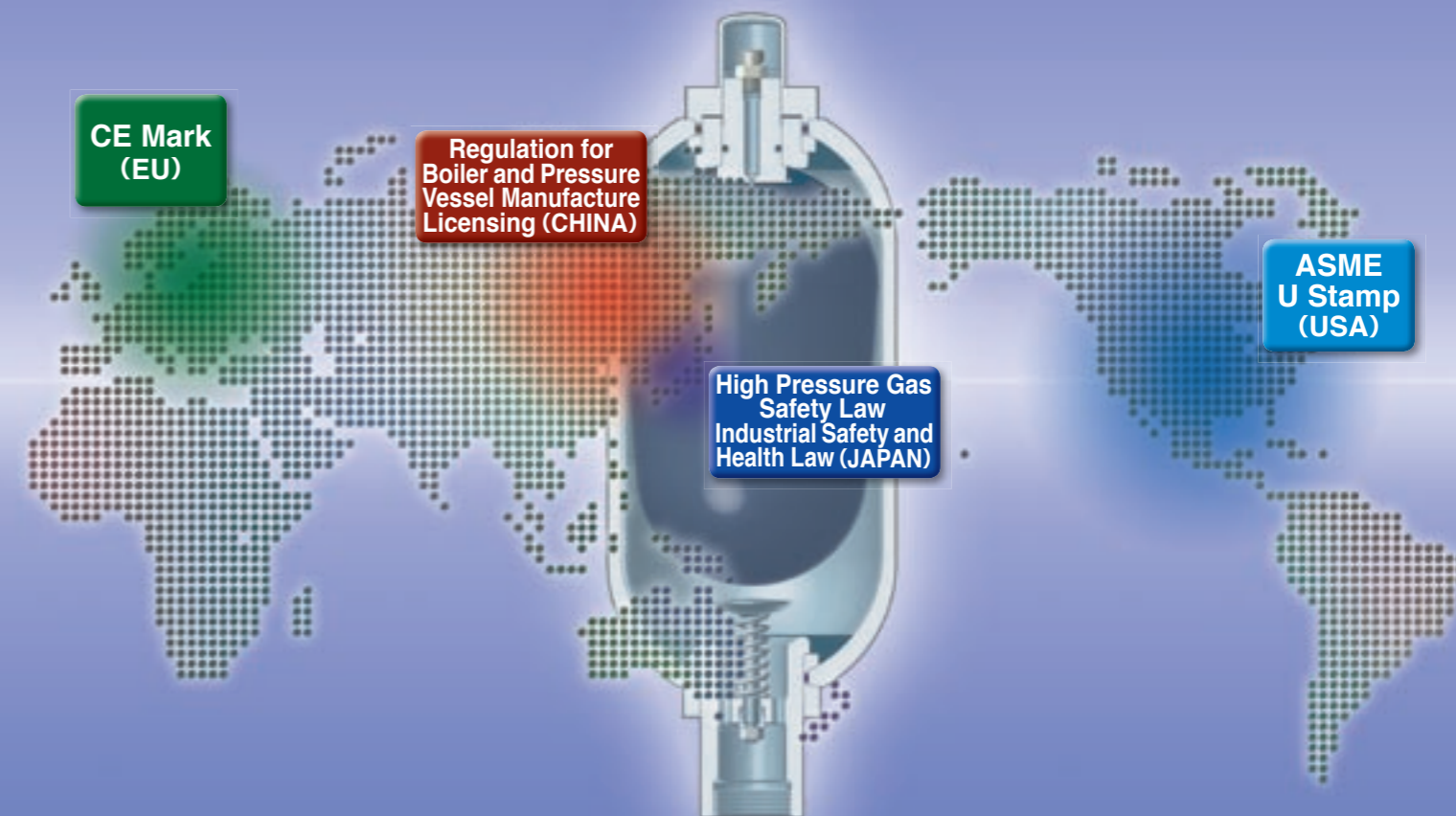1-12-15, Shiba-Daimon, Minato-ku, Tokyo, Japan. Zipcord 105-8587.

http://www.ekk.co.jp/eng/
（NOK GROUP）

The contents are subject to change without notice.

The accumulators utilize the compressibility of gas.
Feature greater energy efficiency, safety, and less noise.

NOK Accumulators have proved very popular with a number of customers as they are highly reliable with a wide ranging lineup available that are supported by global top-class rubber materials, seals and processing techniques, were designed with the environment taken into consideration, and are ISO14000 compliant.

NOK ACCUMULATOR

Summary

List of Model Codes and Dimensions

Accessories and Parts

Handling and Selection

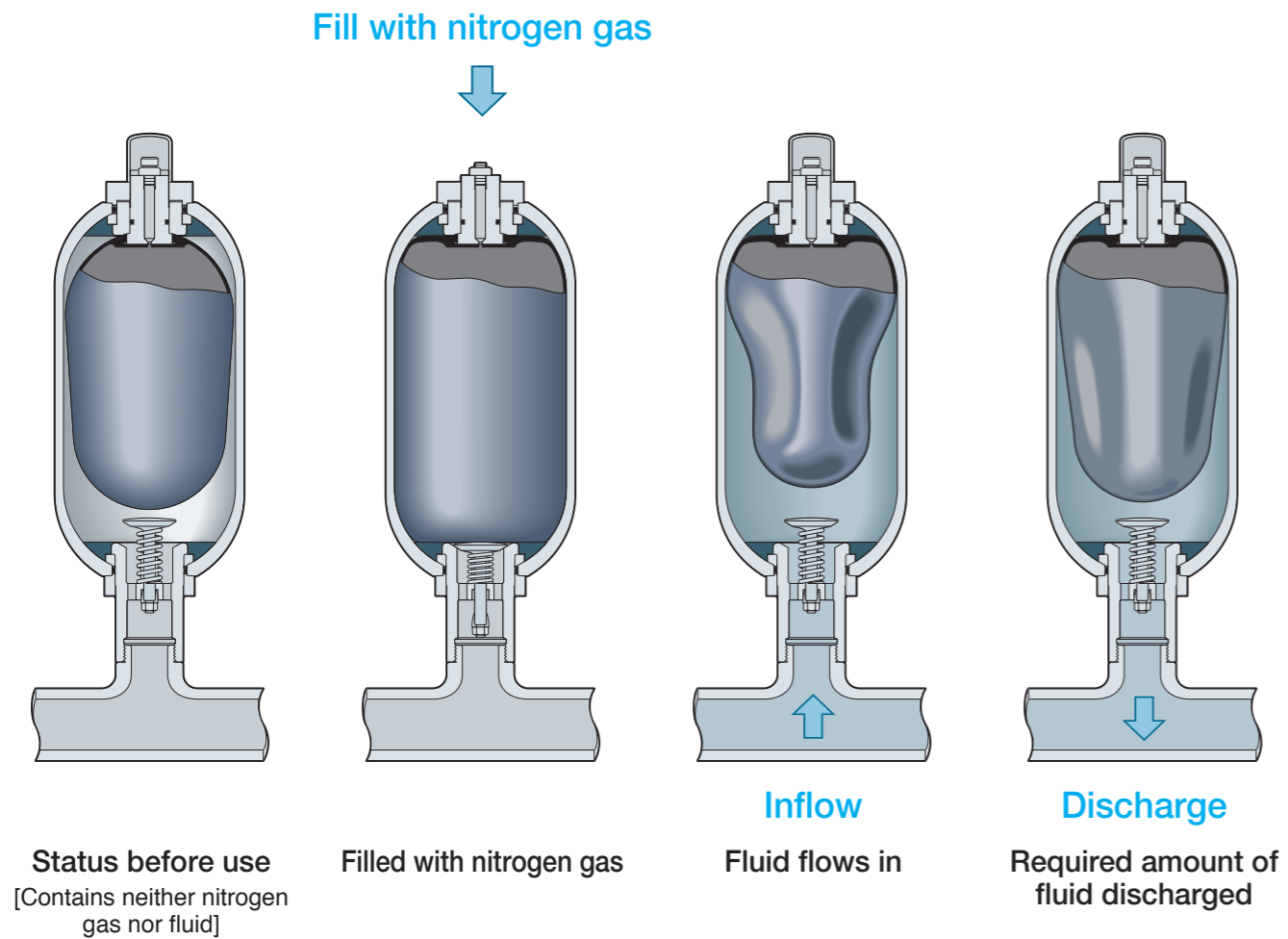ACCUMULATOR

1. Features and Structure of Accumulator

1. Features

The accumulators utilize the compressibility of gas.

Incorporating an accumulator with hydraulic equipment or other machinery that utilizes fluids can enable the accumulation of pressure which can then be used in momentarily supplying large volumes of fluid or absorbing pulses or impact pressure from pipes, while they can also play a significant role in improving the performance of equipment and machinery, including greater energy efficiency and less noise generation.

The accumulators can be divided into being of the membrane or piston type, depending on how the nitrogen gas is separated from the fluid.

◆ The following shows the operating states and structure of a representative bladder type membrane accumulator:

Fill with nitrogen gas

Status before use
[Contains neither nitrogen gas nor fluid]

Filled with nitrogen gas

Inflow
Fluid flows in

Discharge
Required amount of fluid discharged

2. Structure （AT series）

TR Cap [Fusible-plug Safety Valve]
A safety valve that senses an abnormally high temperature. It can be attached to the gas valve as a replacement to the cap.
(*Can also be attached to a Minilator.)

TR cap
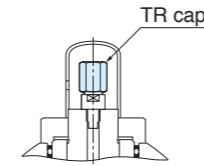
Gas Control Valve
The valve integrates a filling port for the nitrogen gas, a pressure gauge, and safety valve, and is attached to the valve stem.
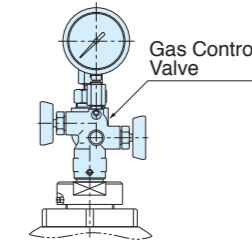
Gas Control Valve
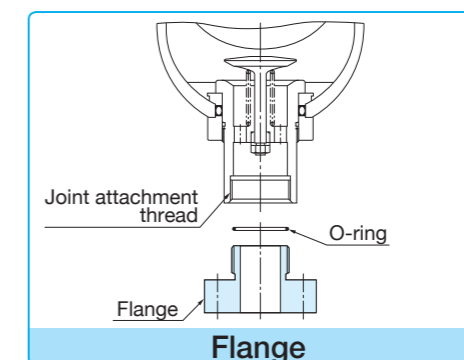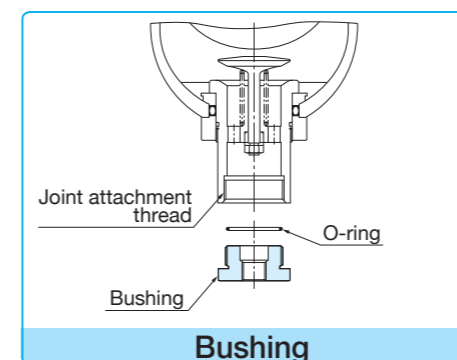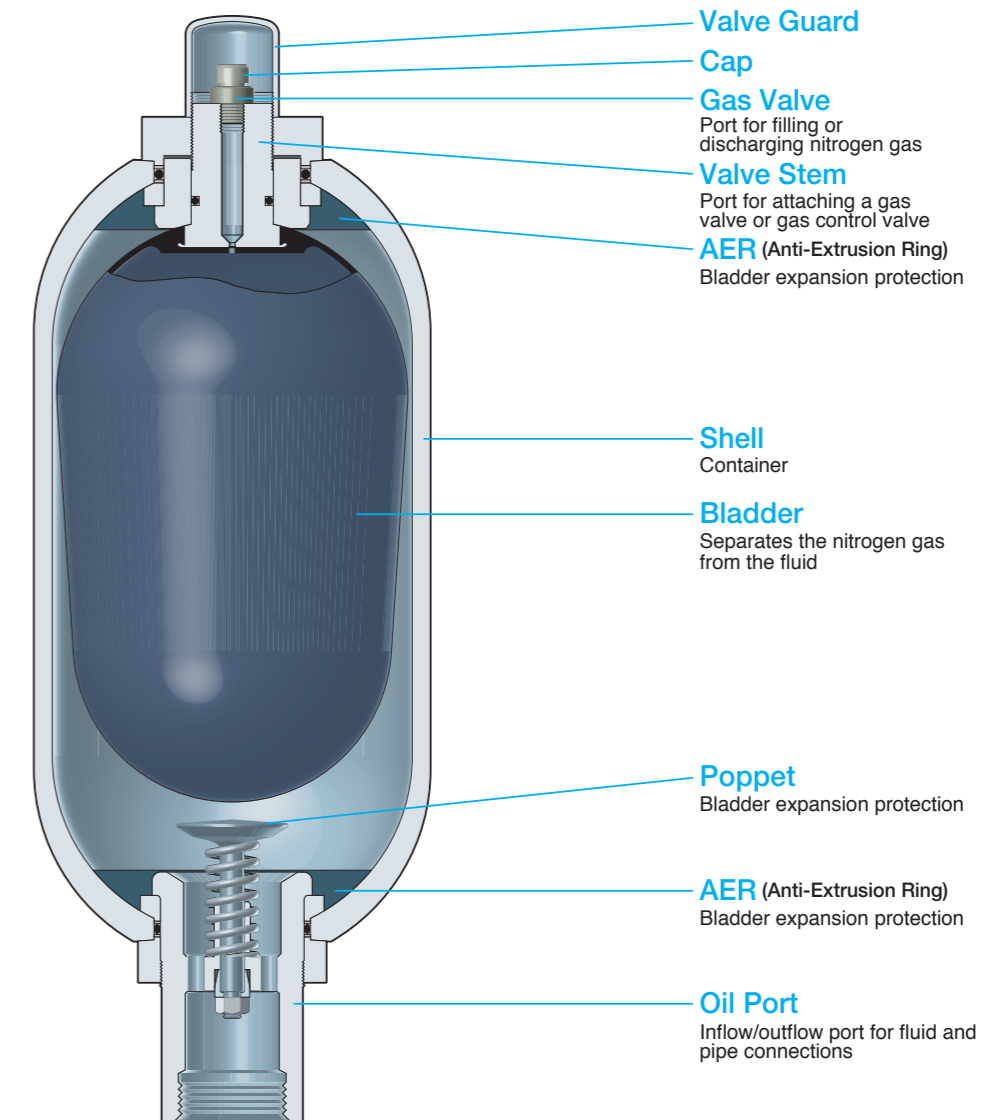
Valve Guard

Cap

Gas Valve
Port for filling or discharging nitrogen gas

Valve Stem
Port for attaching a gas valve or gas control valve

AER (Anti-Extrusion Ring)
Bladder expansion protection

Shell
Container

Bladder
Separates the nitrogen gas from the fluid

Poppet
Bladder expansion protection

AER (Anti-Extrusion Ring)
Bladder expansion protection

Oil Port
Inflow/outflow port for fluid and pipe connections

Joint attachment thread

O-ring

Bushing

Bushing

Joint attachment thread

O-ring

Flange

Flange

Summary

2. Use of Accumulator

1. Energy Accumulation

Accumulators are widely used as a supplementary energy source.
The system in which pressurized oil discharged from accumulators is used to operate cylinders enables pumps to be smaller, shortens their cycles, and conserves energy.

Large pumps   Small pumps
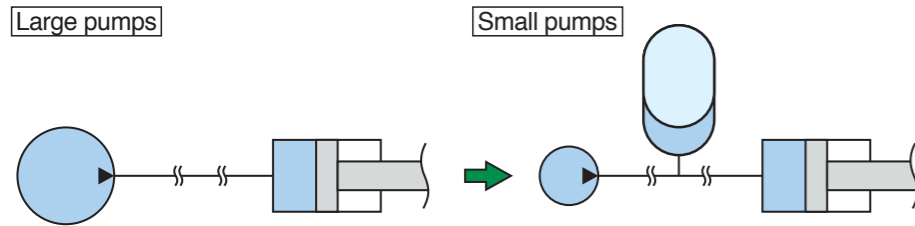
[Major Examples of Usage]

- Hydraulic presses
- Injection molding machines
- Die-cast machines
- Automotive brake systems
- Power shovels
- Vibration testing machines
- Circuit breakers for transformer substations
- Water supply systems
- Home pumps
- Equipment for ironworks, power plants, and chemical plants
- Ship engines

2. Pulse Absorption

All pressurized fluid discharged from pumps has a pulse.
Pulses produce noise or vibrations that can cause instability or damage devices.
The use of an accumulator can attenuate pulses.

P   P

[Major Examples of Usage]
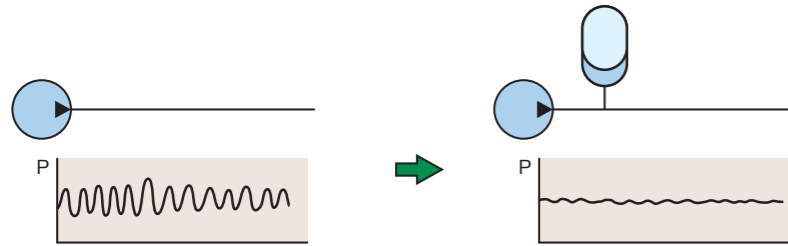
- Machine tools
- Breakers for construction machinery
- Concrete compressors
- Hydraulic elevators
- Power sprayers
- Water purification plants
- Descaling equipment

3. Impact Absorption

The rapid closure of valves or sudden changes in load within a hydraulic circuit can result in impact pressure in pipes, which can then lead to noise or damage to those pipes or devices.
The use of an accumulator can mitigate any such internal shock.
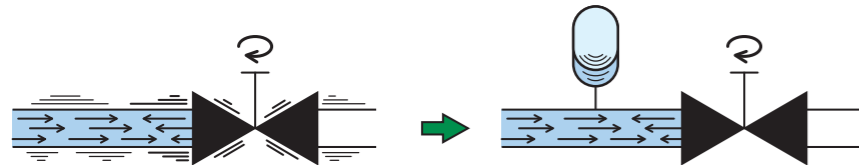
- Water pipes
- Jet fuel injection equipment
- Mud-water compressors
- Pipelines

4. Thermal Expansion Compensation

Changes in the volume of a liquid resulting from changes in the temperature within a closed circuit can increase or decrease the internal pressure. An accumulator can be used to mitigate any such fluctuations in the pressure.

t (℃)
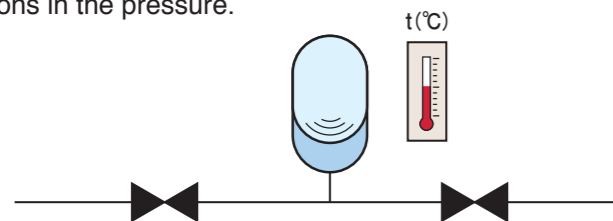
- Boilers
- Pressurized water heaters
- Central heating systems
- Fire extinguishing systems

5. Gas Spring

The use of the accumulators as a gas spring rather than a metal spring enables larger load systems to be downsized.
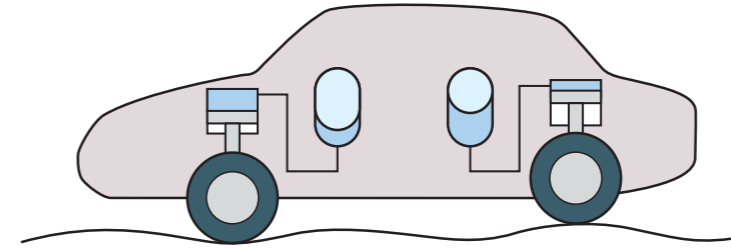
[Major Examples of Usage]

- Vehicle suspensions
- Suspensions for construction machinery or other vehicles
- Agricultural machinery
- Coal mills
- Cement mills
- Cone crushers

6. Equilibrium Action

The accumulators can be used as counter balances.
The accumulators smoothly balance the weight or impact of products and machinery via gas pressure.
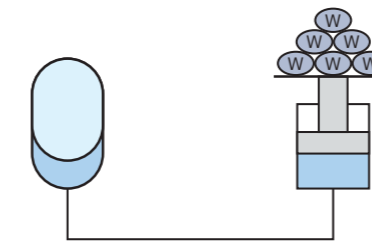
- Large crane systems
- Large-scale machinery tools
- Hydraulic pressure molding machinery

7. Leak Compensation

The accumulators can compensate for any decreases in pressure due to internal leaks and thus retain the pressure of pressure control circuits or during any maintenance work.
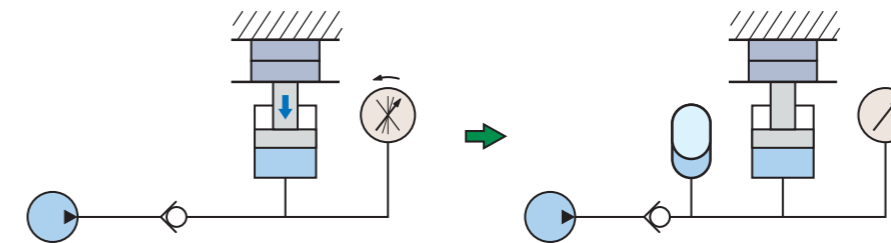
- Clamping equipment
- Other types of hydraulic equipment

8. Transfer Barrier

The use of a transfer barrier type accumulator enables transfers to take place within the fluid circuit without the different types of fluids or gases mixing.
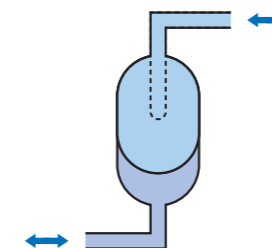
- Compressor lubricant supplier
- Boosters
- Sealed tanks

Summary

3. Type of Accumulator

NOK has a wide variety of accumulators available that can satisfy the demands of differing applications and usage conditions.

Summary

Minilators
Compact, small volume type

See: page 12

MA series
Stainless-steel type

ME series
Lightweight aluminum type

MB series
Steel type

MC series
Steel type

Diaphragm type
Maintenance-free, small volume spherical type

See: page 14

MU series
Rubber diaphragm type

See: page 15

MUV series
Rubber/resin layered diaphragm type

Gas retention to at least 10 times that of single rubber type

Bladder type
Replaceable bladders for subsequent use with larger products

See: page 18

AL series

Bladder replaceable from the fluid side

See: page 20

AT series

Bladders may be replaced either from the gas or fluid side

Piston type
Enables higher pressure and larger volume designs

See: page 30

PA series

(NB) No further surface treatment beyond a basecoat applied to standard products.

Expansion tank
Low-pressure type for use with water that is compliant with the Food Sanitation Law of Japan

See: page 31

ET series

Type A

Type B

Type C

4. Selection Procedure of Accumulator

Use the following procedure to select the most appropriate accumulator:

1. Determine the application of the accumulator   page 4

Determine the application of the accumulator from its intended use.

Examples of Intended Use:	Use:
●Reducing the power supplied to a hydraulic press	Energy Accumulation
●Instantaneous operation of a hydraulic cylinder	Energy Accumulation
●Preventing pump pulsations from damaging devices	Pulse Absorption
●Preventing any damage to pipes when switching valves	Impact Absorption
●Preventing any damage to devices when a closed circuit is at high temperature	Thermal Expansion Compensation
●Car and crane suspension systems	Gas Spring
●Small power operation of heavy objects	Equilibrium Action
●Preventing any loss in pressure due to leakage from valves while pumps are under suspension	Leak Compensation
●Compressing high-viscosity lubrication using hydraulic oil	Transfer Barrier

2. Calculate the required volume of gas   page 58

Calculate the required volume of gas from the intended usage conditions.
Example calculations and worksheets are available for use in calculating the relevant energy accumulation, pulsation absorption, and impact absorption.
Please consult your nearest sales contact for any other purposes.

3. Select the most appropriate accumulator   pages 9 to 39

After calculating the required volume of gas, set the following specifications to select the most appropriate accumulator.

Specification Setting	
①Maximum Working Pressure	System pressure or greater
②Volume of Gas	Calculated required volume of gas or greater
③Rubber Material	Must comply with the fluid used and temperature conditions
④Maximum Discharge Rate	Necessary rate or greater
⑤Specification of Wet Part	Must comply with the fluid used
⑥Joint for Fluid Port Connecting	Kind and size
⑦Specifications Required by the Gas Side	Kind and size

Please consult your nearest sales contact in advance in any case where you will require certification or application to follow any pertinent laws or standards.

●High Pressure Gas Safety Law (high pressure gas production equipment)
●Industrial Safety and Health Law (class-2 pressure vessel)
●ASME U Stamp (American Society of Mechanical Engineers)
●Regulation for Boiler and Pressure Vessel Manufacture Licensing (China)
●CE Marking (European Pressure Equipment Directive)
●Other

The Product Codes for the AT series vary by applicable laws and standards.
See pages 22 through 28.

Fill in the Accumulator Selection Request (page 68) and we will select the most appropriate accumulator for you.

5. Accumulator Lists of Maximum Working Pressures and Volumes

Accumulator for Use in Japan

Series	Nominal Volume	Maximum Working Pressure: MPa						
		6.86	14.7	16	20.6	22.6	29.4	34.3
MA MB MC ME MU MUV	30cm³	ME70-30						
	100	ME70-100			MB210-100			
	150	MUV70-150						
	300	MA70-300			MB210-300			
		ME70-300						
		MU70-300						
	500	MA70-500			MB210-500			
		ME70-500						
		MUV70-500						
		MU70-500						
	700		MU150-700					
	1000	MC70-1000			MC210-1000			
	2000	MC70-2000			MC210-2000			
	3000	MC70-3000			MC210-3000			
	5000	MC70-5000			MC210-5000			
AL AT PA	1ℓ		AL150-1		PA210-1		AL300-1	
	2				PA210-2			
	2.4		AL150-2.4				AL300-2.4	
	3				PA210-3			
	4		AL150-4		PA210-4		AL300-4	
	5		AL150-5		PA210-5		AL300-5	
	10			AT18M-10	PA210-10	AT25M-10		AT35M-10
	20			AT18M-20	PA210-20	AT25M-20		AT35M-20
	30			AT18M-30	AT23M-30	AT25M-30		AT35M-30
					PA210-30			
	40				AT23M-40			
					PA210-40			
	50			AT18M-50	AT23M-50	AT25M-50		
					PA210-50			
	60				AT23M-60			
	80				AT23M-80			
	120				AT23M-120			
	150				AT23M-150			
	160				AT23M-160			

Expansion Tank for Use in Japan

Series	Nominal Volume	Maximum Working Pressure: MPa			
		0.45	0.5	0.85	2.0
ET	0.5ℓ	ET4.5-0.5			
	1	ET4.5-1			
	2		ET5-2		
	10			ET8.5-10	
	20			ET8.5-20	ET20-20

AT Series for Overseas Use

Series	Nominal Volume	Maximum Working Pressure: MPa			
		18	23	25	35
AT	10ℓ	AT18M-10		AT25M-10	AT35M-10
	20	AT18M-20		AT25M-20	AT35M-20
	30	AT18M-30	AT23M-30	AT25M-30	AT35M-30
	40		AT23M-40		
	50	AT18M-50	AT23M-50	AT25M-50	
	60		AT23M-60		
	80		AT23M-80		
	120		AT23M-120		
	150		AT23M-150		
	160		AT23M-160		

[Meaning of symbols used]
◎ : Standard product (with Model Codes and Product Codes provided)
○ : No Product Code provided. Specify using Model Code.
(○) : Consult your nearest sales contact.

Volume Category	Less than 1ℓ					1～5ℓ			10～160ℓ	0.5～20ℓ	Volume Category
Type of Accumulator	Minilators			Diaphragm type		Minilators	Bladder type	Piston type	Bladder type	Piston type	Expansion tank	Type of Accumulator
Model	MA	MB	ME	MU	MUV	MC	AL	PA	AT	PA	ET	Model
Series / Shape				Rubber Diaphragm	Rubber/Resin Layered Diaphragm						Type A / Type B / Type C	Shape / Series
Shell Material	Stainless Steel	Steel	Aluminum	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Shell Material
Standard Surface Treatment	Stainless Steel Base	Parkerized	Aluminum Base	Plated	Plated	Parkerized	Parkerized	Basecoat	Parkerized	Basecoat	Paint	Standard Surface Treatment
Nominal Volume (Unit)	(cm³) 300·500	(cm³) 100 / 300·500	30 / 100 300 / 500	(cm³) 300 500 700	150 500	(cm³) 1000·2000 3000·5000	(ℓ) 1·2.4 4·5	(ℓ) 1·2·3·4·5	(ℓ) 10·20·30·40·50·60 80·120·150·160	(ℓ) 10·20·30·40·50	(ℓ) Type A 0.5·1 2 / Type B 10·20 / Type C 20	Nominal Volume (Unit)
Maximum Working Pressure (MPa)	6.86	20.6	6.86	6.86 14.7	6.86	6.86·20.6	14.7·29.4	20.6	16～35[*6]	20.6	0.45 0.5 / 0.85 / 2.0	Maximum Working Pressure (MPa)
Maximum Discharge Flow (ℓ/min)[*1]	30	30 / 80	20 / 30	30	10 30	80	126 370	700～1400	600～4800[*6]	450～2800	30 / 90 / 90	Maximum Discharge Flow (ℓ/min)[*1]
Applicable Fluids[*2] – General Mineral Oil	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	(○)	General Mineral Oil
Phosphate Ester	○	○	○	—	—	○	○	○	○	○	—	Phosphate Ester
Industrial Water	○	(○)	○	—	—	(○)	○	(○)	○	(○)	○	Industrial Water
Water Glycol	○	○	○	—	—	○	○	○	○	○	—	Water Glycol
Potable Water	—	—	—	—	—	—	—	—	—	—	◎	Potable Water

Applicable Temperature Range for Each Type of Rubber Material [*3]:

	MA	MB	ME	MU	MUV	MC	AL	PA	AT	PA	ET Type A	ET Type B
NBR	100/−20	80/−40	—	100/−20	100/−20	100/−20	80/−40	100/−40	100/−20	100/−40	—	—
IIR	—	—	100/−30	—	—	—	—	—	—	—	85/−10	85/−10
FKM	—	—	—	—	—	—	100/−30	150/−15	80/−30	150/−15	—	—

Maximum Compression Ratio[*5]	4			8		3	4	Restrictionless	4	Restrictionless	2	Maximum Compression Ratio[*5]
Specifications of Joint for Fluid Port Connecting	Rc3/8	Rc3/8 / Rc1/2	Rc3/8	R1/2 G1/2 / R3/4 G3/4	R3/8 G3/8 / R3/4 G3/4	Rc3/4	Select Bushing or Flange		Select Bushing or Flange		G1/2 G3/4 / R3/4 / Rc1¹/₄	Specifications of Joint for Fluid Port Connecting
Specifications required by the gas side – TR Caps Included[*5]	◎			—		◎	◎	◎	◎	◎	—	TR Caps Included[*5]
Gas Control Valve Included	—			—		—	○	○	○	○	—	Gas Control Valve Included
Direction Attached	Vertical/Horizontal			Restrictionless		Vertical	Vertical	Restrictionless	Vertical	Restrictionless	Restrictionless / Vertical/Horizontal	Direction Attached
Maintenance – Gas Filling	Supported			Not Supported		Supported	Supported	Supported	Supported	Supported	Not Supported / Supported	Gas Filling
Bladder and Seal Replacement	Consult your nearest sales contact	Not Supported		Not Supported	Not Supported (Gas retention at least 10 times that of MU)	Not Supported	Supported Replace from the fluid side	Consult your nearest sales contact	Supported Replaceable either from the gas or fluid side	Consult your nearest sales contact	Not Supported	Bladder and Seal Replacement
Refer to the Model Code Dimensions and Product Code Page	Page 12			Page 14	Page 15	Page 12	Page 18	Page 30	Page 20	Page 30	Page 31	Refer to the Model Code Dimensions and Product Code Page

*1: General mineral oil used at room temperature.
*2: The specifications of the accumulators can vary depending on the type of fluid used. For more details please refer to the Model Code Configurations of each individual series.
*3: The pressure of the nitrogen gas in the accumulator can gradually drop as a result of it seeping through the rubber.
Caution should be exercised with regard to maintenance as the pressure of the gas can drop faster at higher temperatures (see page 55).

- ■ NBR (Standard Nitrile Rubber)
- ■ NBR (Nitrile Rubber for Low Temperature Use)
- ▨ IIR (Butyl Rubber)
- ▢ FKM (Fluororubber)
- ▨ CM (Chlorinated Polyethylene)

Consult your nearest sales contact if you wish to constantly use the product at high temperature.

*4: Compression Ratio: Ratio of maximum operating pressure (P₃) to gas filling pressure (P₁). [P₃/P₁]
Convert the value to the absolute pressure for use in the calculation if the accumulator is used at 1 MPa or less.
[Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

Note that use of the product at a pressure exceeding the maximum compression ratio can shorten the useful lifespan of the bladder.

*5: Not applicable if the ambient temperature always exceeds 80 °C.
*6: The maximum working pressure and maximum discharge flow for the AT series can vary by individual model.
See [AT Series] on pages 20 and 21 for more details.

List of Model Codes and Dimensions

MA, MB, MC, ME series

Compact and Small-Volume Bladder Type Accumulator

■ Model Code Configuration

Series

Symbol	Type
MA	Stainless-Steel Type
MB	Steel Type
MC	Steel Type
ME	Lightweight Aluminum Type

Bladder Rubber Material

Symbol	Material	Fluid	Temperature	Note
30	NBR (Standard Nitrile Rubber)	Common Mineral Hydraulic Oil, Industrial Water, Water Glycol	−20〜100℃	Standard Material
10	NBR (Nitrile Rubber for Low Temperature Use)	Common Mineral Hydraulic Oil	−40〜80℃	Material For Low Temperature
40	IIR (Butyl Rubber)	Phosphoric Ester Hydraulic Oil	−30〜100℃	(Note)

(Note) Because this material cannot be applied in some kinds of phosphoric ester hydraulic oil, please consult your nearest sales.

□□□ - □□ - □□ / □

Nominal Pressure

Nominal Volume

□ : Basic Model Code

Specifications Required by the Gas Side

Symbol	Specification	Page
None	—	—
E	TR Cap	37 Page (Note)

(Note) In case of ambient temperature always exceeding 80℃, TR Cap cannot be used.

Fluid

● MB・MC series

Symbol	Fluid	Note
None	Common Mineral Hydraulic Oil Phosphoric Ester Hydraulic Oil	—
W	Industrial Water (Components ❶, ❷, and ❸ are made of SUS304)	The shape and dimensions can differ from those of standard products.

● MA・ME series

Symbol	Fluid
None	Common Mineral Hydraulic Oil Phosphoric Ester Hydraulic Oil Industrial Water

MA series (Stainless-Steel Type) [SUS316]
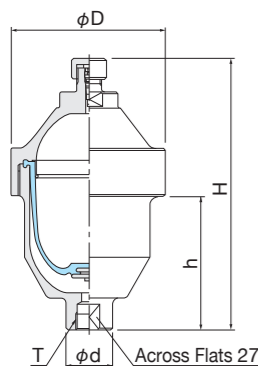
Across Flats 27

MB series (Steel Type)

Across Flats 36 (MB210-100: Across Flats 40)

MC series (Steel Type)

Across Flats 36 (MC□-5000: Across Flats 34)

ME series (Lightweight Aluminum Type)

Across Flats 27
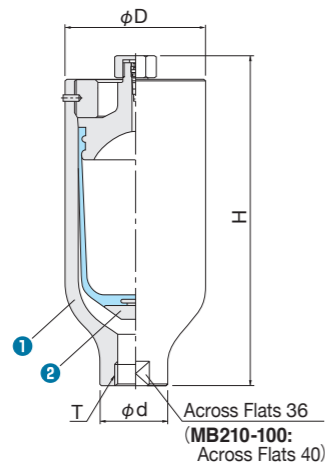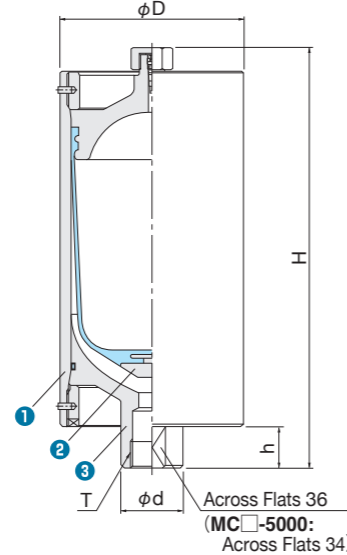
■ Minilator Standard Product Model Codes and Dimensions

■ Includes TR Cap

MA, ME series — 5/8-18UNF
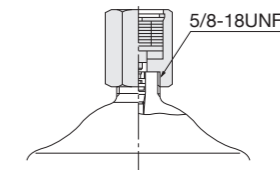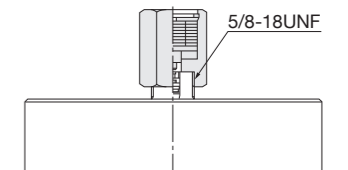
MB, MC series — 5/8-18UNF

● Rubber Material : **Symbol 30** (NBR Standard Nitrile Rubber)
● Applicable Fluid : **Common Mineral Hydraulic Oil**

Symbol	Model Code	Maximum Working Pressure MPa	Gas Volume cm³	Mass kg	Dimension mm				Thread T	Maximum Discharge Flow Rate ℓ/min	Product Code	
					H	D	h	d			Without TR Cap	With TR Cap
MA	MA 70- 300-30(/E)	6.86	310	1.8	169(187)	96	83	30	Rc3/8	30	KA1789 A0	KA6237 A4
	MA 70- 500-30(/E)		480	2.0	215(233)		129				KA4414 A4	KA6540 A4
MB	MB210- 100-30(/E)	20.6	100	1.0	166(183)	48	—	48	Rc3/8	30	KA4887 B4	KA6601 B4
	MB210- 300-30(/E)		300	4.5	205(224)	87	—	40	Rc1/2	80	KA1598 B0	KA3180 B4
	MB210- 500-30(/E)		500	5.5	265(285)						KA1599 B0	KA4284 B0
MC	MC 70-1000-30(/E)	6.86	980	7.4	260(280)	114.3	25	40	Rc3/4	80	KA0062 C0	KA4224 C0
	MC 70-2000-30(/E)		2000	11.0	420(440)						KA4499 C4	KA6708 C4
	MC 70-3000-30(/E)		2600	12.0	493(513)						KA0063 C0	KA4319 C0
	MC 70-5000-30(/E)		4800	18.0	490(510)	152.4					KA0064 C0	KA4194 C0
	MC210-1000-30(/E)	20.6	980	8.6	270(290)	114.3	25	40	Rc3/4		KA0058 C0	KA4023 C0
	MC210-2000-30(/E)		2000	12.0	430(450)						KA4500 C4	KA5769 C4
	MC210-3000-30(/E)		2600	13.0	510(531)						KA0060 C0	KA4235 C0
	MC210-5000-30(/E)		5100	29.0	490(510)	165.2	20				KA0061 C0	KA4717 C0
ME	ME 70- 30-30(/E)	6.86	30	0.25	93(113)	62	37	30	Rc3/8	20	KA2475 E0	KA4954 E0
	ME 70- 100-30(/E)		110	0.5	110(130)	86	45				KA2476 E0	KA4214 E0
	ME 70- 300-30(/E)		310	1.0	163(182)	103	79	31		30	KA2477 E0	KA4017 E0
	ME 70- 500-30(/E)		480	1.1	210(230)		126				KA3306 E0	KA4280 E0

Notes: ( ) with TR Cap
Please designate Model Code and Product Code in your order.

■ Fixing Band for MC Series

With hexagon nut and flat washer
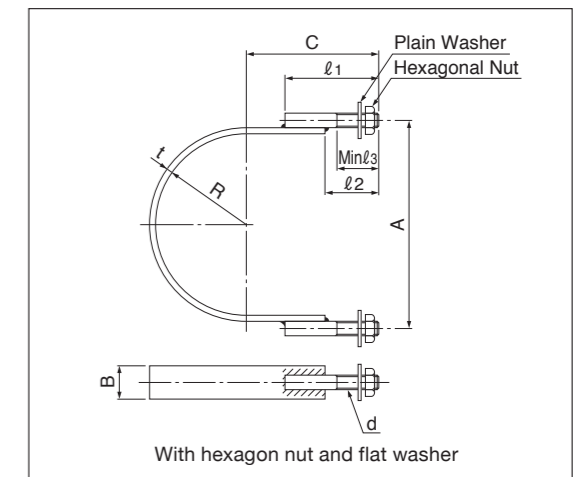
Model Code	Applicable MC Series	Dimension mm									Mass kg	Product Code
		A	B	C	ℓ1	ℓ2	ℓ3	d	R	t		
PAL101-101	MC 70・210 -1000, 2000, 3000	135	22	85	60	35	27	M10	58	4.5	0.3	EB6611 Z4
PAL101-103	MC 70・210 -5000	187	22	115	80	40	31	M10	84	4.5	0.4	EB6613 Z4

Please designate Model Code and Product Code in your order.

8. Diaphragm Type Accumulator

MU series
Spherical Accumulator with Rubber Diaphragm

■ **Model Code Configuration**
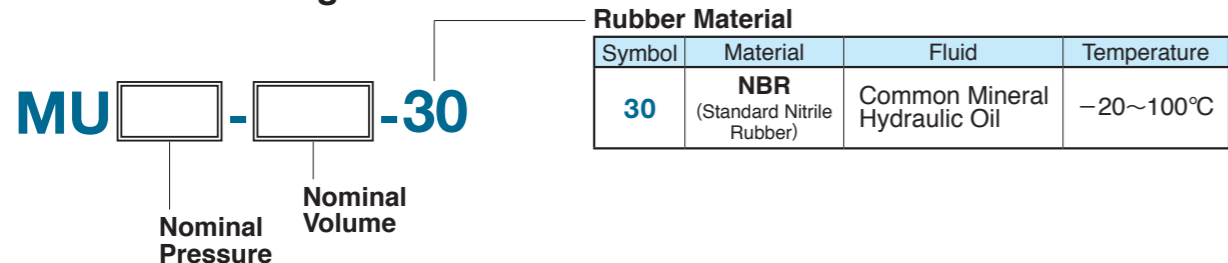
MU ☐☐ - ☐☐ -30

Nominal Pressure

Nominal Volume

Rubber Material

Symbol	Material	Fluid	Temperature
30	NBR (Standard Nitrile Rubber)	Common Mineral Hydraulic Oil	−20～100℃

● The product is delivered filled with nitrogen gas at the factory. Please ensure to let us know the desired gas pressure (＿＿MPa at ＿＿℃) when placing an order.
● Cannot be refilled with gas. Use at 50 ℃ or less recommended.

The pressure will drop faster (natural loss of gas due to permeation) at higher working temperatures, which also results in faster degradation of the functionality of the accumulator.
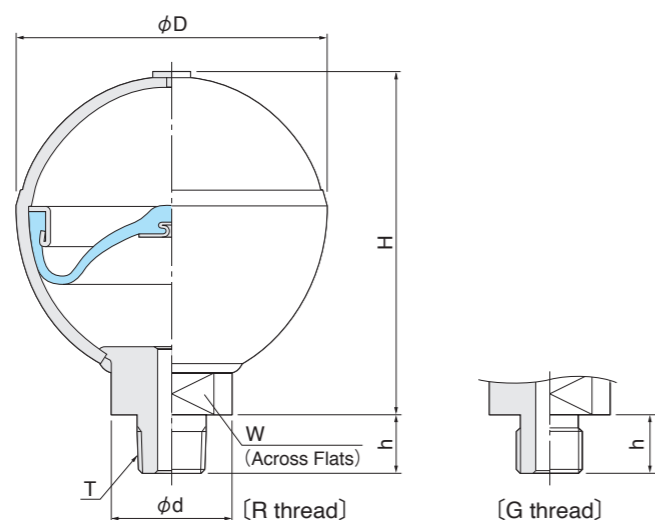
〔R thread〕 〔G thread〕

Model Code	Maximum Working Pressure MPa	Gas Volume cm³	Mass kg	Dimension mm					Thread T	Maximum Discharge Flow Rate ℓ/min	Product Code
				H	D	d	W	h			
MU 70-300-30	6.86	300	1.2	107	98	38	27	18	R1/2	30	KA6917 U4
				109				16	G1/2		KA6909 U4
MU 70-500-30		500	1.7	122	111	38	27	18	R1/2		KA6918 U4
				122				16	G1/2		KA6910 U4
MU150-700-30	14.7	700	3.0	142	130	56	36	21	R3/4		KA6919 U4
				146				18	G3/4		KA6911 U4

Please designate Model Code and Product Code in your order.

[Reference] Dimensions of the G thread used to attach other equipment (O-ring seal: JIS B 2351)

Details of Section A
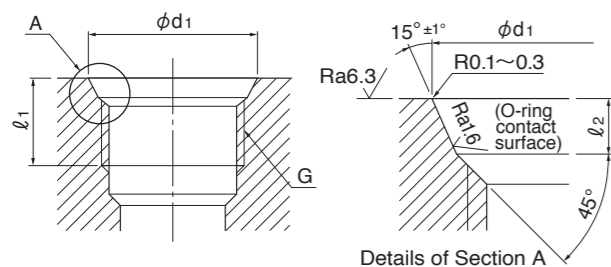
Nominal Designation	Dimension mm			Included O-ring JIS B 2401-1
	$d_1{}^{+0.1}_{0}$	ℓ_1	$\ell_2{}^{+0.4}_{0}$	
G1/2	22.6	19	2.5	OR NBR-70-1 zP18-N
G3/4	29.8	20	3.5	OR NBR-70-1 P22.4-N

14

MUV series
Spherical Accumulator with Rubber/Resin Layered Diaphragm
Long-life type retaining at least 10 times as much gas as the MU type

■ **Model Code Configuration**

MUV ☐☐ - ☐☐ -30

Nominal Pressure

Nominal Volume

Rubber Material

Symbol	Material	Fluid	Temperature
30	NBR (Standard Nitrile Rubber)	Common Mineral Hydraulic Oil	−20～100℃

● The product is delivered filled with nitrogen gas at the factory. Please ensure to let us know the desired gas pressure (＿＿MPa at ＿＿℃) when placing an order.
● Cannot be refilled with gas. Use at 80 ℃ or less recommended.

Use of NOK's polymeric material technology and processing technology has resulted in a resin layered diaphragm that dramatically improves the gas retention of accumulators.
This accumulator should be selected if a longer lifespan and maintenance-free operation are desired.
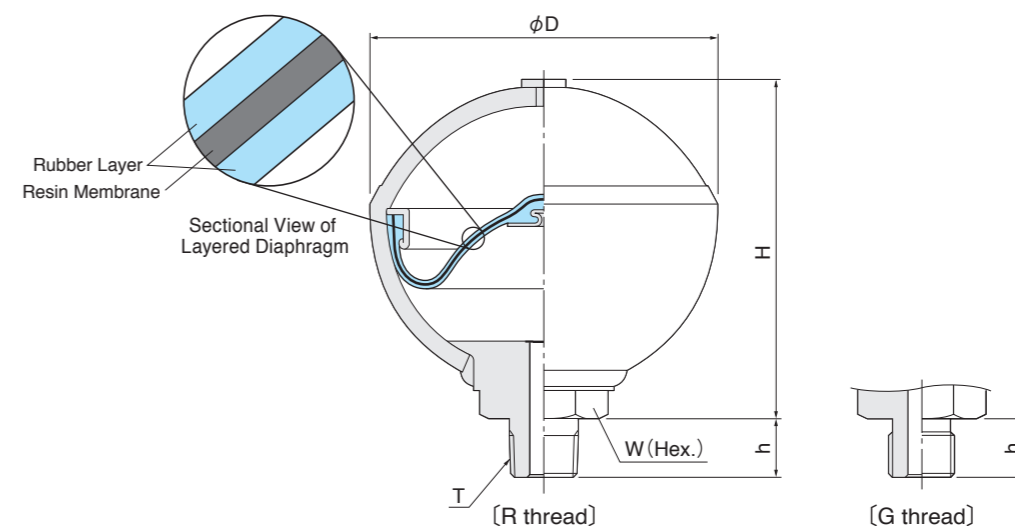
Rubber Layer
Resin Membrane
Sectional View of Layered Diaphragm

〔R thread〕 〔G thread〕

Model Code	Maximum Working Pressure MPa	Gas Volume cm³	Mass kg	Dimension mm				Thread T	Maximum Discharge Flow Rate ℓ/min	Product Code
				H	D	W	h			
MUV70-150-30	6.86	150	0.7	93	86	30	14	R3/8	10	KA6912 U4
								G3/8		KA6949 U4
MUV70-500-30		500	2.5	117	128	36	18	R3/4	30	KA6914 U4
								G3/4		KA6951 U4

Please designate Model Code and Product Code in your order.

[Reference] Dimensions of the G thread used to attach other equipment (O-ring seal: JIS B 2351)

Details of Section A
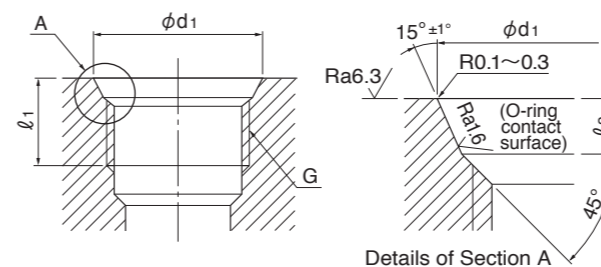
Nominal Designation	Dimension mm			Included O-ring JIS B 2401-1
	$d_1{}^{+0.1}_{0}$	ℓ_1	$\ell_2{}^{+0.4}_{0}$	
G3/8	18.6	16	2.5	OR NBR-70-1 P14-N
G3/4	29.8	20	3.5	OR NBR-70-1 P22.4-N

15

■Model Code Configuration

①Series

Symbol
AL
AT

②Nominal Pressure

③Nominal Volume

`□ □ - □ □ - □ - □/□ □ □`

: Basic Model Code

④Rubber Material

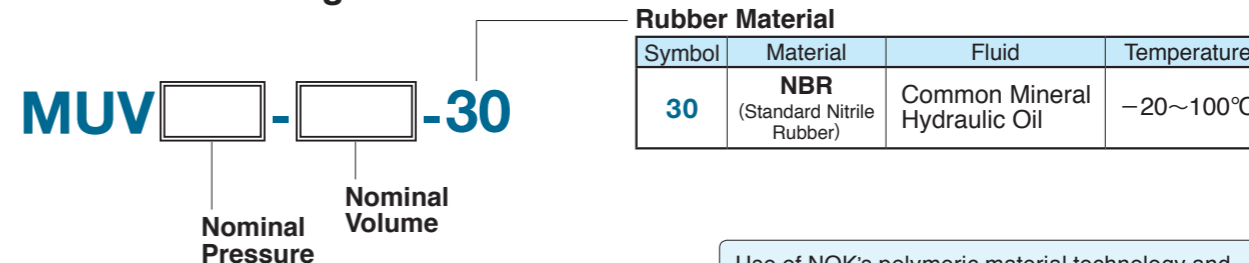| Symbol	Material	Fluid	Temperature	Note
30	NBR (Standard Nitrile Rubber)	Common Mineral Hydraulic Oil, Industrial Water, Water Glycol	−20~100℃	Standard Material
10	NBR (Nitrile Rubber for Low Temperature Use)	Common Mineral Hydraulic Oil	−40~80℃	Material For Low Temperature
40	IIR (Butyl Rubber)	Phosphoric Ester Hydraulic Oil	−30~100℃	(Note)

(Note) Because this material cannot be applied in some kinds of phosphoric ester hydraulic oil, please consult your nearest sales contact.

⑥Specifications Required by the Gas Side

Symbol	Specification	Page
None	—	—
E	TR Cap	Page 37 (Note)
M	Fuse Metal Safety Valve	Page 39
GF06	Gas Port Flange used as Transfer Barrier	Page 29

(Note) In case of ambient temperature always exceeding 80℃, TR Cap cannot be used.

⑦Gas Control Valve Types

Symbol	Specification	Page
None	Standard Type	—
GCS	With Gas ControlValve Types	Page 38

⑤Joint for Fluid Port Connecting

Symbol	Specification	Page
None	No Connecting Part	—
T**	Bushing	Page 32
F**	21 MPa Flange Set	Page 33
H**	35 MPa Flange Set	Page 34
D**	Manifold Direct Assembly Type	Page 35

Standard Material: Steel
For Industrial Water: Stainless Steel

〔Fluid Contact Metal Parts〕

Inner Surface of Shell

Retainer Ring (For AER)

Oil Port Body Assembly

⑧Fluid

Symbol	Fluid	Fluid Contact Metal Parts Specification (See the left picture.)		
		Inner Surface of Shell	Retainer Ring (For AER)	Oil Port Body Assembly
None	Common Mineral Hydraulic Oil Phosphoric Ester Hydraulic Oil	Parkerizing (Standard)		
W	Industrial Water	Epoxy (Note) Coating	Stainless Steel	

(Note) The maximum working temperature of the epoxy coated type is 40 ℃.

⑨Type of Oil Port Body Assembly

Symbol	Maximum Discharge Flow Rate（ℓ/min）			
	AL1, 2.4 ℓ	AL4, 5 ℓ	AT10~60 ℓ	AT80~160 ℓ
None	126	370	600	1800
SH	—		1260	—
HF	—		1800	—
MH	—		2280	
UH	—		4800	

*The Product Codes for the AT series vary by applicable laws and standards.
 See pages 22 through 28.

■Example of Model Code Configuration

Model Code	Specification
AT 25M - 10 - 30 ① ② ③ ④	①AT Series ②Maximum Working Pressure: **22.6 MPa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber)
AT 25M - 10 - 30/T06 ① ② ③ ④ ⑤	①AT Series ②Maximum Working Pressure: **22.6 MPa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber) ⑤Joint: **Bushing Rc3/4**
AT 25M - 10 - 30/T06 E ① ② ③ ④ ⑤ ⑥	①AT Series ②Maximum Working Pressure: **22.6 MPa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber) ⑤Joint: **Bushing Rc3/4** ⑥With TR Cap
AT 25M - 10 GCS - 30/F06 ① ② ③ ⑦ ④ ⑤	①AT Series ②Maximum Working Pressure: **22.6 MPa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber) ⑤Joint: F Type Flange: **25 A** ⑦With Gas Control Valve Types Spring Safety Valve as the Code Is Not Followed by an M (See page 38 for the Model Code Configuration of GCS models.)
AT 25M - 10 GCS - 30/W T06 M ① ② ③ ⑦ ④ ⑧ ⑤ ⑥	①AT Series ②Maximum Working Pressure: **22.6 MPa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber) ⑤Joint: **Bushing Rc3/4** ⑥Fuse Metal Safety Valve when Combined with GCS（M） ⑦With GCS ⑧For Water Service （Inner Surface of Shell: Epoxy Coating, Fluid Contact Metal Parts: Stainless Steel）
AT 25M - 10 GCS - 30 - HF/W F16 M ① ② ③ ⑦ ④ ⑨ ⑧ ⑤ ⑥	①AT Series ②Maximum Working Pressure: **22.6M Pa** (Japanese Model Specifications) ③Nominal Volume: **10 ℓ** ④Rubber Material : **NBR** (Standard Nitrile Rubber) ⑤Joint: F Type Flange **50 A** ⑥Fuse Metal Safety Valve when Combined with GCS ⑦With GCS ⑧For Water Service ⑨High Flow, Maximum Discharge Flow Rate 1800 ℓ/min

AL series (1, 2.4, 4, 5ℓ)

Bladder Type Accumulator with the Bladder Replaceable from the Fluid Side

■Basic Model

Nominal Pressure
Nominal Volume

■With TR CAP

AL1, 2.4   AL4, 5

5/8-18UNF   5/8-18UNF

AL□-1, 2.4   AL□-4, 5

Hex. 21 / Hex. 26   Hex. 30 / Hex. 32
G3/4 φ35.6 Across Flats 32   G11/4 φ56 Across Flats 52
φ49   φ82
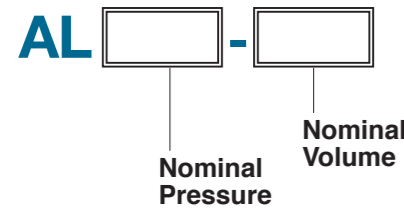
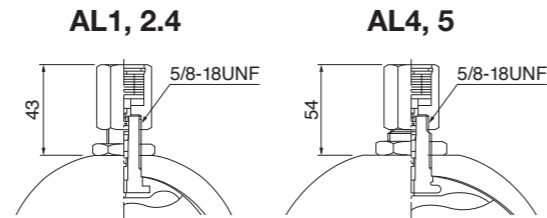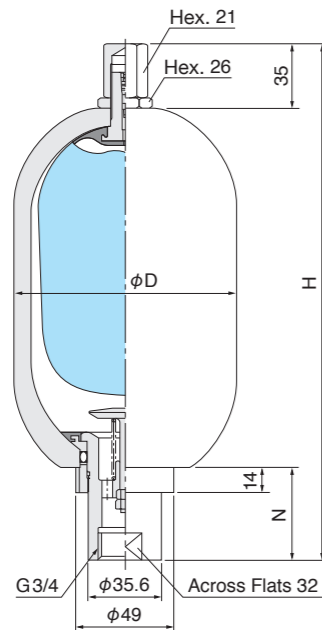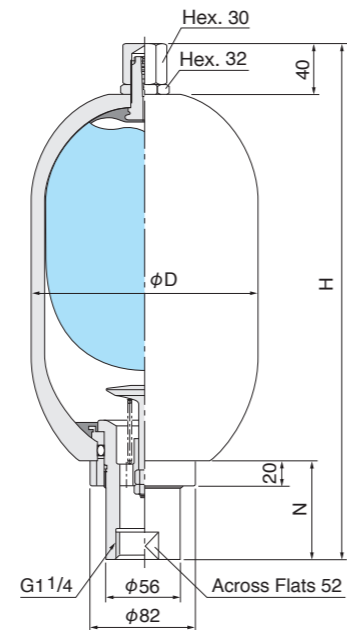| Nominal Volume ℓ	Basic Model	Maximum Working Pressure MPa	Gas Volume ℓ	Mass kg	Dimension mm			Maximum Discharge Flow Rate ℓ/min
					H (Note)	D	N	
1	AL150-1	14.7	1.0	7.6	282(290)	120.0	51	126
	AL300-1	29.4						
2.4	AL150-2.4	14.7	2.5	13.6	487(495)	120.0	51	
	AL300-2.4	29.4						
4	AL150-4	14.7	3.7	14.3	404(418)	168.3	79	370
	AL300-4	29.4		20.3	405(419)	177.8	78	
5	AL150-5	14.7	5.2	18.3	495(509)	168.3	79	
	AL300-5	29.4		26.3	496(510)	177.8	78	

Note: Values in brackets represent the dimensions with a TR cap attached.

■AL series Standard Model

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code	Model Code	Product Code
1	14.7	None	G3/4	AL150-1-30	KY5001 B5	AL150-1-30/E	KY7025 B5
		Bushing	R3/8	/T03	KY5002 A5	/T03E	KY7002 B5
			R1/2	/T04	KY5003 B5	/T04E	KY7003 B5
			R3/4	/T06	KY5004 B5	/T06E	KY7004 B5
		F Type Flange	15A	/F04	KY5533 B5	/F04E	KY7533 B5
			20A	/F06	KY5534 B5	/F06E	KY7534 B5
	29.4	None	G3/4	AL300-1-30	KY5005 B5	AL300-1-30/E	KY7005 B5
		Bushing	R3/8	/T03	KY5006 A5	/T03E	KY7006 B5
			R1/2	/T04	KY5007 B5	/T04E	KY7007 B5
			R3/4	/T06	KY5008 B5	/T06E	KY7008 B5
		H Type Flange	15A	/H04	KY5841 B5	/H04E	KY7841 B5
			20A	/H06	KY5842 B5	/H06E	KY7842 B5
2.4	14.7	None	G3/4	AL150-2.4-30	KY5009 B5	AL150-2.4-30/E	KY7009 B5
		Bushing	R3/8	/T03	KY5010 A5	/T03E	KY7010 B5
			R1/2	/T04	KY5011 B5	/T04E	KY7011 B5
			R3/4	/T06	KY5012 B5	/T06E	KY7012 B5
		F Type Flange	15A	/F04	KY5537 B5	/F04E	KY7537 B5
			20A	/F06	KY5538 B5	/F06E	KY7538 B5
	29.4	None	G3/4	AL300-2.4-30	KY5013 B5	AL300-2.4-30/E	KY7013 B5
		Bushing	R3/8	/T03	KY5014 A5	/T03E	KY7014 B5
			R1/2	/T04	KY5015 B5	/T04E	KY7015 B5
			R3/4	/T06	KY5016 B5	/T06E	KY7016 B5
		H Type Flange	15A	/H04	KY5843 B5	/H04E	KY7843 B5
			20A	/H06	KY5844 B5	/H06E	KY7844 B5
4	14.7	None	G11/4	AL150-4-30	KY5017 B5	AL150-4-30/E	KY7017 B5
		Bushing	R1/2	/T04	KY5018 B5	/T04E	KY7018 B5
			R3/4	/T06	KY5019 A5	/T06E	KY7019 B5
		F Type Flange	20A	/F06	KY5541 B5	/F06E	KY7541 B5
			25A	/F08	KY5542 B5	/F08E	KY7542 B5
	29.4	None	G11/4	AL300-4-30	KY5021 B5	AL300-4-30/E	KY7021 B5
		Bushing	R1/2	/T04	KY5022 B5	/T04E	KY7022 B5
			R3/4	/T06	KY5023 A5	/T06E	KY7023 B5
		H Type Flange	20A	/H06	KY5845 B5	/H06E	KY7845 B5
			25A	/H08	KY5846 B5	/H08E	KY7846 B5
5	14.7	None	G11/4	AL150-5-30	KY5001 B6	AL150-5-30/E	KY7001 B6
		Bushing	R1/2	/T04	KY5002 B6	/T04E	KY7002 B6
			R3/4	/T06	KY5003 A6	/T06E	KY7003 B6
		F Type Flange	20A	/F06	KY5178 B6	/F06E	KY7178 B6
			25A	/F08	KY5179 B6	/F08E	KY7179 B6
	29.4	None	G11/4	AL300-5-30	KY5005 B6	AL300-5-30/E	KY7005 B6
		Bushing	R1/2	/T04	KY5006 B6	/T04E	KY7006 B6
			R3/4	/T06	KY5007 A6	/T06E	KY7007 B6
		H Type Flange	20A	/H06	KY5340 B6	/H06E	KY7340 B6
			25A	/H08	KY5341 B6	/H08E	KY7341 B6

Please designate Model Code and Product Code in your order.

# AT series (10, 20, 30, 40, 50, 60, 80, 120, 150, 160 ℓ)

Bladder Type Accumulator with the Bladder Replaceable from Both the Gas and Fluid Sides

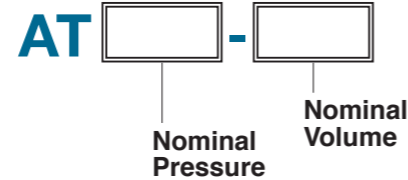| Applicable Regulations and Standards	
Japan	High Pressure Gas Safety Law
China	Regulation for Boiler and Pressure Vessel Manufacture Licensing
EU	Pressure Equipment Directive (P.E.D.) 〈CE Mark〉
USA	ASME Sec.Ⅷ Div.1 〈U-Stamp〉

Please contact us concerning compliance with any other regulations and standards.

10～60ℓ ●Standard Model ●SH Type
10～50ℓ ●HF, MH Type
80～160ℓ ●Standard Model ●MH Type
10～160ℓ ●UH Type
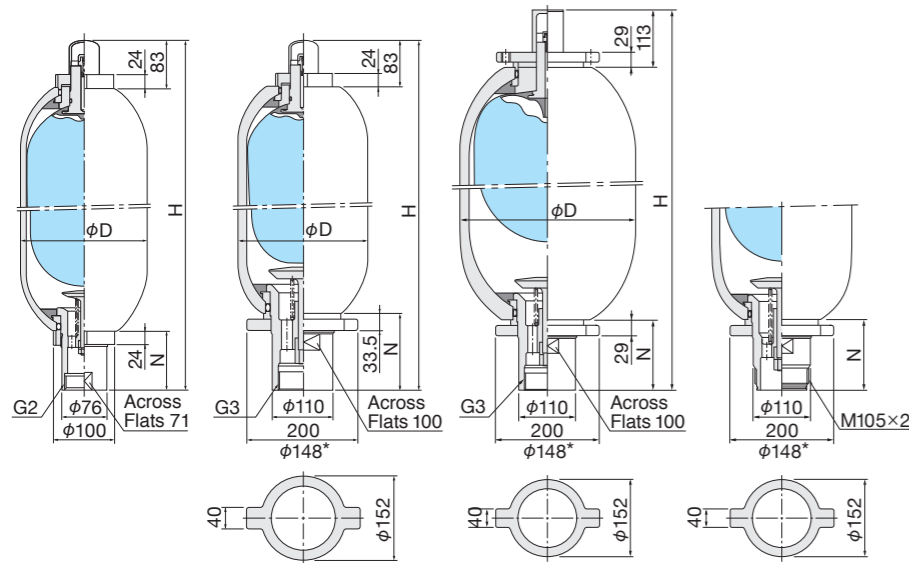
＊：Dimensions of the CE Mark Products

■Basic Model

AT ☐ - ☐
Nominal Pressure — Nominal Volume

■With TR CAP (10～60ℓ)

5/8-18UNF
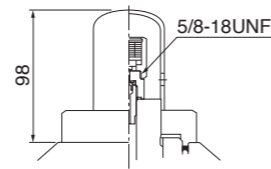
■AT series Standard Flow Rate Models
The maximum working pressure will vary depending on the applicable regulations and standards.

Nominal Volume ℓ	Max Working Pressure Japan MPa	China USA MPa	EU bar	Basic Model	Gas Volume ℓ	Mass kg	Dimension mm H (Note)	D	N	Maximum Discharge Flow Rate ℓ/min
10	16	18	180	AT18M-10	10	36	610(625)	223	102	600
	22.6	25	250	AT25M-10		40		229		
	34.3	35	350	AT35M-10		57	613(628)	245	99	
20	16	18	180	AT18M-20	19	52	912(927)	223	102	600
	22.6	25	250	AT25M-20		63		229		
	34.3	35	350	AT35M-20		91	915(930)	245	99	
30	16	18	180	AT18M-30	35	80	1432(1447)	223	102	600
	20.6	23	230	AT23M-30	35	96	1104(1119)	273		
	22.6	25	250	AT25M-30	34	100	1432(1447)	229		
	34.3	35	350	AT35M-30	34	149	1435(1450)	245	99	
40	20.6	23	230	AT23M-40	45	116	1324(1339)	273	102	600
50	16	18	180	AT18M-50	51	106	1950(1965)	223	102	600
	20.6	23	230	AT23M-50	55	138	1544(1559)	273		
	22.6	25	250	AT25M-50	50	137	1950(1965)	229		
60	20.6	23	230	AT23M-60	64	158	1764(1779)	273	102	600
80	20.6	23	230	AT23M-80	79	225	1452(1452)	356	138	1800
120	20.6	23	230	AT23M-120	129	329	2125(2125)	356	138	1800
150	20.6	23	230	AT23M-150	152	377	2435(2435)	356	138	1800
160	20.6	23	230	AT23M-160	158	389	2515(2515)	356	138	1800

AT23M-30,40,50,60 are short types.

Note: Values in brackets represent the dimensions with a TR cap attached.

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■AT series High Flow Rate Models
The maximum working pressure will vary depending on the applicable regulations and standards.

Type	Maximum Discharge Flow Rate ℓ/min	Nominal Volume ℓ	Max Working Pressure Japan MPa	China USA MPa	EU bar	Basic Model	Gas Volume ℓ	Mass kg	Dimension mm H (Note)	D	N
Semi High Flow (SH)	1260	10	16	18	180	AT18M-10-＊-SH	10	36	610(625)	223	102
			22.6	25	250	AT25M-10-＊-SH		40		229	
			34.3	35	350	AT35M-10-＊-SH		57	613(628)	245	99
		20	16	18	180	AT18M-20-＊-SH	19	52	912(927)	223	102
			22.6	25	250	AT25M-20-＊-SH		63		229	
			34.3	35	350	AT35M-20-＊-SH		91	915(930)	245	99
		30	16	18	180	AT18M-30-＊-SH	35	80	1432(1447)	223	102
			20.6	23	230	AT23M-30-＊-SH	35	96	1104(1119)	273	
			22.6	25	250	AT25M-30-＊-SH	34	100	1432(1447)	229	
			34.3	35	350	AT35M-30-＊-SH	34	149	1435(1450)	245	99
		40	20.6	23	230	AT23M-40-＊-SH	45	116	1324(1339)	273	
		50	16	18	180	AT18M-50-＊-SH	51	106	1950(1965)	223	
			20.6	23	230	AT23M-50-＊-SH	55	138	1544(1559)	273	102
			22.6	25	250	AT25M-50-＊-SH	50	137	1950(1965)	229	
		60	20.6	23	230	AT23M-60-＊-SH	64	158	1764(1779)	273	
High Flow (HF)	1800	10	22.6	25	250	AT25M-10-＊-HF	10	48	657(672)	229	141
		20				AT25M-20-＊-HF	18	71	942(957)		
		30				AT25M-30-＊-HF	33	108	1462(1477)		
		40	20.6	23	230	AT23M-40-＊-HF	45	124	1358(1373)	273	143
		50	22.6	25	250	AT25M-50-＊-HF	49	145	1980(1995)	229	141
Middle High Flow (MH)	2280	10	22.6	25	250	AT25M-10-＊-MH	10	48	657(672)	229	141
		20				AT25M-20-＊-MH	18	71	942(957)		
		30				AT25M-30-＊-MH	33	108	1462(1477)		
		40	20.6	23	230	AT23M-40-＊-MH	45	124	1358(1373)	273	143
		50	22.6	25	250	AT25M-50-＊-MH	49	145	1980(1995)	229	141
		80				AT23M-80-＊-MH	79	225	1452(1452)	356	138
		120	20.6	23	230	AT23M-120-＊-MH	129	329	2125(2125)		
		150				AT23M-150-＊-MH	152	377	2435(2435)		
		160				AT23M-160-＊-MH	158	389	2515(2515)		
Ultra High Flow (UH)	4800	10	22.6	25	250	AT25M-10-＊-UH	10	48	657(672)	229	141
		20				AT25M-20-＊-UH	18	71	942(957)		
		30				AT25M-30-＊-UH	33	108	1462(1477)		
		40	20.6	23	230	AT23M-40-＊-UH	45	124	1358(1373)	273	143
		50	22.6	25	250	AT25M-50-＊-UH	49	145	1980(1995)	229	141
		80				AT23M-80-＊-UH	79	225	1452(1452)	356	138
		120	20.6	23	230	AT23M-120-＊-UH	129	329	2125(2125)		
		150				AT23M-150-＊-UH	152	377	2435(2435)		
		160				AT23M-160-＊-UH	158	389	2515(2515)		

AT23M-30,40,50,60 are short types.

＊：Symbol of Rubber Material

Note: Values in brackets represent the dimensions with a TR cap attached.

List of Model Codes and Dimensions

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To place an order from the AT series for Japan:

Ensure to specify the: (1) "Model Code" and (2) "Product Code" when placing an order.

(1) Example "Model Code" Configuration

■Standard Product: List of Model Codes and Product Codes

AT series   Standard Flow Rate Models : 10, 20 ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	16	Bushing	R3/4	AT18M-10-30/T06	KY5000 □0	AT18M-10-30/T06E	KY7000 □0
			R1	/T08	KY5001 □0	/T08E	KY7001 □0
		F Type Flange	20A	/F06	KY5002 □0	/F06E	KY7002 □0

⇒ Maximum Working Pressure: **16 MPa**, Volume: 10ℓ, Connection Dimensions: R3/4, Joint for Fluid Port Connecting: **Bushing**

(2) Example "Product Code" Configuration

KY○○○○ □0

③ **The Applicable Regulations and Inspections are provided below**

② Provides Specific Model Codes

① Bladder Type Accumulator

③ **Select "Applicable Regulations and Inspections" from the Following:**
K：High Pressure Gas Safety Law (high pressure gas production equipment)
S：In-house Inspection

（Example）**KY5000 K0：**
① Bladder Type Accumulator ② Model: AT18M-10-30/T06 ③ High Pressure Gas Safety Law

■Standard Product: List of Model Codes and Product Codes

AT series   Standard Flow Rate Models: 10, 20 ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	16	Bushing	R3/4	AT18M-10-30/T06	KY5000 □0	AT18M-10-30/T06E	KY7000 □0
			R1	/T08	KY5001 □0	/T08E	KY7001 □0
		F Type Flange	20A	/F06	KY5002 □0	/F06E	KY7002 □0
	22.6	Bushing	R3/4	AT25M-10-30/T06	KY5003 □0	AT25M-10-30/T06E	KY7003 □0
			R1	/T08	KY5004 □0	/T08E	KY7004 □0
		F Type Flange	20A	/F06	KY5005 □0	/F06E	KY7005 □0
	34.3	Bushing	R3/4	AT35M-10-30/T06	KY5006 □0	AT35M-10-30/T06E	KY7006 □0
			R1	/T08	KY5007 □0	/T08E	KY7007 □0
		H Type Flange	20A	/H06	KY5008 □0	/H06E	KY7008 □0
20	16	Bushing	R3/4	AT18M-20-30/T06	KY5009 □0	AT18M-20-30/T06E	KY7009 □0
			R1	/T08	KY5010 □0	/T08E	KY7010 □0
		F Type Flange	20A	/F06	KY5011 □0	/F06E	KY7011 □0
	22.6	Bushing	R3/4	AT25M-20-30/T06	KY5012 □0	AT25M-20-30/T06E	KY7012 □0
			R1	/T08	KY5013 □0	/T08E	KY7013 □0
		F Type Flange	20A	/F06	KY5014 □0	/F06E	KY7014 □0
	34.3	Bushing	R3/4	AT35M-20-30/T06	KY5015 □0	AT35M-20-30/T06E	KY7015 □0
			R1	/T08	KY5016 □0	/T08E	KY7016 □0
		H Type Flange	20A	/H06	KY5017 □0	/H06E	KY7017 □0

Please designate Model Code and Product Code in your order.   *Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

■Standard Product: List of Model Codes and Product Codes

AT series   Standard Flow Rate Models: 30, 40, 50, 60 ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
30	16	Bushing	R3/4	AT18M-30-30/T06	KY5018 □0	AT18M-30-30/T06E	KY7018 □0
			R1	/T08	KY5019 □0	/T08E	KY7019 □0
		F Type Flange	20A	/F06	KY5020 □0	/F06E	KY7020 □0
	20.6	Bushing	R3/4	AT23M-30-30/T06	KY5021 □0	AT23M-30-30/T06E	KY7021 □0
			R1	/T08	KY5022 □0	/T08E	KY7022 □0
		F Type Flange	20A	/F06	KY5023 □0	/F06E	KY7023 □0
	22.6	Bushing	R3/4	AT25M-30-30/T06	KY5024 □0	AT25M-30-30/T06E	KY7024 □0
			R1	/T08	KY5025 □0	/T08E	KY7025 □0
		F Type Flange	20A	/F06	KY5026 □0	/F06E	KY7026 □0
	34.3	Bushing	R3/4	AT35M-30-30/T06	KY5027 □0	AT35M-30-30/T06E	KY7027 □0
			R1	/T08	KY5028 □0	/T08E	KY7028 □0
		H Type Flange	20A	/H06	KY5029 □0	/H06E	KY7029 □0
40	20.6	Bushing	R3/4	AT23M-40-30/T06	KY5030 □0	AT23M-40-30/T06E	KY7030 □0
			R1	/T08	KY5031 □0	/T08E	KY7031 □0
		F Type Flange	20A	/F06	KY5032 □0	/F06E	KY7032 □0
50	16	Bushing	R3/4	AT18M-50-30/T06	KY5033 □0	AT18M-50-30/T06E	KY7033 □0
			R1	/T08	KY5034 □0	/T08E	KY7034 □0
		F Type Flange	20A	/F06	KY5035 □0	/F06E	KY7035 □0
	20.6	Bushing	R3/4	AT23M-50-30/T06	KY5036 □0	AT23M-50-30/T06E	KY7036 □0
			R1	/T08	KY5037 □0	/T08E	KY7037 □0
		F Type Flange	20A	/F06	KY5038 □0	/F06E	KY7038 □0
	22.6	Bushing	R3/4	AT25M-50-30/T06	KY5039 □0	AT25M-50-30/T06E	KY7039 □0
			R1	/T08	KY5040 □0	/T08E	KY7040 □0
		F Type Flange	20A	/F06	KY5041 □0	/F06E	KY7041 □0
60	20.6	Bushing	R3/4	AT23M-60-30/T06	KY5042 □0	AT23M-60-30/T06E	KY7042 □0
			R1	/T08	KY5043 □0	/T08E	KY7043 □0
		F Type Flange	20A	/F06	KY5044 □0	/F06E	KY7044 □0

Please designate Model Code and Product Code in your order.   *Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

AT series Standard Flow Rate Models: 80, 120, 150, 160 ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
80	20.6	F Type Flange	40A	AT23M-80-30/F12	KY5045 □0	AT23M-80-30/F12E	KY7045 □0
			50A	/F16	KY5046 □0	/F16E	KY7046 □0
		D Type Flange	50A	/D16	KY5047 □0	/D16E	KY7047 □0
120	20.6	F Type Flange	40A	AT23M-120-30/F12	KY5048 □0	AT23M-120-30/F12E	KY7048 □0
			50A	/F16	KY5049 □0	/F16E	KY7049 □0
		D Type Flange	50A	/D16	KY5050 □0	/D16E	KY7050 □0
150	20.6	F Type Flange	40A	AT23M-150-30/F12	KY5051 □0	AT23M-150-30/F12E	KY7051 □0
			50A	/F16	KY5052 □0	/F16E	KY7052 □0
		D Type Flange	50A	/D16	KY5053 □0	/D16E	KY7053 □0
160	20.6	F Type Flange	40A	AT23M-160-30/F12	KY5054 □0	AT23M-160-30/F12E	KY7054 □0
			50A	/F16	KY5055 □0	/F16E	KY7055 □0
		D Type Flange	50A	/D16	KY5056 □0	/D16E	KY7056 □0

Please designate Model Code and Product Code in your order.   *Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

■Standard Product: List of Model Codes and Product Codes

AT series　Semi High Flow (SH) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	16	F Type Flange	32A	AT18M-10-30-SH/F10	KY5057 □0	AT18M-10-30-SH/F10E	KY7057 □0
	22.6			AT25M-10-30-SH/F10	KY5058 □0	AT25M-10-30-SH/F10E	KY7058 □0
	34.3	H Type Flange		AT35M-10-30-SH/H10	KY5059 □0	AT35M-10-30-SH/H10E	KY7059 □0
20	16	F Type Flange		AT18M-20-30-SH/F10	KY5060 □0	AT18M-20-30-SH/F10E	KY7060 □0
	22.6			AT25M-20-30-SH/F10	KY5061 □0	AT25M-20-30-SH/F10E	KY7061 □0
	34.3	H Type Flange		AT35M-20-30-SH/H10	KY5062 □0	AT35M-20-30-SH/H10E	KY7062 □0
30	16	F Type Flange		AT18M-30-30-SH/F10	KY5063 □0	AT18M-30-30-SH/F10E	KY7063 □0
	20.6			AT23M-30-30-SH/F10	KY5064 □0	AT23M-30-30-SH/F10E	KY7064 □0
	22.6			AT25M-30-30-SH/F10	KY5065 □0	AT25M-30-30-SH/F10E	KY7065 □0
	34.3	H Type Flange		AT35M-30-30-SH/H10	KY5066 □0	AT35M-30-30-SH/H10E	KY7066 □0
40	20.6	F Type Flange		AT23M-40-30-SH/F10	KY5067 □0	AT23M-40-30-SH/F10E	KY7067 □0
50	16	F Type Flange		AT18M-50-30-SH/F10	KY5068 □0	AT18M-50-30-SH/F10E	KY7068 □0
	20.6			AT23M-50-30-SH/F10	KY5069 □0	AT23M-50-30-SH/F10E	KY7069 □0
	22.6			AT25M-50-30-SH/F10	KY5070 □0	AT25M-50-30-SH/F10E	KY7070 □0
60	20.6	F Type Flange		AT23M-60-30-SH/F10	KY5071 □0	AT23M-60-30-SH/F10E	KY7071 □0

Please designate Model Code and Product Code in your order.　　*Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

AT series　High Flow (HF) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	22.6	F Type Flange	50A	AT25M-10-30-HF/F16	KY5072 □0	AT25M-10-30-HF/F16E	KY7072 □0
		D Type Flange		/D16	KY5073 □0	/D16E	KY7073 □0
20	22.6	F Type Flange		AT25M-20-30-HF/F16	KY5074 □0	AT25M-20-30-HF/F16E	KY7074 □0
		D Type Flange		/D16	KY5075 □0	/D16E	KY7075 □0
30	22.6	F Type Flange		AT25M-30-30-HF/F16	KY5076 □0	AT25M-30-30-HF/F16E	KY7076 □0
		D Type Flange		/D16	KY5077 □0	/D16E	KY7077 □0
40	20.6	F Type Flange		AT23M-40-30-HF/F16	KY5078 □0	AT23M-40-30-HF/F16E	KY7078 □0
		D Type Flange		/D16	KY5079 □0	/D16E	KY7079 □0
50	22.6	F Type Flange		AT25M-50-30-HF/F16	KY5080 □0	AT25M-50-30-HF/F16E	KY7080 □0
		D Type Flange		/D16	KY5081 □0	/D16E	KY7081 □0

Please designate Model Code and Product Code in your order.　　*Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

AT series　Middle High Flow (MH) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	22.6	F Type Flange	65A	AT25M-10-30-MH/F20	KY5082 □0	AT25M-10-30-MH/F20E	KY7082 □0
		D Type Flange		/D20	KY5083 □0	/D20E	KY7083 □0
20	22.6	F Type Flange		AT25M-20-30-MH/F20	KY5084 □0	AT25M-20-30-MH/F20E	KY7084 □0
		D Type Flange		/D20	KY5085 □0	/D20E	KY7085 □0
30	22.6	F Type Flange		AT25M-30-30-MH/F20	KY5086 □0	AT25M-30-30-MH/F20E	KY7086 □0
		D Type Flange		/D20	KY5087 □0	/D20E	KY7087 □0
40	20.6	F Type Flange		AT23M-40-30-MH/F20	KY5088 □0	AT23M-40-30-MH/F20E	KY7088 □0
		D Type Flange		/D20	KY5089 □0	/D20E	KY7089 □0
50	22.6	F Type Flange		AT25M-50-30-MH/F20	KY5090 □0	AT25M-50-30-MH/F20E	KY7090 □0
		D Type Flange		/D20	KY5091 □0	/D20E	KY7091 □0
80	20.6	F Type Flange		AT23M-80-30-MH/F20	KY5092 □0	AT23M-80-30-MH/F20E	KY7092 □0
		D Type Flange		/D20	KY5093 □0	/D20E	KY7093 □0
120	20.6	F Type Flange		AT23M-120-30-MH/F20	KY5094 □0	AT23M-120-30-MH/F20E	KY7094 □0
		D Type Flange		/D20	KY5095 □0	/D20E	KY7095 □0
150	20.6	F Type Flange		AT23M-150-30-MH/F20	KY5096 □0	AT23M-150-30-MH/F20E	KY7096 □0
		D Type Flange		/D20	KY5097 □0	/D20E	KY7097 □0
160	20.6	F Type Flange		AT23M-160-30-MH/F20	KY5098 □0	AT23M-160-30-MH/F20E	KY7098 □0
		D Type Flange		/D20	KY5099 □0	/D20E	KY7099 □0

Please designate Model Code and Product Code in your order.　　*Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

■Standard Product: List of Model Codes and Product Codes

AT series　Ultra High Flow (UH) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP	
				Model Code	Product Code*	Model Code	Product Code*
10	22.6	D Type Flange	80A	AT25M-10-30-UH/D24	KY5100 □0	AT25M-10-30-UH/D24E	KY7100 □0
20	22.6			AT25M-20-30-UH/D24	KY5101 □0	AT25M-20-30-UH/D24E	KY7101 □0
30	22.6			AT25M-30-30-UH/D24	KY5102 □0	AT25M-30-30-UH/D24E	KY7102 □0
40	20.6			AT23M-40-30-UH/D24	KY5103 □0	AT23M-40-30-UH/D24E	KY7103 □0
50	22.6			AT25M-50-30-UH/D24	KY5104 □0	AT25M-50-30-UH/D24E	KY7104 □0
80	20.6			AT23M-80-30-UH/D24	KY5105 □0	AT23M-80-30-UH/D24E	KY7105 □0
120	20.6			AT23M-120-30-UH/D24	KY5106 □0	AT23M-120-30-UH/D24E	KY7106 □0
150	20.6			AT23M-150-30-UH/D24	KY5107 □0	AT23M-150-30-UH/D24E	KY7107 □0
160	20.6			AT23M-160-30-UH/D24	KY5108 □0	AT23M-160-30-UH/D24E	KY7108 □0

Please designate Model Code and Product Code in your order.　　*Select K (high pressure gas) or S (in-house inspection) with regard to □ of the Product Code.

List of Model Codes and Dimensions

To place an order from the AT series for overseas:

Ensure to specify the: (1) "Model Code" and (2) "Product Code" when placing an order.

(1) Example "Model Code" Configuration

Overseas Regulations and Standards Compliant Products

■Standard Product: List of Model Codes and Product Codes

AT series　Standard Flow Rate Models : 10, 20ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP Model Code	Without TR CAP Product Code*	With TR CAP (Note) Model Code	With TR CAP (Note) Product Code*
10	18	Bushing	R3/4	AT18M-10-30/T06	KY5000□0	AT18M-10-30/T06E	KY7000□0
			R1	/T08	KY5001□0	/T08E	KY7001□0
		F Type Flange	20A	/F06	KY5002□0	/F06E	KY7002□0

⇒ Maximum Working Pressure: **18 MPa**, Volume: **10ℓ**, Connection Dimensions: **R3/4**, Joint for Fluid Port Connecting: **Bushing**

(2) Example "Product Code" Configuration

KY○○○○ □0

③The Applicable Regulations and Inspections are provided below
②Provides Specific Model Codes
①Bladder Type Accumulator

③**Select "Applicable Regulations and Inspections" from the Following:**
G : Regulation for Boiler and Pressure Vessel Manufacture Licensing (China) (*10ℓ and 20ℓ are not applicable.)
U : ASME U-Stamp (American Society of Mechanical Engineers)
E : CE Mark (European Pressure Equipment Directive)

（Example) **KY5000 K0 :**
①Bladder Type Accumulator ②Model: AT18M-10-30/T06 ③CE Mark Compliant

Overseas Regulations and Standards Compliant Products

■Standard Product: List of Model Codes and Product Codes

AT series　Standard Flow Rate Models : 10, 20ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP Model Code	Without TR CAP Product Code*	With TR CAP (Note) Model Code	With TR CAP (Note) Product Code*
10	18	Bushing	R3/4	AT18M-10-30/T06	KY5000□0	AT18M-10-30/T06E	KY7000□0
			R1	/T08	KY5001□0	/T08E	KY7001□0
		F Type Flange	20A	/F06	KY5002□0	/F06E	KY7002□0
	25	Bushing	R3/4	AT25M-10-30/T06	KY5003□0	AT25M-10-30/T06E	KY7003□0
			R1	/T08	KY5004□0	/T08E	KY7004□0
		F Type Flange	20A	/F06	KY5005□0	/F06E	KY7005□0
	35	Bushing	R3/4	AT35M-10-30/T06	KY5006□0	AT35M-10-30/T06E	KY7006□0
			R1	/T08	KY5007□0	/T08E	KY7007□0
		H Type Flange	20A	/H06	KY5008□0	/H06E	KY7008□0
20	18	Bushing	R3/4	AT18M-20-30/T06	KY5009□0	AT18M-20-30/T06E	KY7009□0
			R1	/T08	KY5010□0	T08E	KY7010□0
		F Type Flange	20A	/F06	KY5011□0	/F06E	KY7011□0
	25	Bushing	R3/4	AT25M-20-30/T06	KY5012□0	AT25M-20-30/T06E	KY7012□0
			R1	/T08	KY5013□0	/T08E	KY7013□0
		F Type Flange	20A	/F06	KY5014□0	/F06E	KY7014□0
	35	Bushing	R3/4	AT35M-20-30/T06	KY5015□0	AT35M-20-30/T06E	KY7015□0
			R1	/T08	KY5016□0	/T08E	KY7016□0
		H Type Flange	20A	/H06	KY5017□0	/H06E	KY7017□0

Please designate Model Code and Product Code in your order.
* Select E (CE Mark) or U (ASME U-Stamp) with regard to □ of the Product Code. Note: CE Mark models are not available for any models with a TR cap.

Overseas Regulations and Standards Compliant Products

■Standard Product: List of Model Codes and Product Codes

AT series　Standard Flow Rate Models: 30, 40, 50, 60ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP Model Code	Without TR CAP Product Code*	With TR CAP (Note) Model Code	With TR CAP (Note) Product Code*
30	18	Bushing	R3/4	AT18M-30-30/T06	KY5018□0	AT18M-30-30/T06E	KY7018□0
			R1	/T08	KY5019□0	/T08E	KY7019□0
		F Type Flange	20A	/F06	KY5020□0	/F06E	KY7020□0
	23	Bushing	R3/4	AT23M-30-30/T06	KY5021□0	AT23M-30-30/T06E	KY7021□0
			R1	/T08	KY5022□0	/T08E	KY7022□0
		F Type Flange	20A	/F06	KY5023□0	/F06E	KY7023□0
	25	Bushing	R3/4	AT25M-30-30/T06	KY5024□0	AT25M-30-30/T06E	KY7024□0
			R1	/T08	KY5025□0	/T08E	KY7025□0
		F Type Flange	20A	/F06	KY5026□0	/F06E	KY7026□0
	35	Bushing	R3/4	AT35M-30-30/T06	KY5027□0	AT35M-30-30/T06E	KY7027□0
			R1	/T08	KY5028□0	/T08E	KY7028□0
		H Type Flange	20A	/H06	KY5029□0	/H06E	KY7029□0
40	23	Bushing	R3/4	AT23M-40-30/T06	KY5030□0	AT23M-40-30/T06E	KY7030□0
			R1	/T08	KY5031□0	/T08E	KY7031□0
		F Type Flange	20A	/F06	KY5032□0	/F06E	KY7032□0
50	18	Bushing	R3/4	AT18M-50-30/T06	KY5033□0	AT18M-50-30/T06E	KY7033□0
			R1	/T08	KY5034□0	/T08E	KY7034□0
		F Type Flange	20A	/F06	KY5035□0	/F06E	KY7035□0
	23	Bushing	R3/4	AT23M-50-30/T06	KY5036□0	AT23M-50-30/T06E	KY7036□0
			R1	/T08	KY5037□0	/T08E	KY7037□0
		F Type Flange	20A	/F06	KY5038□0	/F06E	KY7038□0
	25	Bushing	R3/4	AT25M-50-30/T06	KY5039□0	AT25M-50-30/T06E	KY7039□0
			R1	/T08	KY5040□0	/T08E	KY7040□0
		F Type Flange	20A	/F06	KY5041□0	/F06E	KY7041□0
60	23	Bushing	R3/4	AT23M-60-30/T06	KY5042□0	AT23M-60-30/T06E	KY7042□0
			R1	/T08	KY5043□0	/T08E	KY7043□0
		F Type Flange	20A	/F06	KY5044□0	/F06E	KY7044□0

Please designate Model Code and Product Code in your order.
*Select E (CE Mark), U (ASME U-Stamp) or G (Regulation for Boiler and Pressure Vessel Manufacture Licensing) with regard to □ of the Product Code. Note: CE Mark models are not available for any models with a TR cap.

AT series　Standard Flow Rate Models: 80, 120, 150, 160ℓ
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP Model Code	Without TR CAP Product Code*	With TR CAP (Note) Model Code	With TR CAP (Note) Product Code*
80	23	F Type Flange	40A	AT23M-80-30/F12	KY5045□0	AT23M-80-30/F12E	KY7045□0
			50A	/F16	KY5046□0	/F16E	KY7046□0
		D Type Flange	50A	/D16	KY5047□0	/D16E	KY7047□0
120	23	F Type Flange	40A	AT23M-120-30/F12	KY5048□0	AT23M-120-30/F12E	KY7048□0
			50A	/F16	KY5049□0	/F16E	KY7049□0
		D Type Flange	50A	/D16	KY5050□0	/D16E	KY7050□0
150	23	F Type Flange	40A	AT23M-150-30/F12	KY5051□0	AT23M-150-30/F12E	KY7051□0
			50A	/F16	KY5052□0	/F16E	KY7052□0
		D Type Flange	50A	/D16	KY5053□0	/D16E	KY7053□0
160	23	F Type Flange	40A	AT23M-160-30/F12	KY5054□0	AT23M-160-30/F12E	KY7054□0
			50A	/F16	KY5055□0	/F16E	KY7055□0
		D Type Flange	50A	/D16	KY5056□0	/D16E	KY7056□0

AT series　Semi High Flow (SH) Type
●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP Model Code	Without TR CAP Product Code*	With TR CAP (Note) Model Code	With TR CAP (Note) Product Code*
10	18	F Type Flange		AT18M-10-30-SH/F10	KY5057□0	AT18M-10-30-SH/F10E	KY7057□0
	25			AT25M-10-30-SH/F10	KY5058□0	AT25M-10-30-SH/F10E	KY7058□0
	35	H Type Flange		AT35M-10-30-SH/H10	KY5059□0	AT35M-10-30-SH/H10E	KY7059□0
20	18	F Type Flange		AT18M-20-30-SH/F10	KY5060□0	AT18M-20-30-SH/F10E	KY7060□0
	25			AT25M-20-30-SH/F10	KY5061□0	AT25M-20-30-SH/F10E	KY7061□0
	35	H Type Flange		AT35M-20-30-SH/H10	KY5062□0	AT35M-20-30-SH/H10E	KY7062□0
30	18	F Type Flange	32A	AT18M-30-30-SH/F10	KY5063□0	AT18M-30-30-SH/F10E	KY7063□0
	23			AT23M-30-30-SH/F10	KY5064□0	AT23M-30-30-SH/F10E	KY7064□0
	25			AT25M-30-30-SH/F10	KY5065□0	AT25M-30-30-SH/F10E	KY7065□0
	35	H Type Flange		AT35M-30-30-SH/H10	KY5066□0	AT35M-30-30-SH/H10E	KY7066□0
40	23	F Type Flange		AT23M-40-30-SH/F10	KY5067□0	AT23M-40-30-SH/F10E	KY7067□0
50	18	F Type Flange		AT18M-50-30-SH/F10	KY5068□0	AT18M-50-30-SH/F10E	KY7068□0
	23			AT23M-50-30-SH/F10	KY5069□0	AT23M-50-30-SH/F10E	KY7069□0
	25			AT25M-50-30-SH/F10	KY5070□0	AT25M-50-30-SH/F10E	KY7070□0
60	23	F Type Flange		AT23M-60-30-SH/F10	KY5071□0	AT23M-60-30-SH/F10E	KY7071□0

Please designate Model Code and Product Code in your order.
*Select E (CE Mark), U (ASME U-Stamp) or G (Regulation for Boiler and Pressure Vessel Manufacture Licensing) with regard to □ of the Product Code. Note: CE Mark models are not available for any models with a TR cap.

■Standard Product: List of Model Codes and Product Codes

AT series   High Flow (HF) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP (Note)	
				Model Code	Product Code*	Model Code	Product Code*
10	25	F Type Flange	50A	AT25M-10-30-HF/F16	KY5072 □0	AT25M-10-30-HF/F16E	KY7072 □0
		D Type Flange		/D16	KY5073 □0	/D16E	KY7073 □0
20	25	F Type Flange		AT25M-20-30-HF/F16	KY5074 □0	AT25M-20-30-HF/F16E	KY7074 □0
		D Type Flange		/D16	KY5075 □0	/D16E	KY7075 □0
30		F Type Flange		AT25M-30-30-HF/F16	KY5076 □0	AT25M-30-30-HF/F16E	KY7076 □0
		D Type Flange		/D16	KY5077 □0	/D16E	KY7077 □0
40	23	F Type Flange		AT23M-40-30-HF/F16	KY5078 □0	AT23M-40-30-HF/F16E	KY7078 □0
		D Type Flange		/D16	KY5079 □0	/D16E	KY7079 □0
50	25	F Type Flange		AT25M-50-30-HF/F16	KY5080 □0	AT25M-50-30-HF/F16E	KY7080 □0
		D Type Flange		/D16	KY5081 □0	/D16E	KY7081 □0

Please designate Model Code and Product Code in your order.
*Select E (CE Mark), U (ASME U-Stamp) or G (Regulation for Boiler and Pressure Vessel Manufacture Licensing) with regard to □ of the Product Code.   Note: CE Mark models are not available for any models with a TR cap.

AT series   Middle High Flow (MH) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP (Note)	
				Model Code	Product Code*	Model Code	Product Code*
10	25	F Type Flange	65A	AT25M-10-30-MH/F20	KY5082 □0	AT25M-10-30-MH/F20E	KY7082 □0
		D Type Flange		/D20	KY5083 □0	/D20E	KY7083 □0
20	25	F Type Flange		AT25M-20-30-MH/F20	KY5084 □0	AT25M-20-30-MH/F20E	KY7084 □0
		D Type Flange		/D20	KY5085 □0	/D20E	KY7085 □0
30		F Type Flange		AT25M-30-30-MH/F20	KY5086 □0	AT25M-30-30-MH/F20E	KY7086 □0
		D Type Flange		/D20	KY5087 □0	/D20E	KY7087 □0
40	23	F Type Flange		AT23M-40-30-MH/F20	KY5088 □0	AT23M-40-30-MH/F20E	KY7088 □0
		D Type Flange		/D20	KY5089 □0	/D20E	KY7089 □0
50	25	F Type Flange		AT25M-50-30-MH/F20	KY5090 □0	AT25M-50-30-MH/F20E	KY7090 □0
		D Type Flange		/D20	KY5091 □0	/D20E	KY7091 □0
80		F Type Flange		AT23M-80-30-MH/F20	KY5092 □0	AT23M-80-30-MH/F20E	KY7092 □0
		D Type Flange		/D20	KY5093 □0	/D20E	KY7093 □0
120	23	F Type Flange		AT23M-120-30-MH/F20	KY5094 □0	AT23M-120-30-MH/F20E	KY7094 □0
		D Type Flange		/D20	KY5095 □0	/D20E	KY7095 □0
150		F Type Flange		AT23M-150-30-MH/F20	KY5096 □0	AT23M-150-30-MH/F20E	KY7096 □0
		D Type Flange		/D20	KY5097 □0	/D20E	KY7097 □0
160		F Type Flange		AT23M-160-30-MH/F20	KY5098 □0	AT23M-160-30-MH/F20E	KY7098 □0
		D Type Flange		/D20	KY5099 □0	/D20E	KY7099 □0

Please designate Model Code and Product Code in your order.
*Select E (CE Mark), U (ASME U-Stamp) or G (Regulation for Boiler and Pressure Vessel Manufacture Licensing) with regard to □ of the Product Code.   Note: CE Mark models are not available for any models with a TR cap.

AT series   Ultra High Flow (UH) Type

●Rubber Material: Symbol 30 (NBR Standard Nitrile Rubber)
●Applicable Fluid: Common Mineral Hydraulic Oil

Nominal Volume ℓ	Maximum Working Pressure MPa	Joint for Fluid Port Connecting	Size	Without TR CAP		With TR CAP (Note)	
				Model Code	Product Code*	Model Code	Product Code*
10	23	D Type Flange	80A	AT25M-10-30-UH/D24	KY5100 □0	AT25M-10-30-UH/D24E	KY7100 □0
20	23			AT25M-20-30-UH/D24	KY5101 □0	AT25M-20-30-UH/D24E	KY7101 □0
30				AT25M-30-30-UH/D24	KY5102 □0	AT25M-30-30-UH/D24E	KY7102 □0
40	21			AT23M-40-30-UH/D24	KY5103 □0	AT23M-40-30-UH/D24E	KY7103 □0
50	23			AT25M-50-30-UH/D24	KY5104 □0	AT25M-50-30-UH/D24E	KY7104 □0
80				AT23M-80-30-UH/D24	KY5105 □0	AT23M-80-30-UH/D24E	KY7105 □0
120	21			AT23M-120-30-UH/D24	KY5106 □0	AT23M-120-30-UH/D24E	KY7106 □0
150				AT23M-150-30-UH/D24	KY5107 □0	AT23M-150-30-UH/D24E	KY7107 □0
160				AT23M-160-30-UH/D24	KY5108 □0	AT23M-160-30-UH/D24E	KY7108 □0

Please designate Model Code and Product Code in your order.
*Select E (CE Mark), U (ASME U-Stamp) or G (Regulation for Boiler and Pressure Vessel Manufacture Licensing) with regard to □ of the Product Code.   Note: CE Mark models are not available for any models with a TR cap.

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10. Transfer Barrier Type

> The transfer barrier type is used to pump any fluids or gases other than hydraulic fluid.

■Model Code Configuration

$$AT\square-\square-\square-TB/\square\quad GF06$$

18M ～ 25M	10 ～ 160	10 30 40	None ～ W	T04 ～ F12

- Nominal Pressure (18M ～ 25M)
- Nominal Volume (10 ～ 160)
- Rubber Material (10 30 40)
- Fluid (None ～ W)
- Joint for Fluid Port Connecting / Upper Flange (T04 ～ F12)
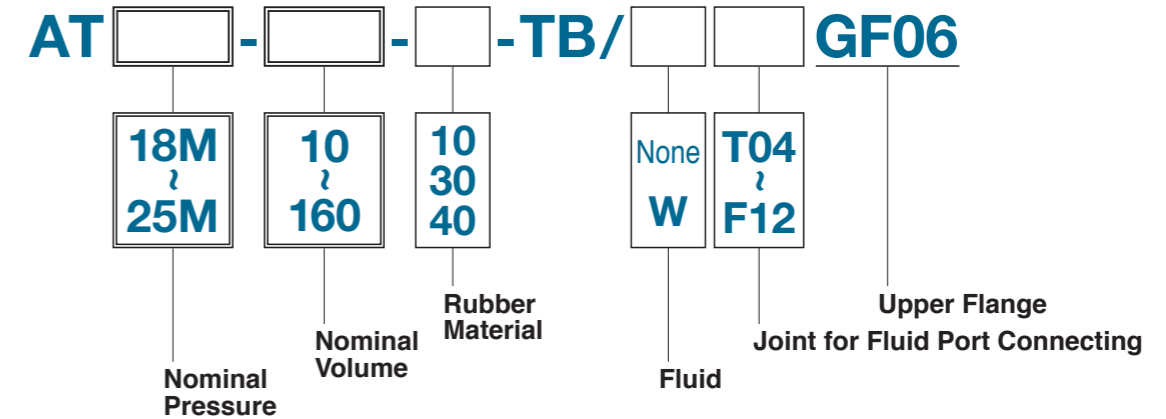
• The AT series is the standard applicable accumulator with an upper flange connection.

AT series 10～60ℓ
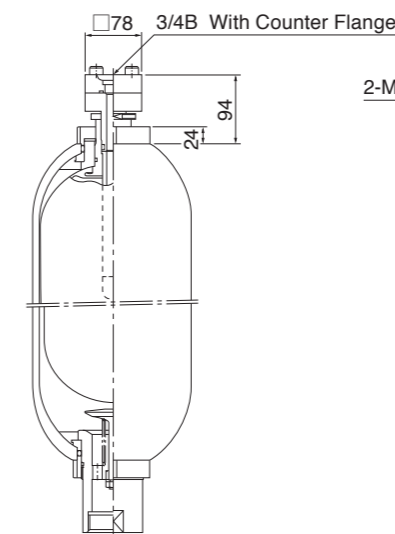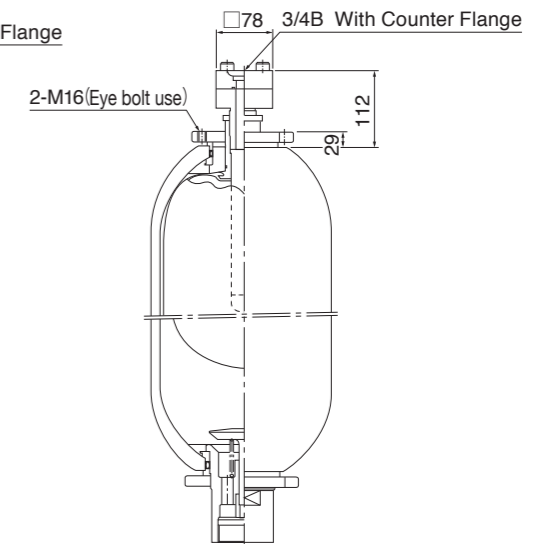
□78 3/4B With Counter Flange
94
24

AT series 80～160ℓ

□78 3/4B With Counter Flange
2-M16 (Eye bolt use)
112
29

Consult your nearest sales contact to place an order.

PA series — FOR HIGH PRESSURE AND BIG VOLUME, WE CAN DESIGN FREELY

The Original Seal Makes The Accumulator Have Low Friction And High Sealing Ability.

■ Model Code Configuration

Material of O-rings

Symbol	Material	Fluid	Temperature	Note
30	NBR (Standard Nitrile Rubber)	Common Mineral Hydraulic Oil	−20~100°C	Standard Material
10	NBR (Nitrile Rubber for Low Temperature Use)	Common Mineral Hydraulic Oil	−40~80°C	Material For Low Temp.
70	FKM (Fluororubber)	Common Mineral Hydraulic Oil Phosphoric Ester Hydraulic Oil	−15~150°C	(Note) For High Temp., For Chemicals

(Note) If the maximum working temperature exceeds 100 °C, then ensure to consult your nearest sales contact as it will require a special design.

PA 210 - ☐ - ☐ / ☐

- Nominal Pressure
- Nominal Volume
- Joint for Fluid Port Connecting
- Specifications Required by the Gas Side

None / E (Note)

(Note) In case of ambient temperature always exceeding 80°C, TR Cap cannot be used.

Type A **Type B** **Type C**

The following list is of representative sizes. Please consult your nearest sales contact for any other size.

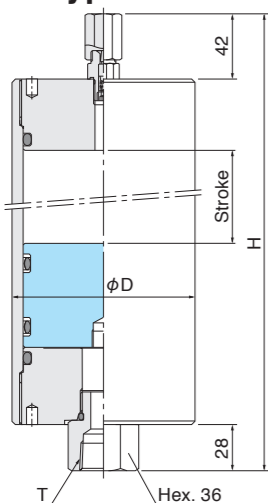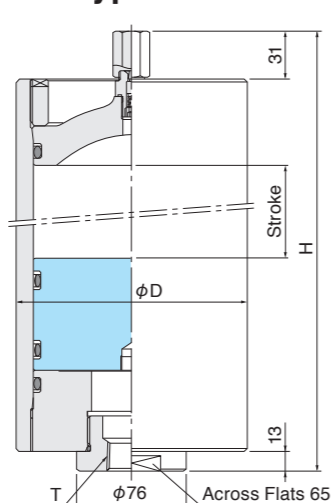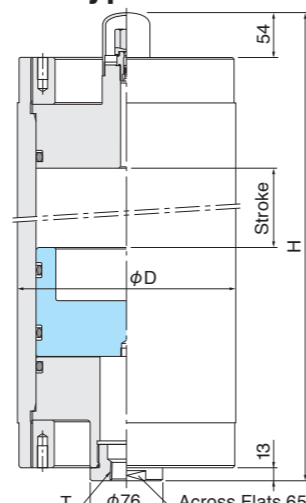| Type	Inner mm	Standard Product Model	Maximum Working Pressure MPa	Gas Volume ℓ	Mass kg	Dimension mm H	Dimension mm D	Thread T	Stroke mm	Maximum Discharge Flow Rate ℓ/min	Product Code Without TR CAP	Product Code With TR CAP
A	100	PA210- 1-30/T06(E)	20.6	1	13	340(357)	114.3	Rc 3/4	128	220 〔700〕	KW6936 A4	KW6924 A4
		PA210- 2-30/T06(E)		2	16	468(485)			256		KW6937 A4	KW6925 A4
		PA210- 3-30/T06(E)		3	18	595(612)			383		KW6938 A4	KW6926 A4
		PA210- 4-30/T06(E)		4	20	722(739)			510		KW6939 A4	KW6927 A4
B	140	PA210- 4-30/T08(E)	20.6	4	37	489(507)	165.2	Rc 1	254	450 〔1400〕	KW6940 A4	KW6928 A4
		PA210- 5-30/T08(E)		5	40	554(572)			319		KW6941 A4	KW6929 A4
		PA210-10-30/T08(E)		10	55	879(897)			644		KW6942 A4	KW6930 A4
C	200	PA210-10-30/T08(E)	20.6	10	128	703(718)	241.8	Rc 1	283	450 〔2800〕	KW6943 A4	KW6931 A4
		PA210-20-30/T08(E)		20	166	1032(1047)			612		KW6944 A4	KW6932 A4
		PA210-30-30/T08(E)		30	202	1348(1363)			928		KW6945 A4	KW6933 A4
		PA210-40-30/T08(E)		40	238	1660(1675)			1240		KW6946 A4	KW6934 A4
		PA210-50-30/T08(E)		50	275	1991(2006)			1571		KW6947 A4	KW6935 A4

Notes: ( ) with TR Cap
Please designate Model Code and Product Code in your order.
Consult your nearest sales contact to place an order for a fixing band.

Note: Values in the 〔 〕 represent the maximum discharge flow obtained by changing the bore of the joint for fluid port connecting.

ET series — LOW-PRESSURE ACCUMULATOR FOR WATER

Accumulator for Potable Water that is of Excellent Chlorine Resistance

■ Model Code Configuration

Rubber Material

Symbol	Material	Fluid	Temperature
52 For Type A (0.5, 1, 2 ℓ)	CM (Chlorinated Polyethylene)	Potable Water, Industrial Water	−10~85°C
50 For Type B (10, 20 ℓ) For Type C (20 ℓ)			

ET ☐ - ☐ - ☐

- Nominal Pressure
- Nominal Volume

● Note that Type A (0.5, 1 and 2 ℓ) cannot be refilled with gas.
Use at 40 °C or less is recommended.
Also, the product is delivered filled with nitrogen gas at the factory.
Please ensure to let us know the desired gas pressure (___MPa at ___°C) when placing an order.
Pressure can be specified from 0.04 MPa to 0.5 MPa in 0.01 MPa increments.
● Type B (10 and 20 ℓ) and Type C (20 ℓ) can be refilled with gas.
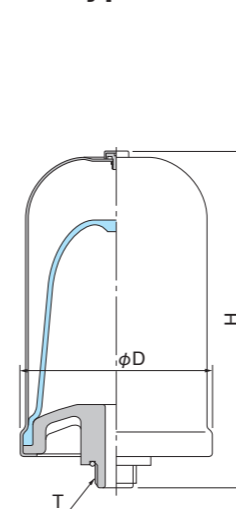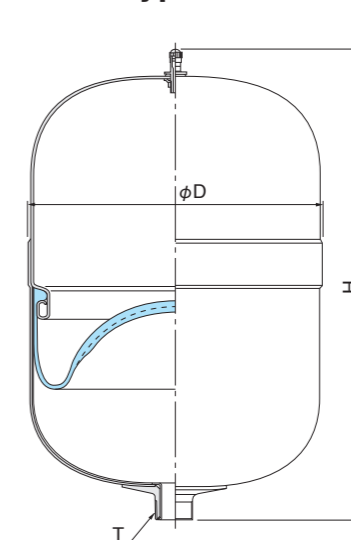
Type A **Type B** **Type C**
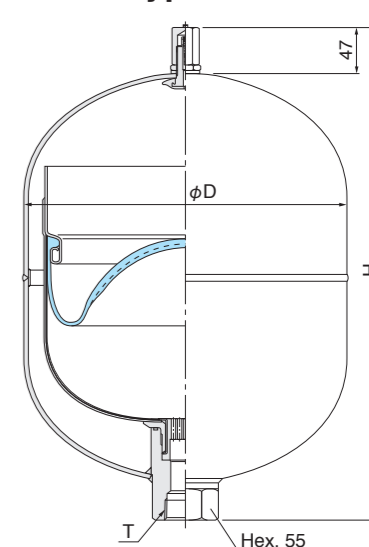
Type	Model Code	Maximum Working Pressure MPa	Gas Volume ℓ	Mass kg	Dimension mm H	Dimension mm D	Thread T	Maximum Discharge Flow Rate ℓ/min	Product Code
A	ET4.5-0.5-52	0.45	0.6	0.6	134	112	G1/2	30	KE7522 J4~KE7523 S4
	ET4.5-1-52		1.0	0.8	201	112	G1/2		KE7524 J4~KE7525 S4
	ET5-2-52	0.5	2.0	1.4	219	143	G 3/4		KE7526 J4~KE7527 S4
B	ET8.5-10-50	0.85	11.5	4.5	375	233	R 3/4	90	KE5671 D4
	ET8.5-20-50		18.6	6.0	440	273	R 3/4		KE5672 E4
C	ET20-20-50	2.0	20	20	472	309	Rc1 1/4	90	KE6957 E4

Please designate Model Code and Product Code in your order.
Type A has different Product Codes for the differing filled gas pressures. Consult your nearest sales contact for more details.

In order to make the accumulator be easily connected, there has prepared bushing and flange of various sizes. Please place order with accumulator.
Selecting of bushing and flange should be in accord with joint mount thread of accumulator fluid port.

| Bushing | Flange |

F Type and H Type Flange
D Type Flange
D Type Flange for UH type
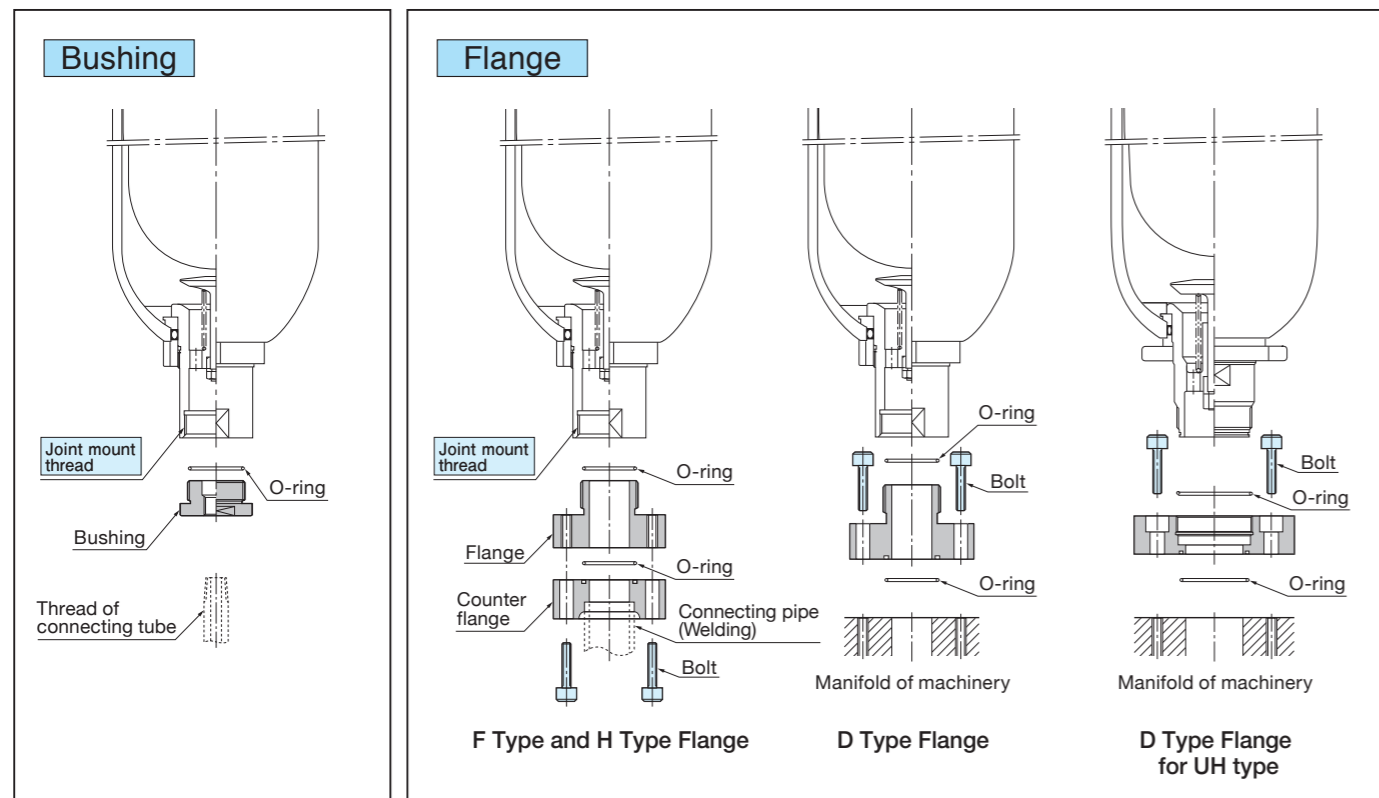
① Bushing (With O-ring and Backup Ring)

Symbol	Thread Size of Connecting Tube	Applicable Accumulator (Joint Mount Thread)	Figure	Dimension mm			O-ring Applied on "F" [Common Mineral Hydraulic Oils]	Purchase separately	
				A	B	C		Model Code	Product Code
T03	R3/8	PA (Type A)		32	8	Rc3/8	JIS B2401-1 OR NBR-90 P22-N	PAL101-049	EB1701 Z1
T04	R1/2	AL1, 2.4 ℓ (G3/4)		36	30	Rc1/2		PAL101-050	EB1702 Z1
T06	R3/4					Rc3/4		PAL101-051	EB1703 Z1
T04	R1/2	AL4, 5 ℓ (G1¹/₄)		50	10	Rc1/2	AS568-222 Former AN6227#27 (JIS NBR-90)	PAL101-052	EB1704 Z1
T06	R3/4					Rc3/4		PAL101-053	EB1705 Z1
T08	R 1					28 Rc1		PAL101-054	EB1706 Z1
T04	R1/2	PA (Types B,C) AT10~60 ℓ (G2)		76	13	Rc1/2	JIS B2401-1 OR NBR-90 G55-N	PAT101-028	EB1707 Z1
T06	R3/4					Rc3/4		PAT101-029	EB1708 Z1
T08	R 1					Rc1		PAT101-030	EB1709 Z1
T10	R1¹/₄					Rc1¹/₄		PAT101-031	EB1710 Z1
T06	R3/4	AT-HF, MH AT80~160 ℓ (G3)		108	40	Rc3/4	AS568-336 Former AN6227#39 (JIS NBR-70-1)	PAT101-032	EB1711 Z1
T08	R1					Rc1		PAT101-033	EB1712 Z1
T10	R1¹/₄					Rc1¹/₄		PAT101-034	EB1713 Z1
T12	R1¹/₂		(With Backup Ring T2) Section Y-O-Y'			Rc1¹/₂		PAT101-035	EB1714 Z1

When purchasing without accumulator ● Please designate Model Code and Product Code. Material: Steel (Standard Material)
● Stainless steel is also available.

② Flange

F-Type Flange Set (With Counter Flange, Bolts, O-rings, Backup Ring)
Maximum Working Pressure: 21 MPa

| Symbol	Connecting Pipe Bore Size	Counter Flange JIS B2291	Applicable Accumulator (Joint Mount Thread)	Figure (Applied O-ring: For Common Mineral Hydraulic Oils)	Dimension mm					Purchase of Flange Set	
					A	B	C	D	E	Model Code	Product Code
F04	15A (1/2B)	SSA15	AL1, 2.4 ℓ (G3/4)	O-ring: JIS B 2401-1 OR NBR-90 P22-N	75	38	16	36	M10	PAL101-056	EB1715 Z1
F06	20A (3/4B)	SSA20					20	40		PAL101-057	EB1716 Z1
F06	20A (3/4B)	SSA20	AL4, 5 ℓ (G1¹/₄)	O-ring: AS568-222 (Former AN6227#27) (JIS NBR-90)	75	38	20	40	M10	PAL101-058	EB1717 Z1
F08	25A (1B)	SSA25			108	43	25	48	M12	PAL101-059	EB1718 Z1
F06	20A (3/4B)	SSA20	AT10~60 ℓ AT-SH type (G2)	O-ring: JIS B 2401-1 OR NBR-90 G55-N	80	38	20	40	M10	PAT101-036	EB1719 Z1
F08	25A (1B)	SSA25			108		25	48	M12	PAT101-037	EB1720 Z1
F10	32A (1¹/₄B)	SSA32					30	56		PAT101-038	EB1721 Z1
F12	40A (1¹/₂B)	SSA40			128	40	37	65	M16	PAT101-039	EB1722 Z1
F12	40A (1¹/₂B)	SSA40	AT-HF, MH AT80~160 ℓ (G3)	O-ring: AS568-336 (Former AN6227#39) (JIS NBR-70-1) (With Backup Ring T2)	128	36	37.5	65	M16	PAT101-101	EB1742 Z1
F16	50A (2B)	SSA50			138		47.5	73		PAT101-102	EB1743 Z1
F20	65A (2¹/₂B)	SSA65			178	45	60	92	M20	PAT101-103	EB1744 Z1
F24	80A (3B)	SSA80			198		71	103	M22	PAT101-104	EB1745 Z1

When purchasing without accumulator ● Please designate Model Code and Product Code. Material: Steel (Standard Material)
● Stainless steel is also available.

【Information】 JIS B 2291 Counter Flange Dimension

Symbol	Nominal Bore Size	Figure	Dimension mm							O-ring Applied on "H" JIS B2401-1 [Common Mineral Hydraulic Oils]
			A	B	C	D	E	F	G	
F04	SSA15		54	22	16	36	11	22.2	11	OR NBR-90 G25-N
F06	SSA20		58	22	20	40	11	27.7	12	OR NBR-90 G30-N
F08	SSA25		68	28	25	48	13	34.5	14	OR NBR-90 G35-N
F10	SSA32		76	28	31.5	56	13	43.2	16	OR NBR-90 G40-N
F12	SSA40		92	36	37.5	65	18	49.1	18	OR NBR-90 G50-N
F16	SSA50		100	36	47.5	73	18	61.1	20	OR NBR-90 G60-N
F20	SSA65		128	45	60	92	22	77.1	22	OR NBR-90 G75-N
F24	SSA80		140	45	71	103	24	90	25	OR NBR-90 G85-N

Accessories and Parts

H-Type Flange Set (With Counter Flange, Bolts, O-rings, Backup Ring)

Maximum Working Pressure: 35 MPa

Symbol	Connecting Pipe Bore Size	Applicable Accumulator (Joint Mount Thread)	Figure (Applied O-ring: For Common Mineral Hydraulic Oils)	A	B	C	D	E	Model Code	Product Code
H04	15A (1/2B)	AL1, 2.4ℓ (G3/4)	G3/4 ... 4-E Tap / O-ring: JIS B 2401-1 OR NBR-90 P22-N	86	42	16	44	M12	PAL101-060	EB1726 Z1
H06	20A (3/4B)	AL1, 2.4ℓ (G3/4)		93	42	20	49	M12	PAL101-061	EB1727 Z1
H06	20A (3/4B)	AL4, 5ℓ (G1 1/4)	G1 1/4 ... 4-E Tap / O-ring: AS568-222 (Former AN6227#27) (JIS NBR-90)	93	42	20	49	M12	PAL101-062	EB1728 Z1
H08	25A (1B)	AL4, 5ℓ (G1 1/4)		108	42	25	57	M16	PAL101-063	EB1729 Z1
H06	20A (3/4B)	AT10~60ℓ AT-SH (G2)	G2 ... 4-E Tap / O-ring: JIS B 2401-1 OR NBR-90 G55-N	93	42	20	49	M12	PAT101-043	EB1730 Z1
H08	25A (1B)	AT10~60ℓ AT-SH (G2)		108	42	25	57	M16	PAT101-044	EB1731 Z1
H10	32A (1 1/4B)	AT10~60ℓ AT-SH (G2)		118	42	30	65	M16	PAT101-045	EB1732 Z1
H12	40A (1 1/2B)	AT10~60ℓ AT-SH (G2)		138	44	37	75	M20	PAT101-046	EB1733 Z1
H16	50A (2B)	AT-HF, MH AT80~160ℓ (G3)	G3 ... 4-E Tap / O-ring: AS568-336 (Former AN6227#39) (JIS NBR-70-1) (With Backup Ring T2)	158	45	47.5	88	M20	PAT101-116	EB1761 Z1
H20	65A (2 1/2B)	AT-HF, MH AT80~160ℓ (G3)		198	55	60	110	M24	PAT101-117	EB1762 Z1
H24	80A (3B)	AT-HF, MH AT80~160ℓ (G3)		228	55	71	124	M30	PAT101-118	EB1763 Z1

When purchasing without accumulator ● Please designate Model Code and Product Code. Material: Steel (Standard Material)
● Stainless steel is also available.

Counter Flange Dimension

Symbol	Connecting Pipe Bore Size	Figure	A	B	C	D	E	F	G	O-ring Applied on "H" JIS B2401-1 [Common Mineral Hydraulic Oils]
H04	15A(1/2B)		74	25	16	44	14	22.2	10	OR NBR-90 G25-N
H06	20A(3/4B)		78	25	20	49	14	27.7	17	OR NBR-90 G30-N
H08	25A(1B)		90	32	25	57	18	34.5	19	OR NBR-90 G35-N
H10	32A(1 1/4B)		100	32	30	65	18	43.2	20	OR NBR-90 G40-N
H12	40A(1 1/2B)		118	40	38	75	22	49.1	23	OR NBR-90 G50-N
H16	50A(2B)		134	45	47.5	88	22	61.1	25	OR NBR-90 G60-N
H20	65A(2 1/2B)		170	55	60	110	26	77.1	28	OR NBR-90 G75-N
H24	80A(3B)		186	55	71	124	32	90	31	OR NBR-90 G85-N

D-Type Flange Set, Manifold Direct Connecting (With Bolts, O-rings, Backup Ring)
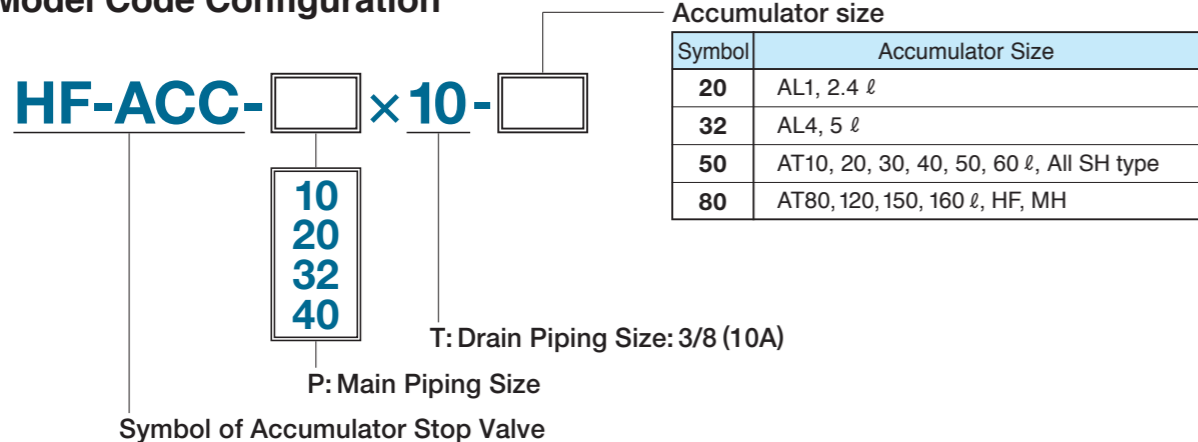
Maximum Working Pressure: 25 MPa

Symbol	Connecting Pipe Bore Size	Applicable Accumulator (Joint Mount Thread)	Figure (Applied O-ring: For Common Mineral Hydraulic Oils)	A	B	C	D	E	O-ring Applied on "G" JIS B2401-1 [Common Mineral Hydraulic Oils]	Model Code	Product Code
D04	15A (1/2B)	AL1, 2.4ℓ (G3/4)	G3/4 ... 4-φE (M10×40L) / O-ring: JIS B 2401-1 OR NBR-90 P22-N	68	25	16	48	11	OR NBR-90 G25-N	PAL101-112	EB1746 Z1
D06	20A (3/4B)	AL1, 2.4ℓ (G3/4)		68	25	20	48	11	OR NBR-90 G30-N	PAL101-113	EB1747 Z1
D06	20A (3/4B)	AL4, 5ℓ (G1 1/4)	G1 1/4 ... 4-φE (M12×45L) / O-ring: AS568-222 (Former AN6227#27) (JIS NBR-90)	76	28	20	56	13	OR NBR-90 G30-N	PAL101-114	EB1748 Z1
D08	25A (1B)	AL4, 5ℓ (G1 1/4)		76	28	25	56	13	OR NBR-90 G35-N	PAL101-115	EB1749 Z1
D10	32A (1 1/4B)	AT10~60ℓ AT-SH type (G2)	G2 ... 4-φE (M16×60L) / O-ring: JIS B 2401-1 OR NBR-90 G55-N	100	36	32	73	18	OR NBR-90 G40-N	PAT101-107	EB1752 Z1
D12	40A (1 1/2B)	AT10~60ℓ AT-SH type (G2)		100	36	38	73	18	OR NBR-90 G50-N	PAT101-108	EB1753 Z1
D16	50A (2B)	AT-HF, MH AT80~160ℓ (G3)	G3 ... 4-φE (M22×80L) / O-ring: AS568-336 (Former AN6227#39) (JIS NBR-70-1) (With Backup Ring T2)	140	45	48	103	24	OR NBR-90 G60-N	PAT101-110	EB1755 Z1
D20	65A (2 1/2B)	AT-HF, MH AT80~160ℓ (G3)		140	45	60	103	24	OR NBR-90 G75-N	PAT101-111	EB1756 Z1
D16	50A (2B)	AT-UH (M105×2 male thread)	M105×2 ... φ32 ... 21.5 ... Section X-O-X' ... 4-φE (M20×55L)	140	45	48	103	22	OR NBR-90 G60-N	PAT101-113	EB1759 Z1
D24	80A (3B)	AT-UH (M105×2 male thread)		155	50	82	112	22	OR NBR-90 G90-N	PAT101-114	EB1760 Z1

When purchasing without accumulator ● Please designate Model Code and Product Code. Material: Steel (Standard Material)
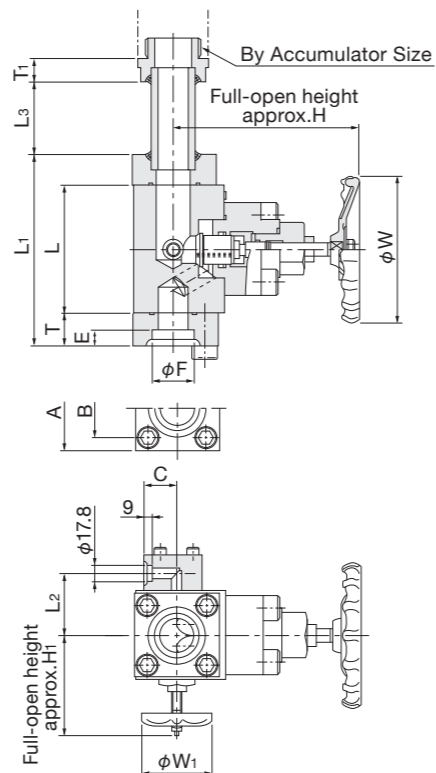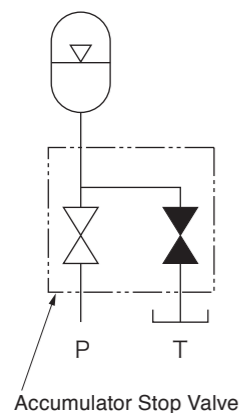● Stainless steel is also available.

Accumulator stop valve is the multiple valve which consists of a main valve and a drain valve.
Fluid pressure can be relieved by shutting the main valve and opening the drain valve,
which facilitates the checking of the filled gas pressure and the replacement of the
accumulator and the bladder.

■Model Code Configuration

HF-ACC-□ ×10-□

Symbol	Accumulator Size
20	AL1, 2.4 ℓ
32	AL4, 5 ℓ
50	AT10, 20, 30, 40, 50, 60 ℓ, All SH type
80	AT80, 120, 150, 160 ℓ, HF, MH

Accumulator size

10
20
32
40

T: Drain Piping Size: 3/8 (10A)

P: Main Piping Size

Symbol of Accumulator Stop Valve

■JIS Symbol Mark

Accumulator Stop Valve

Dimension table

Model Code	Main Piping Size P	Drain Piping Size T	L	L_1	L_2	L_3	T	T_1	A	B	C	E	F	H	H_1	W	W_1	Mass kg
HF-ACC-10×10-□	10A(3/8B)	3/8B (10A)	100	142	47.5	50	21	25	58	40	33	9	17.8	141	96	120	80	6.0
HF-ACC-20×10-□	20A(3/4B)		100	142	47.5	50	21	25	58	40	33	12	27.7	141	96	120	80	6.2
HF-ACC-32×10-□	32A(1¼B)		110	164	60.5	60	27	25	76	56	33	16	43.2	202	109	180	80	13.5
HF-ACC-40×10-□	40A(1½B)		140	210	69.0	80	35	25	92	65	36	18	49.1	209	114	160	80	22.5

(Dimension mm; Flange Dimension covers A, B, C, E, F)

When purchasing without accumulator ● Please designate Accumulator size and main piping size.
● At occasion of applying other hydraulic fluid than mineral oils, please inform applied fluid.
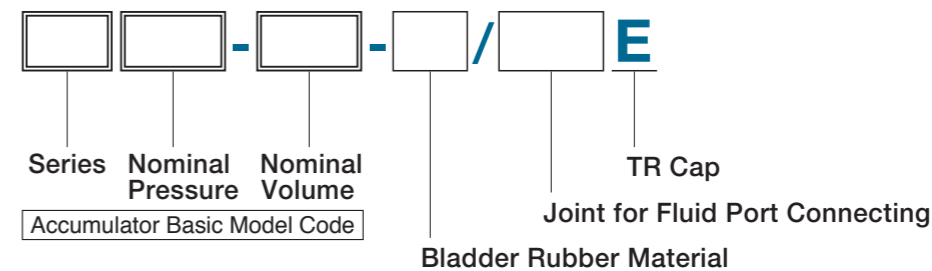
Consult your nearest sales contact if you need the product whose maximum working pressure is over 21MPa.
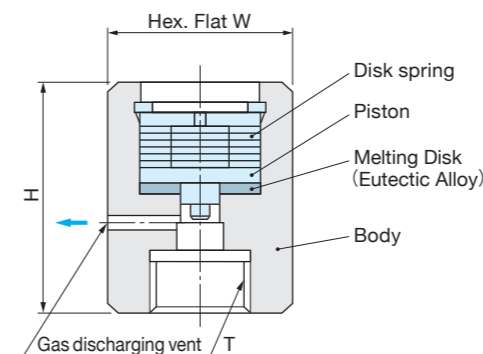

TR Cap is a safety valve, which operates at occasion of unusual high ambient temperature,
such as a fire. NOK recommends applying TR Cap to ensure safety.
Please order with Accumulator.
It can be mounted on an Accumulator in operation without discharging nitrogen gas.

■Model Code Configuration

Please add "**E**" at the end of Accumulator Model Code, such as below.

□□-□-□/□ E

Series   Nominal Pressure   Nominal Volume

Accumulator Basic Model Code

TR Cap

Joint for Fluid Port Connecting

Bladder Rubber Material

■Structure

To purchase TR Cap separately, please designate
Model Code and Product Code.

Model Code	Dimension mm H	W	T	Product Code	Note
TR3-150	30	22	5/8-18UNF	EB 3710 S0	Standard

■Operating Description

Usual   Unusual

Nitrogen gas   Nitrogen gas

Discharging

Press Valve stem and seal released
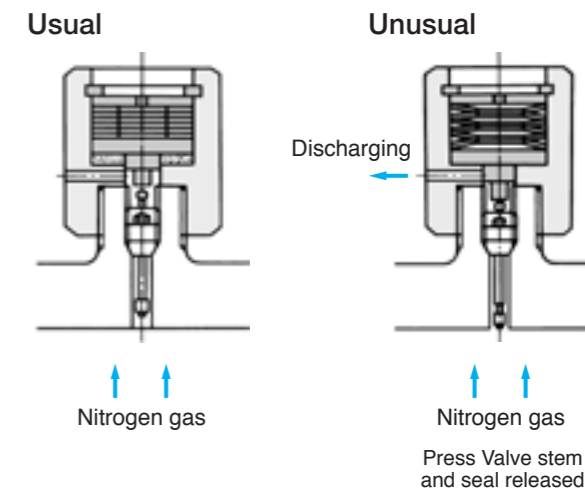
1. External heat of temperature exceeding 150℃ melts Melting Disk. Melting Disk melts due to heating.
2. Due to melting of Melting Disk, the piston is pressed by disk springs to move downward.
3. The piston presses the valve stem of the gas valve and releases the seal.

Thus, nitrogen gas in Accumulator sealed by gas valve is discharged to atmosphere through gas discharging vent.

In case of ambient temperature always exceeding 80℃, TR Cap cannot be used.

Accessories and Parts

The gas control valve not only facilitates the filling of the gas and the gas pressure to be checked but also incorporates a safety valve function.
Two types of safety valve are available: fuse metal or spring type.
Either valve can be selected when ordering an accumulator.

■ Model Code Configuration

| Model Code of the Accumulator | Model Code of the Gas Control Valve |

Series | **Nominal Pressure** | **Nominal Volume**
Basic Model of the Accumulator

Joint for Fluid Port Connecting
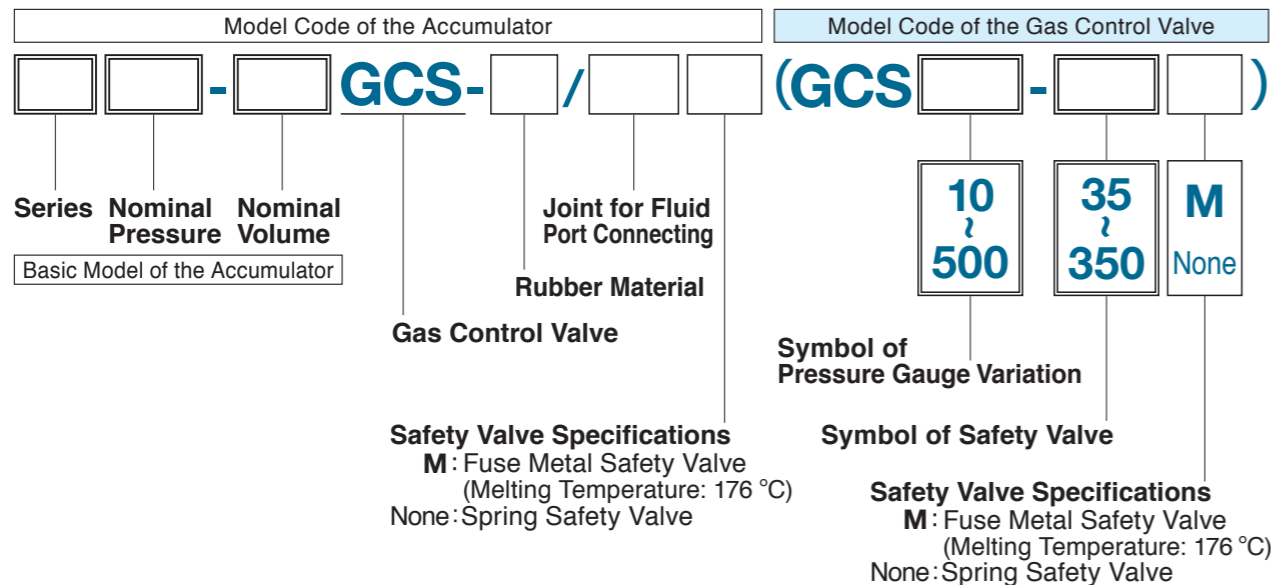**Rubber Material**
Gas Control Valve

Safety Valve Specifications
M：Fuse Metal Safety Valve (Melting Temperature: 176 °C)
None：Spring Safety Valve

Symbol of Pressure Gauge Variation
Symbol of Safety Valve

Safety Valve Specifications
M：Fuse Metal Safety Valve (Melting Temperature: 176 °C)
None：Spring Safety Valve

Ensure the "Maximum working pressure of the accumulator ≤ Maximum working pressure of the safety valve" when selecting a safety valve.

Model Code		Pressure Gauge			Fuse Metal Safety Valve			Spring Safety Valve		
Safety Valve Specifications		Symbol of Pressure Gauge	Scale range of Pressure Gauge	Outside Diameter φ mm	Symbol of Safety Valve	Maximum Working Pressure MPa	Maximum Pressure of Seal MPa	Symbol of Safety Valve	Maximum Working Pressure MPa	Set Safety Valve Pressure MPa
Fuse Metal Safety Valve	Spring Safety Valve									
GCS 10- 35M	GCS 10- 35	10	0~1.0	70	35	3.43	5.15	35	3.43	3.78
GCS 35- 35M	GCS 35- 35	35	0~3.5	70						
GCS 70- 35M	GCS 70- 35	70	0~7.0	70						
GCS 70- 70M	GCS 70- 70				70	6.86	10.3	70	6.86	7.55
GCS160- 70M	GCS160- 70	160	0~16	70						
GCS160-150M	GCS160-150				150	14.7	22.1	150	14.7	16.2
GCS250-150M	GCS250-150	250	0~25	70						
GCS250-175M	GCS250-175				175	17.2	25.7	175	17.2	18.9
GCS250-210M	GCS250-210				210	20.6	30.9	210	20.6	22.7
GCS250-250M	GCS250-250				250	24.5	36.8	250	24.5	27.0
GCS350-250M	GCS350-250	350	0~35	70						
GCS350-300M	—				300	29.4	44.1	—	—	—
GCS500-300M	—	500	0~50	70						
GCS500-350M	—				350	34.3	51.5	—	—	—

● Connector joints are required to attach a valve to an existing accumulator. Consult us and ensure to provide the Model Code of the accumulator concerned.
● Consult us if you need the pressure gauge in any other unit than MPa.
● Please designate Model Code in your order.

■ JIS Symbol Mark
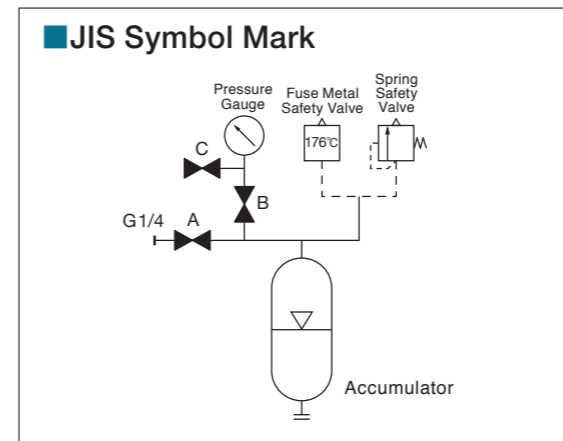
NOK's gas control valve incorporates an independent valve that both protects the pressure gauge and enables any necessary degassing after measuring the pressure.

A: Stop Valve for supplying/discharging gas (Always Closed) (Hose connection screw G1/4)
B: Stop Valve for Pressure Gauge Protection (Always Closed)
C: Valve for releasing residual pressure of pressure gauge (Always Closed)

Notes 1: Supports pressure measurements at ambient temperatures of between -5 and 40 °C.
2: Use of the always open Valve B can lead to degradation of the accuracy of or damage to the pressure gauge.
3: If the valve A is loosened, the gas in the accumulator will leak. When the accumulator is used (other than for maintenance), close this supplying/discharging gas valve securely.

With Fuse Metal Safety Valve
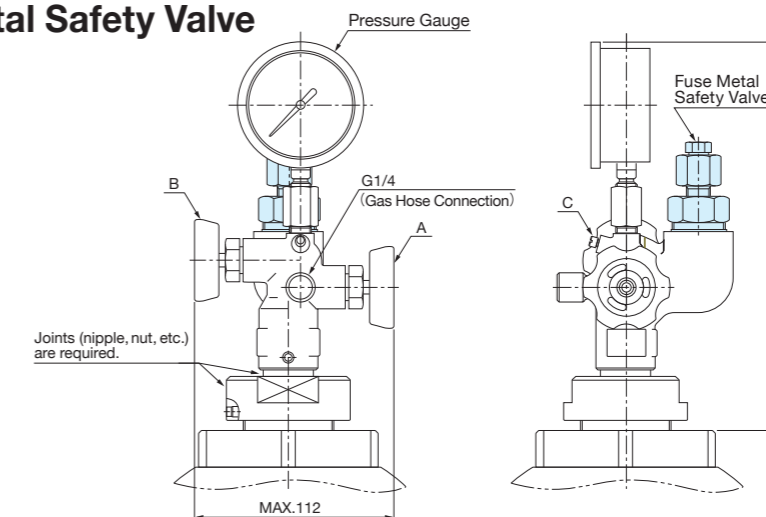
With Spring Safety Valve
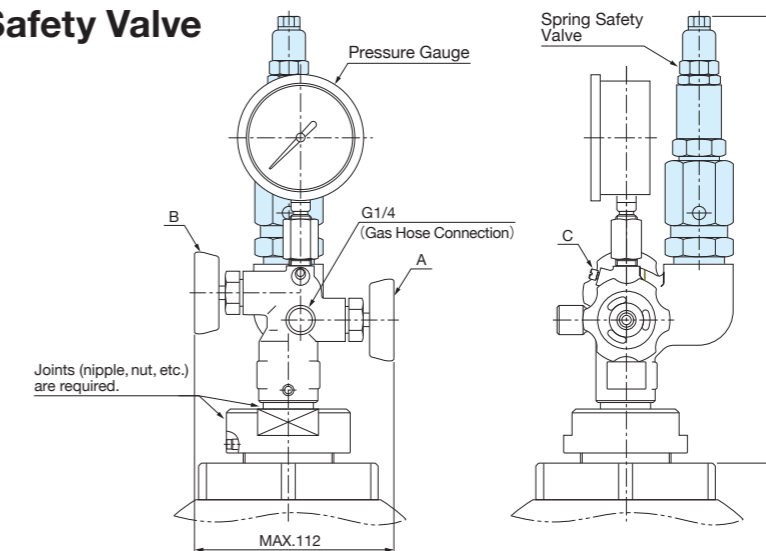
Structure of Fuse Metal Safety Valve
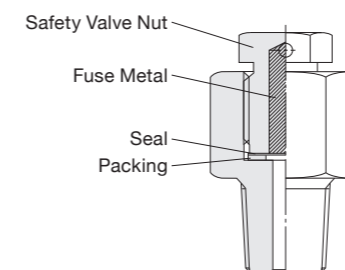
Process Explanation

① External heat of temperature exceeding 176 °C melts Fuse Metal.

② Once the pressure of the gas increases to the seal burst pressure, the pressure of the seal will burst open and release the air.

Accessories and Parts

17. Gas-filling Tool （Charging Assembly）

NOK Charging Assembly is applied to fill nitrogen gas into Accumulator and check gas pressure.
Please purchase Charging Assembly, which is a combination of a Charging Valve and a Hose.
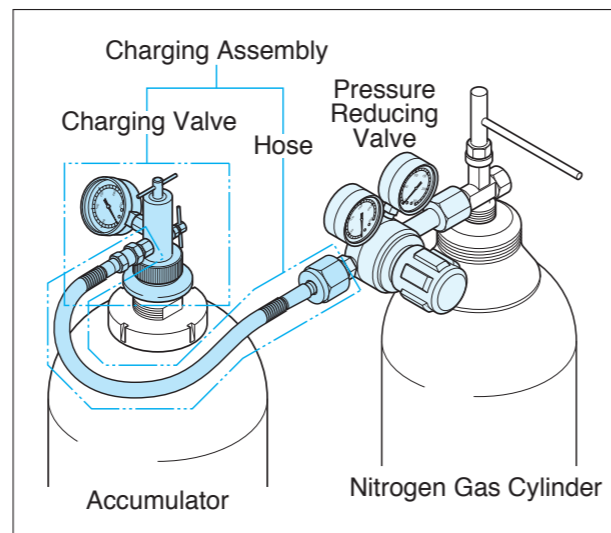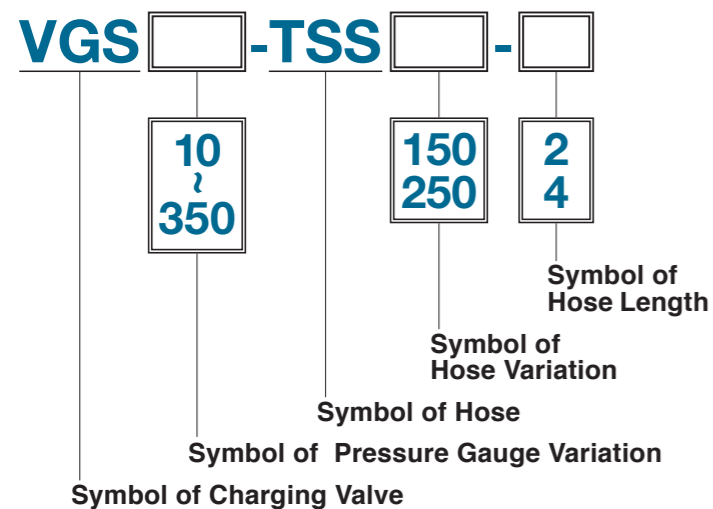
■Model Code Configuration

VGS☐-TSS☐-☐

| 10〜350 | 150 250 | 2 4 |

- Symbol of Hose Length
- Symbol of Hose Variation
- Symbol of Hose
- Symbol of Pressure Gauge Variation
- Symbol of Charging Valve

Charging Assembly
Charging Valve
Hose
Pressure Reducing Valve
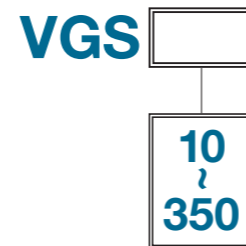Accumulator
Nitrogen Gas Cylinder

At occasion to fill nitrogen gas into accumulator, please apply a pressure reducing valve between nitrogen gas cylinder and hose, so that the filling operation is engaged safely and easily.

Ensure to remove the charging assembly after filling the equipment with nitrogen gas and having carefully inspected it.

Model Code	VGS（Charging Valve）		TSS（Hose）			Product Code
	Symbol of Pressure Gauge	Scale Range of Pressure Gauge MPa	Symbol of Hose	Maximum Working Pressure MPa	Hose Length m	
VGS 10-TSS150-2	10	0〜1.0	150	14.7	2	EB9017 R0
VGS 10-TSS150-4					4	EB9018 R0
VGS 35-TSS150-2	35	0〜3.5			2	EB9033 R0
VGS 35-TSS150-4					4	EB9034 R0
VGS 70-TSS150-2	70	0〜7.0			2	EB9093 R0
VGS 70-TSS150-4					4	EB9094 R0
VGS160-TSS150-2	160	0〜16			2	EB9045 R0
VGS160-TSS150-4					4	EB9046 R0
VGS250-TSS150-2	250	0〜25			2	EB9049 R0
VGS250-TSS150-4					4	EB9050 R0
VGS250-TSS250-2			250	24.5	2	EB9053 R0
VGS250-TSS250-4					4	EB9054 R0
VGS350-TSS250-2	350	0〜35			2	EB9061 R0
VGS350-TSS250-4					4	EB9062 R0

- ●Consult us if you need the pressure gauge in any other unit than MPa.
- ●Please designate Model Code and Product Code in your order.

■Charging Valve

VGS☐

| 10〜350 |

Symbol of Pressure Gauge Variation

A charging valve can be connected to any series accumulator after changing the connection joint. The valve is delivered as shown in Fig. 2.

Applied Accumulator	Connecting Thread	Connecting Joint
AL Series 1〜5ℓ	5/8-18UNF	Remove Joint B and Gasket B, Use Joint A and Gasket A Only (Fig.1)
AT Series		
Minilators		
PA Series		
ET Series (Excluding Type A)	8V1	Combine Joint A and Joint B (Fig. 2)

●No charging valve is required if a gas control valve is already attached.

■Hose

TSS☐-☐/Z

| 150 250 | 2 4 |

Adaptor
Symbol of Hose Length
Symbol of Hose Variation
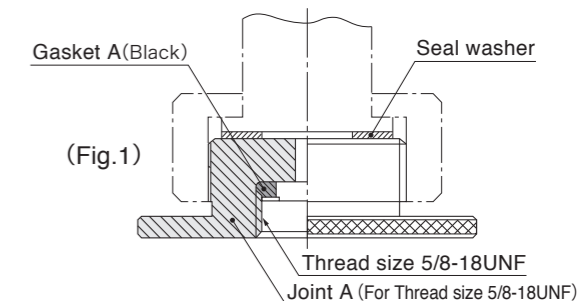
The connection thread for the nitrogen gas cylinder follows JIS specifications.

Joint Size of Nitrogen Gas Cylinder	Connection of Hose and Cylinder
W22 Male thread	Hose can be connected directly
W23 Female thread	Apply adaptor (auxiliary)

- ●Specify the Model Code when purchasing individual VGS and TSS units.
- ●Consult us if the length of TSS(Hose) exceeds 4 m.
- ●Reduction valves are available.
- ●Gaskets, joints, and other parts are also available.

Joint A   Joint B

For Thread size 5/8-18UNF

Gasket A（Black）   Seal washer
（Fig.1）
Thread size 5/8-18UNF
Joint A (For Thread size 5/8-18UNF)

For Thread size 8V1

Gasket B（Red-brown）
Gasket A（Black）   Seal washer
（Fig.2）
Joint A
Joint B（For Thread size 8V1）   Thread size 8V1

Connect to cylinder （W22 Female thread）
Connect to charging valve or gas control valve （G1/4（PF1/4））

Auxiliary

Adaptor

W23-14   W22-14
Gasket （White nylon）
Gas cylinder side   Hose side

■Reduction Valve

PAT101-063
PAT101-064

Standard Model	Adjustable Pressure Range MPa	Primary Pressure Scale MPa	Secondary Pressure Scale MPa	Product Code
PAT101-063	0〜1.6	0〜25	0〜2.5	EB5490 Z4
PAT101-064	0〜11	0〜25	0〜20	EB5491 Z4

●Please designate Model Code and Product Code in your order.

■Gas-Filling Tool Parts (Charging Assembly)

Name	Model Code	Product Code	Details	Figure
Joint Set	PAL101-043	EB4607 Z4	Joint A Joint B Gasket A Gasket B Seal Washers	Gasket B (Red-brown) Gasket A (Black) Seal washer Joint A Joint B (For Thread size 8V1) Thread size 8V1
Joint Gasket	PAL101-069	EB4608 Z4	Gasket A Gasket B Seal Washers	
Hose Gasket	PAL101-045	EB4609 Z4	Hose Cylinder Connection Side Gasket	Gasket
Hose Adapter	PAL101-046	EB4610 Z4	Adaptor	W23-14 W22-14 Gas cylinder side Hose side

●Please designate Model Code and Product Code in your order.

18. Fixing Band

Fixing bands for accumulators are available separately.
Ensure to specify the Model Code and Product Code when purchasing.

Fixing bands for accumulator

Hexagonal Nuts and Plain Washers included

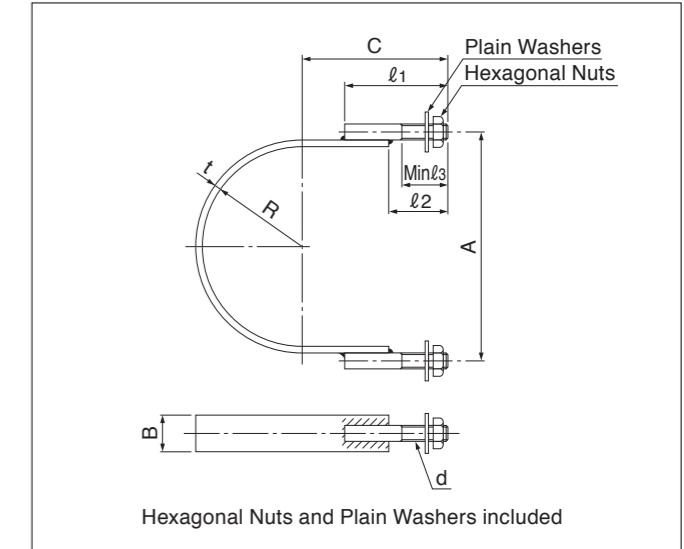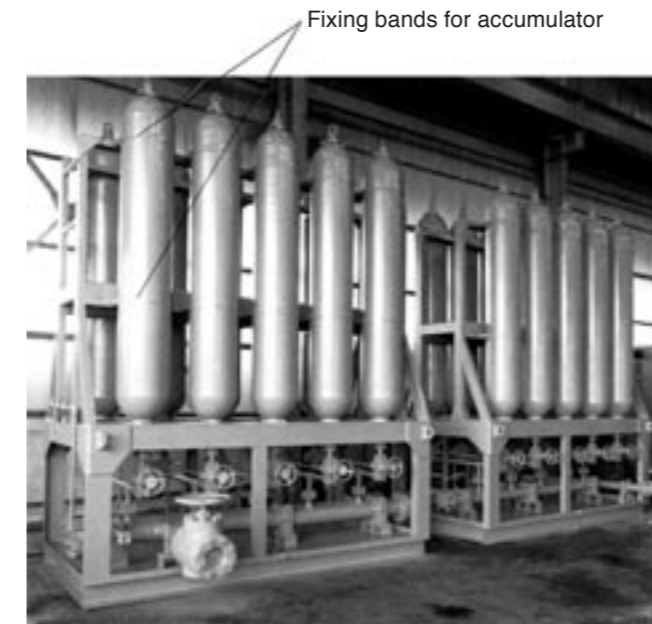| Model Code	Applicable Accumulators	Dimension mm									Mass kg	Product Code
		A	B	C	ℓ_1	ℓ_2	ℓ_3	d	R	t		
PAL101-101	MC70・210-1000, -2000, -3000	135	22	85	60	35	27	M10	58	4.5	0.3	EB6611 Z4
PAL101-102	AL-1, 2.4	141	22	88	60	35	27	M10	61	4.5	0.4	EB6612 Z4
PAL101-103	AL150-4, 5, MC70・210-5000	187	22	115	80	40	31	M10	84	4.5	0.4	EB6613 Z4
PAL101-104	AL300-4, 5	199	22	120	80	40	31	M10	90	4.5	0.45	EB6614 Z4
PAL101-105	AT18M-10, 20, 30, 50 ※AT150-10, 20, 30, 50 ※AT175-10, 20, 30, 50	249	38	150	100	64	36	M12	114	4.5	0.9	EB6615 Z4
PAL101-106	AT25M-10, 20, 30, 50 ※AT250-10, 20, 30, 50	255	38	152	110	60	36	M12	117	4.5	0.95	EB6616 Z4
PAL101-107	AT35M-10, 20, 30 ※AT350-10, 20, 30, 50	271	38	161	115	76	36	M12	125	4.5	1.0	EB6617 Z4
PAL101-108	AT23M-30, 40, 50, 60 ※AT210-30, 40, 50, 60	297	38	175	125	75	40	M12	138	4.5	1.3	EB6618 Z4
PAL101-110	AT23M-80, 120, 150, 160 ※AT210-80, 160 ※AT230-120, 150	390	60	225	160	100	45	M20	179	6.0	3.2	EB6620 Z4

●Ensure to fix any accumulator 30 ℓ or more in place using two bands.
●Please designate Model Code and Product Code in your order.
●The products with an asterisk (※) are listed in the previous catalog.

Consult us for any accumulator stand design and manufacture requirements.

Accessories and Parts

Ensure to use the specialized tools when repairing a bladder type accumulator.

Core Tool

Pull Wire

Pull Rod

Hook Spanner

Hanging Hook

for AT10～60 ℓ

for AT80～160 ℓ
(Two hooks are required per accumulator)
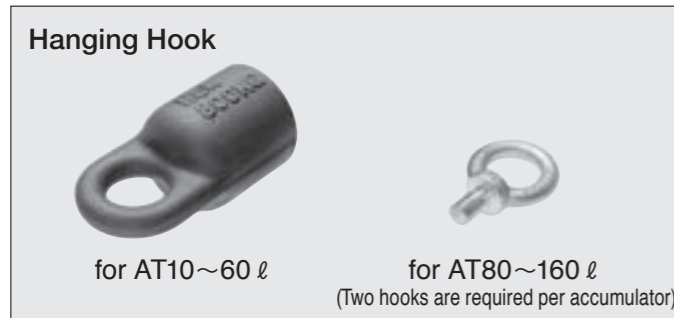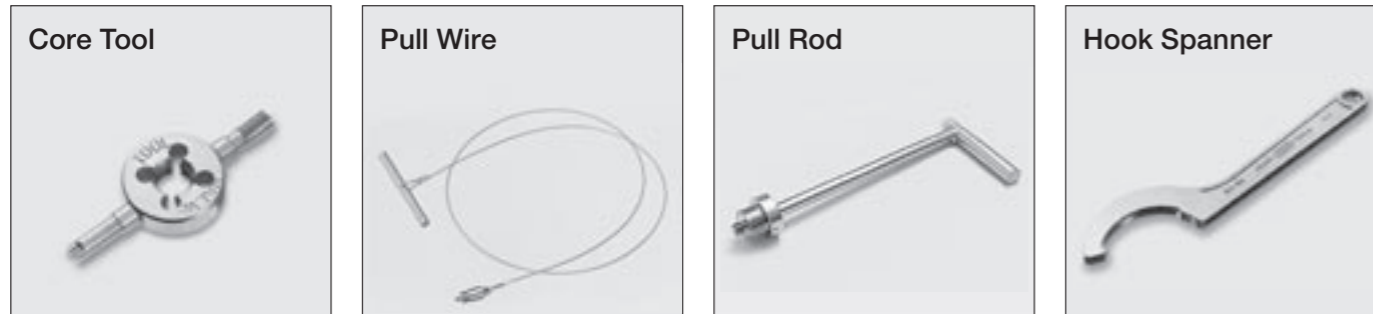
Please consult us separately for the products with the CE Marking as they are different in shape.

Sets of specialized tools are available for assembling and disassembling the AL and AT series.
Please designate Model Code and Product Code in your order. (Tools with ○ are available in sets.)

Model Code	Product Code	Applicable Accumulators		Core Tool	Pull Wire	Pull Rod	Hook Spanner	Hanging Hook
TAL150-1	EB1930 T1	AL series	1, 2.4 ℓ	○	○	—	○	—
TAL150-4	EB1931 T1		4, 5 ℓ	○	○	—	○	—
TAT150-10	EB1937 T1	AT series	10, 20, 30, 40, 50, 60 ℓ	—	—	○	○	○
TAT230-120	EB1938 T1		80, 120, 150, 160 ℓ	—	—	○	—	○

Available separately.

Tool Name	Model Code	Product Code	Applicable Accumulators	Purpose
Core Tool	TAL150-1/A	EB1915 T1	All AL series All Minilaor series	Mounting and removing cores
Pull Wire	TAL150-1/B	EB1933 T1	All AL series	Assembling and removing bladders
Pull Rod	TAT150-10/B	EB1935 T1	All AT series	
Hook Spanner	TAL150-1/C	EB1917 T1	AL series　1, 2.4 ℓ	Fastening and loosening lock rings
	TAL150-4/C	EB1918 T1	AL series　4, 5 ℓ	
	TAT150-10/C	EB1919 T1	AT series　10, 20, 30, 40, 50, 60 ℓ	
Hanging Hook	TAT150-10/D	EB1920 T1	AT series　10, 20, 30, 40, 50, 60 ℓ	Hanging an accumulator (Ensure to use two hooks with AT 80, 120, 150 and 160 accumulators)
	TAT230-120/Z	EB1928 T1	AT series　80, 120, 150, 160 ℓ	

●Please designate Model Code and Product Code in your order.

Bladder replacement kits (with sealing materials) for use in repairing bladder type accumulators are available.

The bladder is an important part of a bladder type accumulator but will eventually need to be replaced. Ensure to replace the bladder as early as possible in thereby preventing any unexpected failures.

Page

1　**AL series**　for 1～5 ℓ ·· 46

2　**AT series**　for 10～60 ℓ and Standard and SH series ························· 48

3　**AT series**　for 10～50 ℓ and HF, MH and UH series ·························· 50

4　**AT series**　for 80～160 ℓ and Standard, MH and UH series ·············· 52

To place an order:

Specify the Model Code and Product Code of the required bladder replacement kit (includes sealing materials)

If you are unsure exactly which replacement kit to select, ensure to first identify the Model Code and Shell No. of the accumulator to be repaired, then consult your nearest sales contact. We can help select the appropriate one.

The Model Code and Shell No. can be found stamped on the shell shoulder on the gas side.

The basic model code is included in the Model Code.
(The Model Code for high flow, middle-high flow, and ultrahigh flow models is followed by HF.)

See the nameplate (below) for products with a specified Product Code.

Model Code (AT○○M-○○)

Shell No. (○○○○)

Accessories and Parts
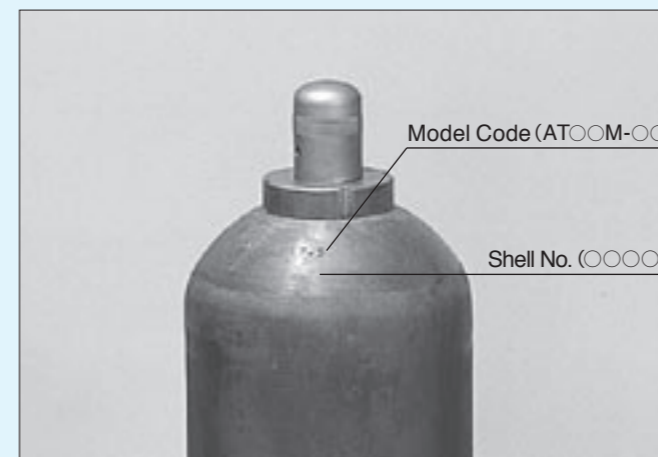
① AL series Bladder Replacement Kit (Includes Sealing Materials)

Ensure to specify the Model Code and Product Code of the kit when purchasing.

⑦Valve Guard
⑤Core
⑥Nut
②Shell
⑬Nameplate
③Bladder Assembly (④, ⑤)
④Bladder
Bladder Replacement Kit (③, ⑩, ⑪, ⑭)
⑧Oil Port Body Assembly
⑨Anti-Extrusion Ring (AER)
⑩O-ring
⑪Backup Ring
⑫Lock Ring
⑭O-ring

■For Gas Valve Types (Standard Type)

Volume Category	Applicable Accumulators	Bladder Replacement Kit (Includes Sealing Materials)	
		Model Code	Product Code
1ℓ	AL150-1-30 AL150-1-30/E	PAL150-1-30	EB1301 B8
	AL300-1-30 AL300-1-30/E		
2.4ℓ	AL150-2.4-30 AL150-2.4-30/E	PAL150-2.4-30	EB1304 B8
	AL300-2.4-30 AL300-2.4-30/E		
4ℓ	AL150-4-30 AL150-4-30/E	PAL150-4-30	EB1307 B8
	AL300-4-30 AL300-4-30/E		
5ℓ	AL150-5-30 AL150-5-30/E	PAL150-5-30	EB1511 B8
	AL300-5-30 AL300-5-30/E		

■For Gas Control Valve Types
(Include O-rings for the gas control valve connection joints and washers for the locking screw)

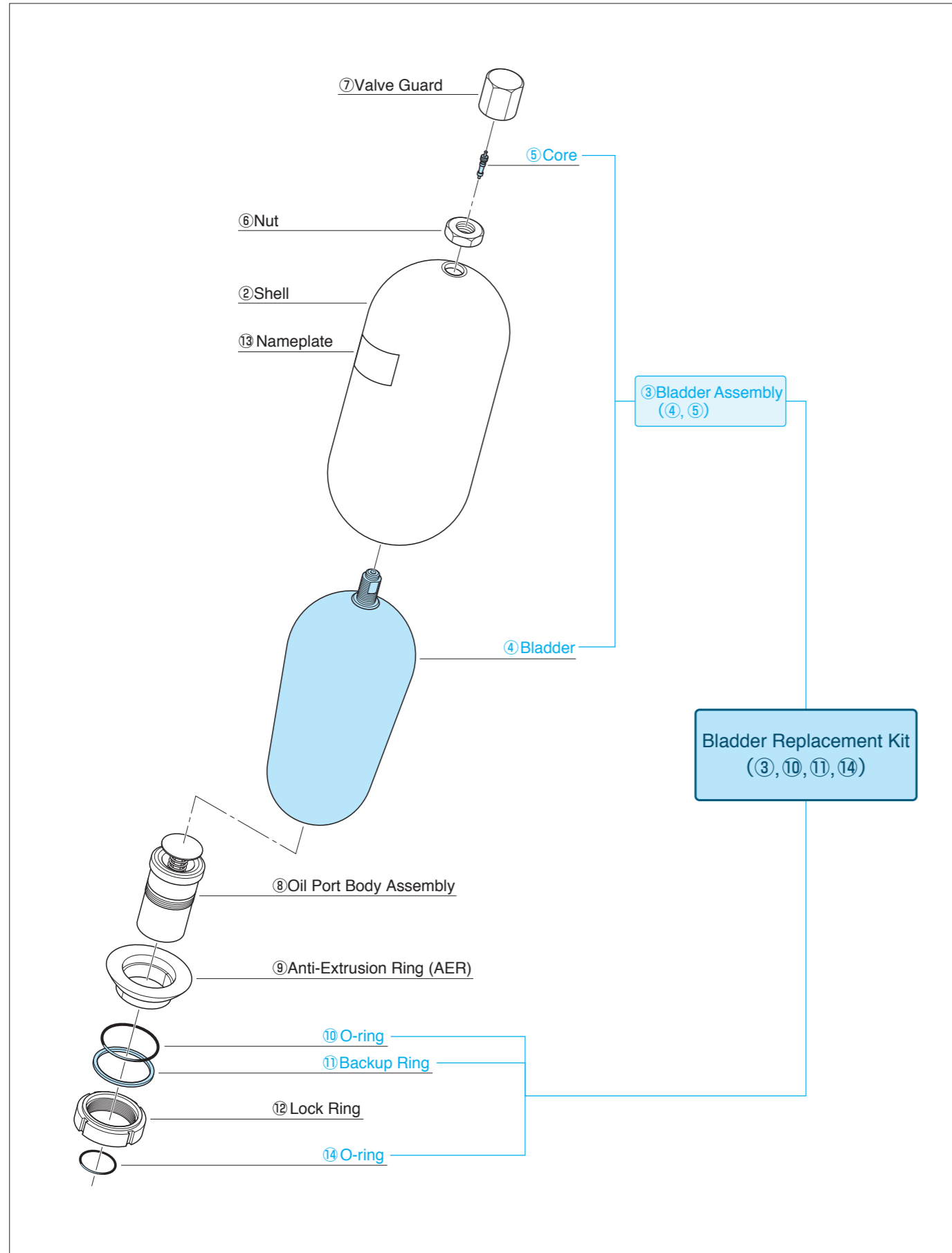| Volume Category	Applicable Accumulators		Bladder Replacement Kit (Includes Sealing Materials)	
			Model Code	Product Code
1ℓ	AL150-1GC-30 AL300-1GC-30	AL150-1GCS-30 AL300-1GCS-30	PAL150-1GC-30	EB1595 B1
2.4ℓ	AL150-2.4GC-30 AL300-2.4GC-30	AL150-2.4GCS-30 AL300-2.4GCS-30	PAL150-2.4GC-30	EB1598 B1
4ℓ	AL150-4GC-30 AL300-4GC-30	AL150-4GCS-30 AL300-4GCS-30	PAL150-4GC-30	EB1601 B1
5ℓ	AL150-5GC-30 AL300-5GC-30	AL150-5GCS-30 AL300-5GCS-30	PAL150-5GC-30	EB1604 B1

Please designate Model Code and Product Code in your order.

Rubber material replacement kit for the standard nitrile rubber (material mark: -30).
Consult your nearest sales contact if you require any other rubber materials than standard.

② AT series　Bladder Replacement Kit (Includes Sealing Materials)

10ℓ～60ℓ (for Standard and SH series)

Ensure to specify the Model Code and Product Code of the kit when purchasing.

⑲Valve Guard
⑪Cap Assembly
⑥Gas Valve Assembly
⑨O-ring
⑦Gas Valve Body Assembly
⑱Gas End Lock Ring
⑰Backup Ring
⑯O-ring
⑮Anti-Extrusion Ring (AER)
⑭Gas Plug
⑤O-ring
③Bladder Assembly (④,⑤,⑥)
④Bladder
②Shell
㉒Nameplate

Gas Control Valve Bladder

Bladder Replacement Kit (③,⑯ x 2,⑰ x 2,㉓)

⑳Oil Port Body Assembly
⑮Anti-Extrusion Ring (AER)
⑯O-ring
⑰Backup Ring
㉑Lock Ring
㉓O-ring

■For Gas Valve Types (Standard Type)

Volume Category	Applicable Accumulators	Bladder Replacement Kit (Includes Sealing Materials)	
		Model Code	Product Code
10ℓ	AT18M-10-30, -SH, /E AT25M-10-30, -SH, /E AT35M-10-30, -SH, /E *AT150-10-30, -SH, /E *AT175-10-30, -SH, /E *AT250-10-30, -SH, /E *AT350-10-30, -SH, /E	**PAT150-10-30**	**EB1313 B1**
20ℓ	AT18M-20-30, -SH, /E AT25M-20-30, -SH, /E AT35M-20-30, -SH, /E *AT150-20-30, -SH, /E *AT175-20-30, -SH, /E *AT250-20-30, -SH, /E *AT350-20-30, -SH, /E	**PAT150-20-30**	**EB1319 B1**
30ℓ	AT18M-30-30, -SH, /E AT25M-30-30, -SH, /E AT35M-30-30, -SH, /E *AT150-30-30, -SH, /E *AT175-30-30, -SH, /E *AT250-30-30, -SH, /E *AT350-30-30, -SH, /E	**PAT150-30-30**	**EB1325 B1**
	AT23M-30-30, -SH, /E *AT210-30-30, -SH, /E	**PAT210-30-30**	**EB1513 B1**
40ℓ	AT23M-40-30, -SH, /E *AT210-40-30, -SH, /E	**PAT210-40-30**	**EB1515 B1**
50ℓ	AT18M-50-30, -SH, /E AT25M-50-30, -SH, /E *AT150-50-30, -SH, /E *AT175-50-30, -SH, /E *AT250-50-30, -SH, /E *AT350-50-30, -SH, /E	**PAT150-50-30**	**EB1331 B1**
	AT23M-50-30, -SH, /E *AT210-50-30, -SH, /E	**PAT210-50-30**	**EB1517 B1**
60ℓ	AT23M-60-30, -SH, /E *AT210-60-30, -SH, /E	**PAT210-60-30**	**EB1337 B1**

The products with an asterisk (*) are listed in the previous catalog.
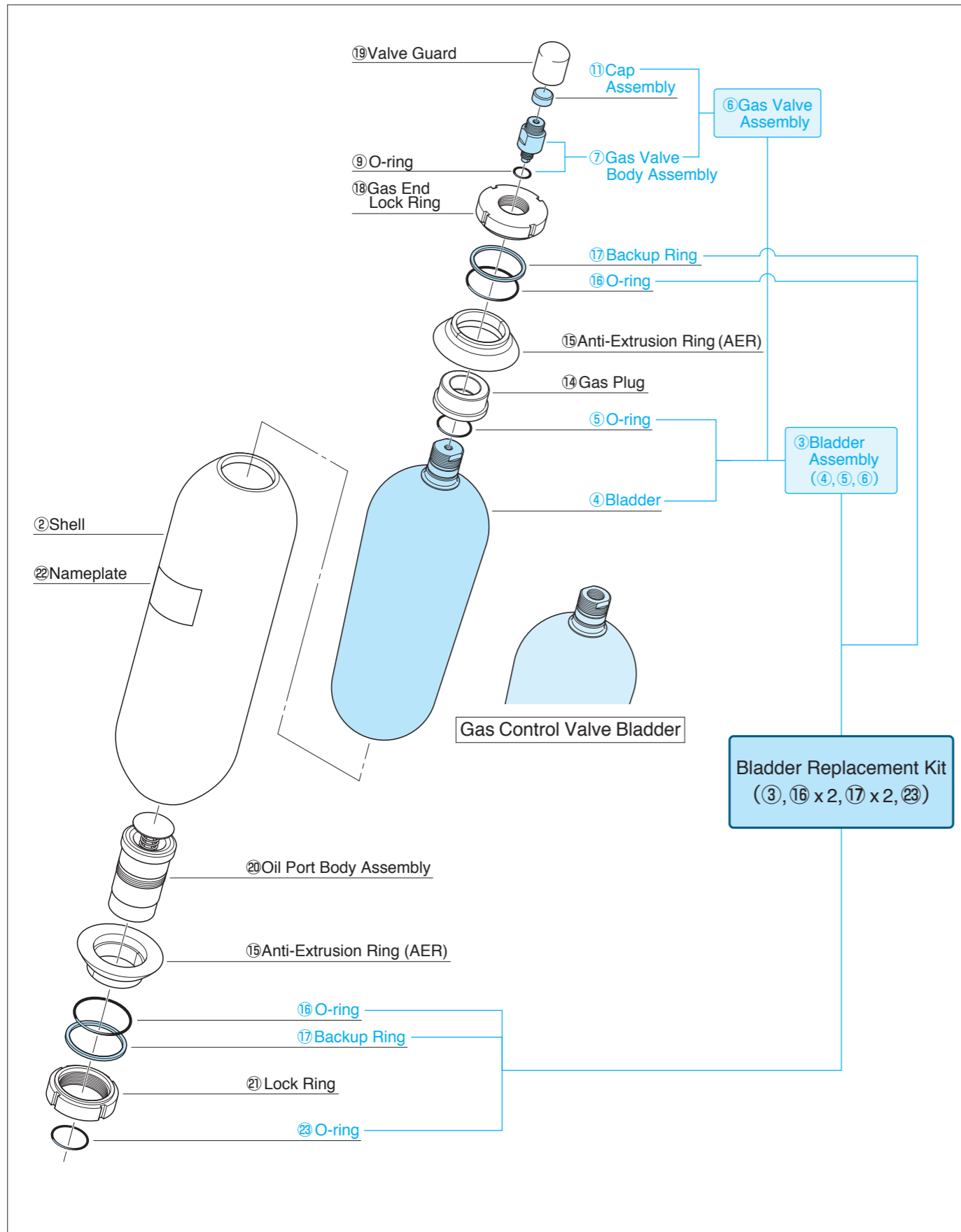
Please designate Model Code and Product Code in your order.

Rubber material replacement kit for the standard nitrile rubber (material mark: -30).
Consult your nearest sales contact if you require any other rubber materials than standard.

If the bladder replacement kit for gas control valve specification is required, consult your nearest sales contact.

Accessories and Parts

10ℓ～50ℓ (for **HF, MH and UH series**)

Ensure to specify the Model Code and Product Code of the kit when purchasing.

Gas Control Valve Bladder

Bladder Replacement Kit
(③,⑯,⑰,㉓,㉔,㉘,㉙)

⑲Valve Guard
⑪Cap Assembly
⑥Gas Valve Assembly
⑨O-ring
⑦Gas Valve Body Assembly
⑱Gas End Lock Ring
⑰Backup Ring
⑯O-ring
⑮Anti-Extrusion Ring (AER)
⑭Gas Plug
⑤O-ring
③Bladder Assembly (④,⑤,⑥)
④Bladder
②Shell
㉗Nameplate
⑳Oil Port Body Assembly
㉑Anti-Extrusion Ring (AER)
㉒Washer
㉓O-ring
㉔Backup Ring
㉕Spacer
㉖Lock Nut
㉘O-ring
㉙Backup Ring

■**For Gas Valve Types (Standard Type)**

Volume Category	Applicable Accumulators	Bladder Replacement Kit (Includes Sealing Materials)	
		Model Code	Product Code
10ℓ	AT25M-10-30-HF, -MH, -UH, /E ※AT250-10-30-HF, -MH, -UH, /E	**PAT250-10-30-HF**	**EB1351 B1**
20ℓ	AT25M-20-30-HF, -MH, -UH, /E ※AT250-20-30-HF, -MH, -UH, /E	**PAT250-20-30-HF**	**EB1354 B1**
30ℓ	AT25M-30-30-HF, -MH, -UH, /E ※AT250-30-30-HF, -MH, -UH, /E	**PAT250-30-30-HF**	**EB1357 B1**
40ℓ	AT23M-40-30-HF, -MH, -UH, /E ※AT210-40-30-HF, -MH, -UH, /E	**PAT210-40-30-HF**	**EB1541 B1**
50ℓ	AT25M-50-30-HF, -MH, -UH, /E ※AT250-50-30-HF, -MH, -UH, /E	**PAT250-50-30-HF**	**EB1360 B1**

The products with an asterisk (※) are listed in the previous catalog.

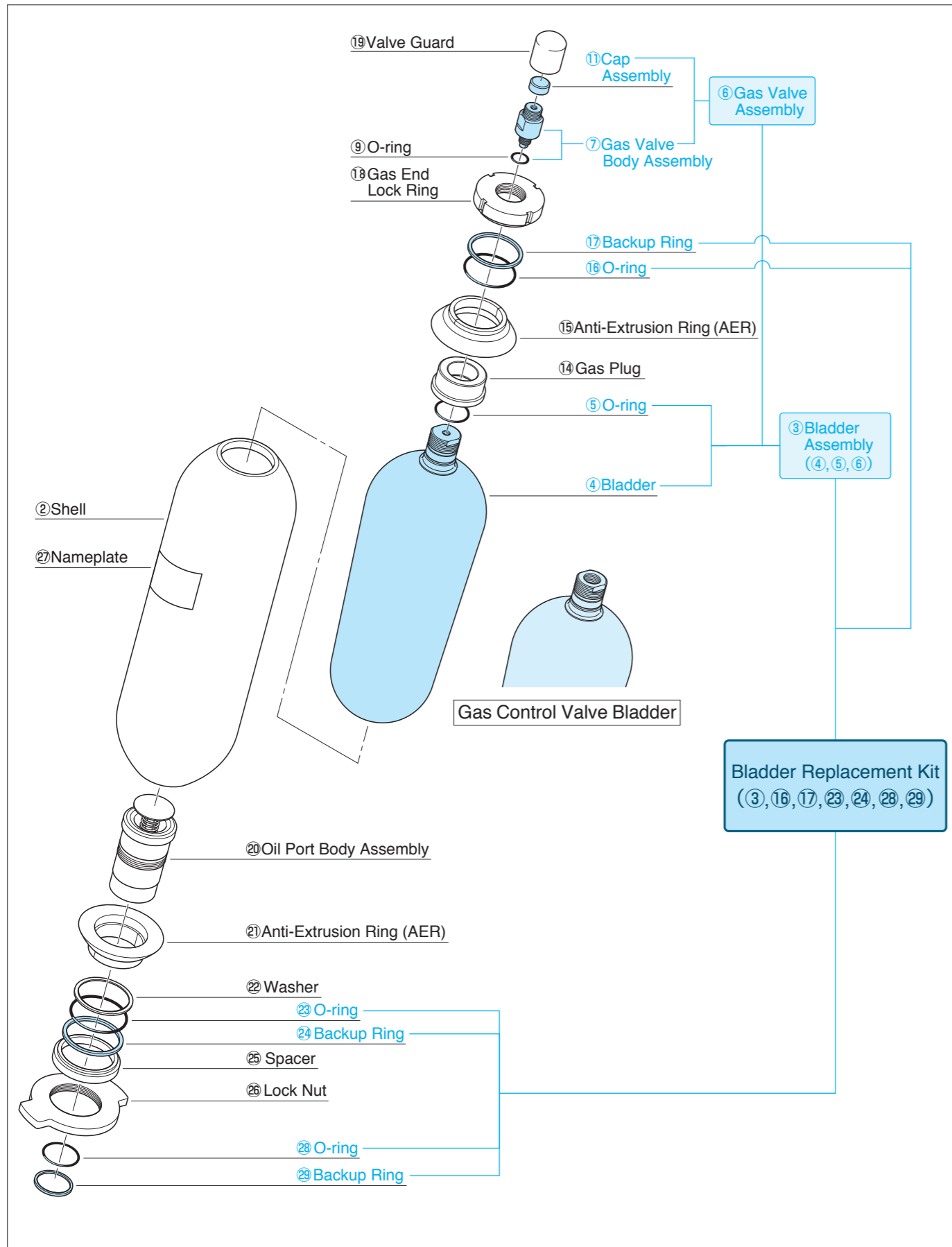Please designate Model Code and Product Code in your order.

Rubber material replacement kit for the standard nitrile rubber (material mark: -30).
Consult your nearest sales contact if you require any other rubber materials than standard.

If the bladder replacement kit for gas control valve specification is required, consult your nearest sales contact.

Accessories and Parts

AT series　Bladder Replacement Kit (Includes Sealing Materials)

80ℓ～160ℓ (for Standard, MH and UH series)

Ensure to specify the Model Code and Product Code of the kit when purchasing.

㉑Valve Guard
⑪Cap Assembly
⑥Gas Valve Assembly
⑨O-ring
⑦Gas Valve Body Assembly
⑳Gas End Lock Nut
⑲Spacer
⑱Backup Ring
⑯Washer
⑰O-ring
⑮Anti-Extrusion Ring (AER)
⑭Gas Plug
⑤O-ring
③Bladder Assembly (④,⑤,⑥)
④Bladder
②Shell
㉔Nameplate
Gas Control Valve Bladder
Bladder Replacement Kit (③,⑰ x 2,⑱ x 2,㉕,㉖)
㉒Oil Port Body Assembly
⑮Anti-Extrusion Ring (AER)
⑯Washer
⑰O-ring
⑱Backup Ring
⑲Spacer
㉓Lock Nut
㉕O-ring
㉖Backup Ring

■**For Gas Valve Types (Standard Type)**

Volume Category	Applicable Accumulators	Bladder Replacement Kit (Includes Sealing Materials)	
		Model Code	Product Code
80ℓ	AT23M-80-30, -MH, -UH, /E *AT210-80-30, -MH, -UH, /E	**PAT210-80-30**	**EB1526　B1**
120ℓ	AT23M-120-30, -MH, -UH, /E *AT230-120-30, -MH, -UH, /E	**PAT230-120-30**	**EB1519　B1**
150ℓ 160ℓ	AT23M-150-30, -MH, -UH, /E AT23M-160-30, -MH, -UH, /E *AT230-150-30, -MH, -UH, /E *AT210-160-30, -MH, -UH, /E	**PAT230-150-30**	**EB1347　B1**

The products with an asterisk (*) are listed in the previous catalog.

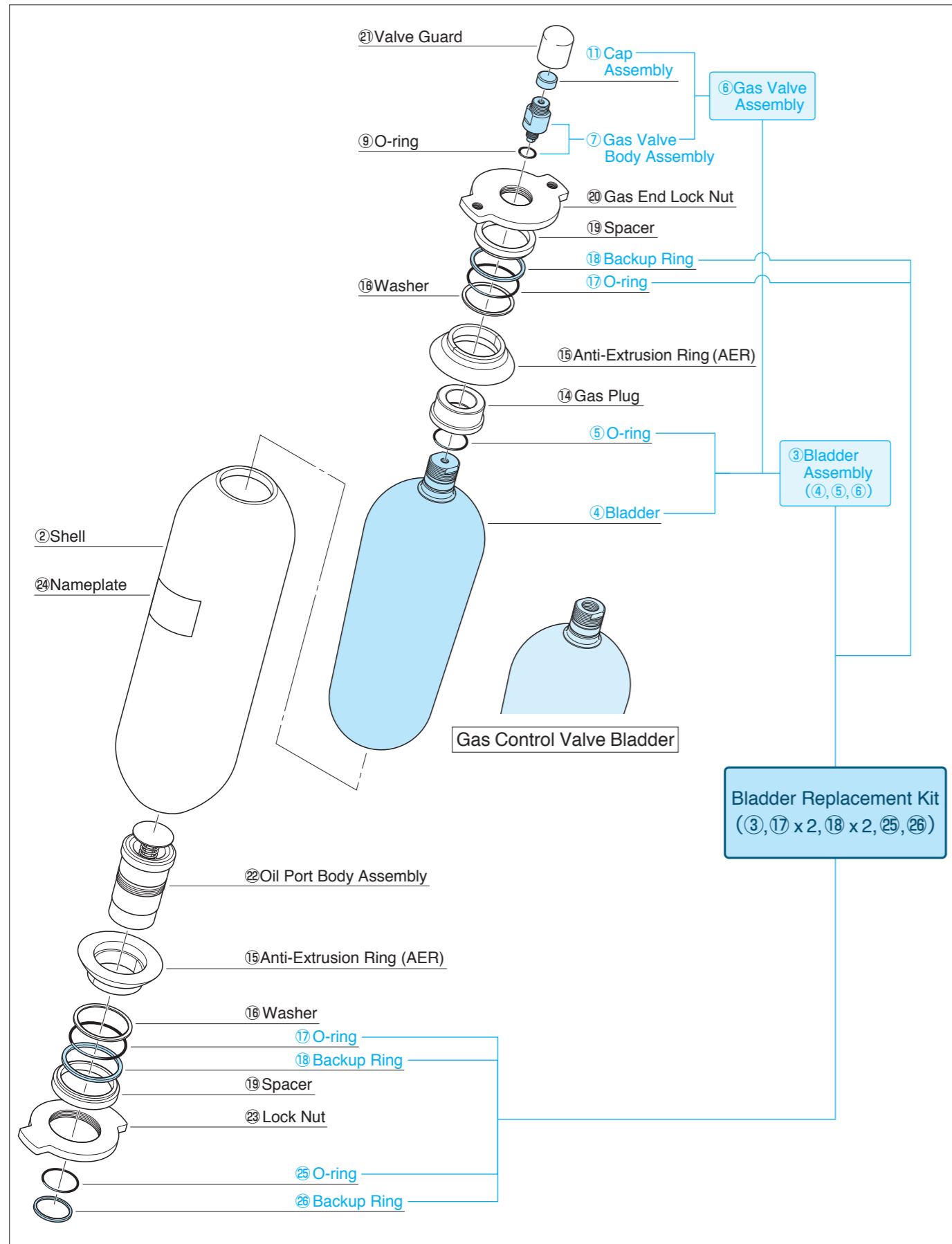Please designate Model Code and Product Code in your order.

Rubber material replacement kit for the standard nitrile rubber (material mark: -30).
Consult your nearest sales contact if you require any other rubber materials than standard.

If the bladder replacement kit for gas control valve specification is required, consult your nearest sales contact.

Accessories and Parts

1. Verify using the nameplate of the accumulator that it is in fact the product you ordered.

2. Never use an accumulator at a pressure exceeding its maximum working pressure.

3. Install the accumulator firmly by the fixing band or other means.

4. Typically the equipment will not have been filled with nitrogen gas when shipped from the factory. Ensure to fill with gas prior to use.
   Ensure not to use an accumulator before being filled with gas or the bladder could be damaged.
   (The MU, MUV and ET series are delivered with nitrogen gas filled at a factory.)

5. Ensure to fill the accumulator with nitrogen gas.

   ● Never use oxygen or any inflammable gas.
   ● Ensure not to use air as it could also shorten the life of the bladder.

6. Ensure to attach a reduction valve to the nitrogen cylinder so that the gas can be filled in a safe and easy manner.

7. Ensure to release the fluid pressure before filling with gas or checking the gas pressure.

   Before releasing the fluid pressure ensure to utilize a bypass pipe (depressurizing pipe) or drain positioned between the main pipe and the accumulator.

8. Carry out the periodic maintenance and inspections of the accumulator (approximately twice a year).
   ① Filled Gas Pressure: Add more gas if insufficient.

   *Nitrogen gas will typically permeate from the bladder causing the gas pressure to drop.
   (See the next page for gas permeation and usage precautions.)

   ② Check for any external nitrogen gas or fluid leaks.
   ③ Check for any damage to the accumulator, loosened screws or other abnormalities.

9. Ensure not to use any other fluid than the factory recommendation or it could result in the bladder being swollen or the lifespan being drastically reduced.

10. Ensure the fluid and gas pressures are at atmospheric pressure before any part disassembly or removal work.

11. Ensure all the nitrogen gas has been removed from the accumulator prior to storage.

12. Before disposing of the accumulator ensure to completely remove any nitrogen gas, and then remove the core, gas valve or gas control valve in thereby ensuring it cannot be reused.

   ● Ensure adequate ventilation of the room when removing any gas from the accumulator.
   (The room could become saturated with nitrogen gas and result in an oxygen deficiency.)
   ● Welding or other processing of accumulators is strictly prohibited.

   Contact your nearest sales contact regarding any necessary on-site gas filling or part replacement services.

Gas Permeation and Usage Precautions

Gases can permeate through rubber and other polymeric membranes. This phenomenon involves the gas dissolving through from either side of the rubber membrane, spreading into the membrane due to the differing concentrations of dissolved gas, and then passing through to the other side of the membrane. Rubber balloons becoming deflated or the drop in air pressure of tires over time are both examples of gas permeation having occurred.

Nitrogen gas in an accumulator will also permeate through the rubber membrane of a diaphragm into the operating oil (fluid).

Gas Molecules
Gas Side
Rubber Membrane
Fluid Side
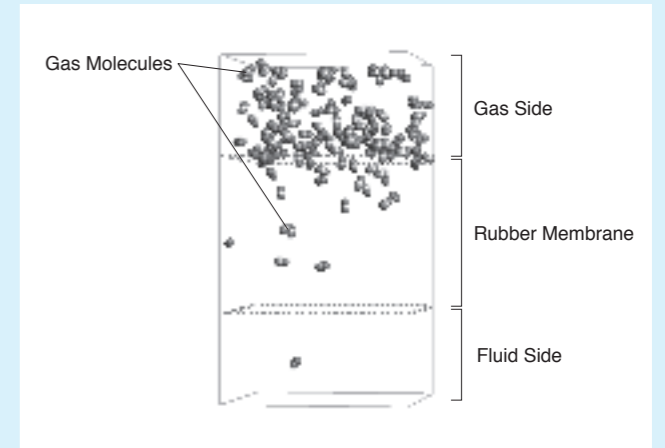
Polymeric Membrane Gas Permeation Model

■ Relationship between Temperature of Accumulator and Decrease in Gas Pressure

Time →
Filled Gas Pressure
30℃
50℃
80℃
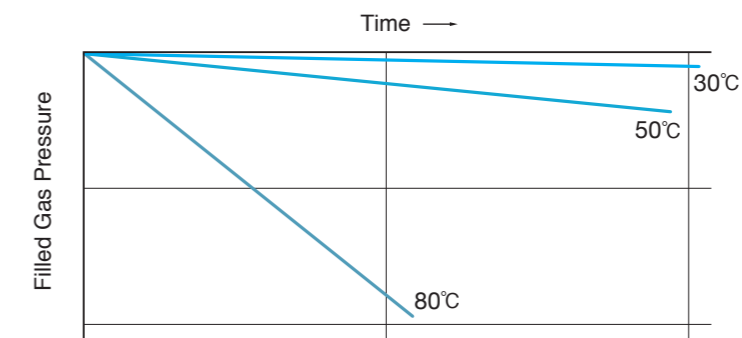
Any increase in temperature can accelerate the gas permeation process. Constant use of an accumulator in a high temperature region, therefore, will require more frequent than usual gas pressure inspections and refills. If Type A (0.5, 1 or 2 ℓ) of the MU or ET series, which is rather small in volume and incapable of being refilled with gas, is always used in a high temperature region then the useful lifespan will be less than usual.

If an accumulator is left filled with gas or the operating pressure has been retained at the filled gas pressure or less, then little gas will penetrate through as the bladder will be tightly adhered to the shell.

Bladder Tightly Adheres to Shell

Please consult your sales contact if you have any inquiries regarding the gas permeation process and inspection frequency.
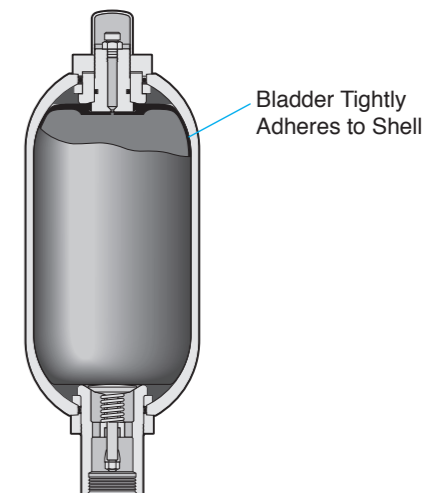
The use of accumulators in Japan is subject to the "High Pressure Gas Safety Law" and "Industrial Safety and Health Law".

The High Pressure Gas Safety Law has precedence over any others with use of accumulators of any volume used at a pressure of 1 MPa or more.

Customers using any accumulator subject to the "High Pressure Gas Safety Law" may be required to apply for permission or submit a notification regarding their use to the prefectural governor. Whether or not an application is required can be determined using the below flowchart, and ensure to contact your nearest sales contact if you do as they can provide you with the necessary documents.

■ Flowchart of Legal Classification and Necessity for Permission or Notifications regarding Use

Conditional (No permission or notification is required)

As per Article 13 of the General Rule
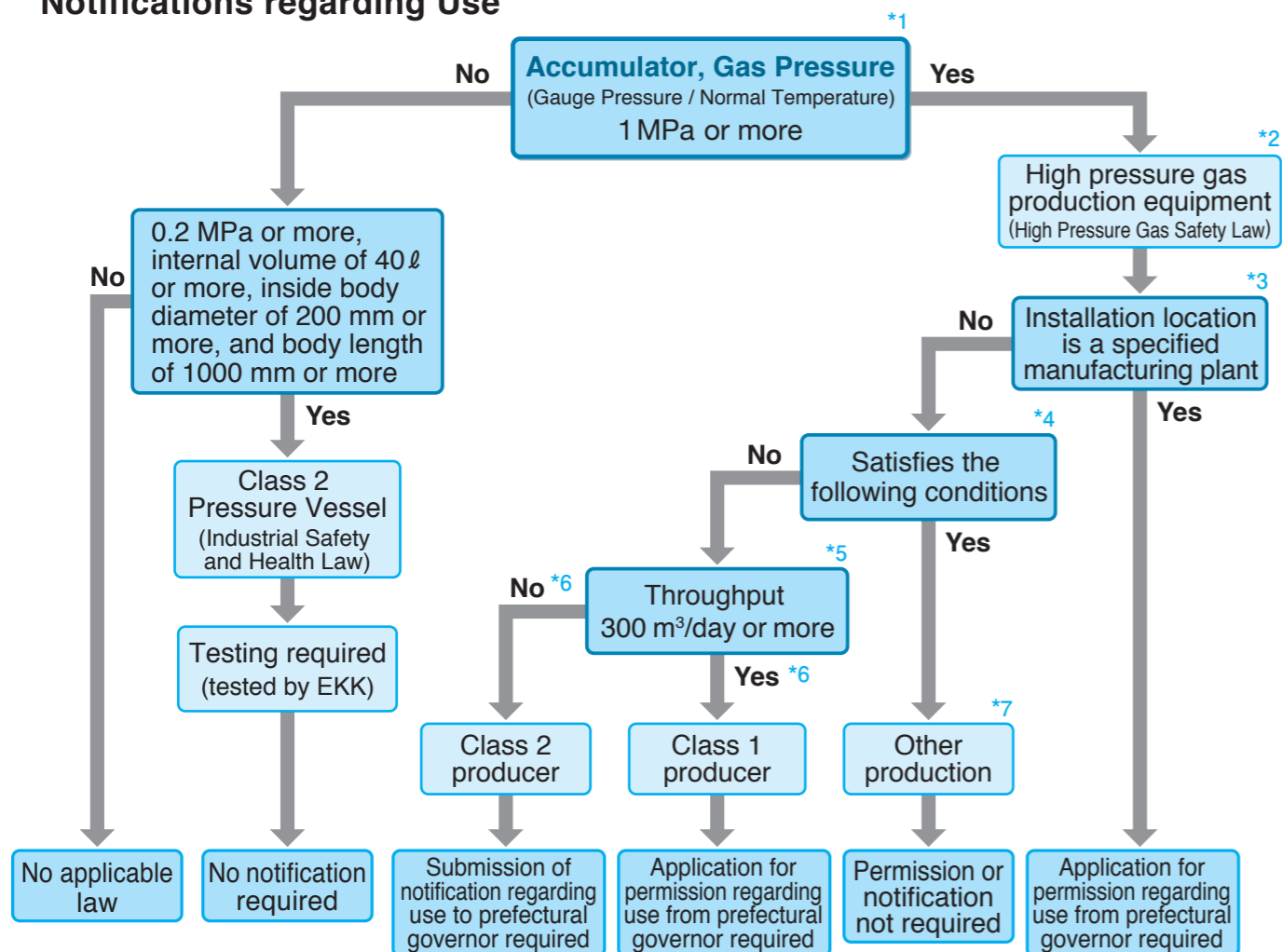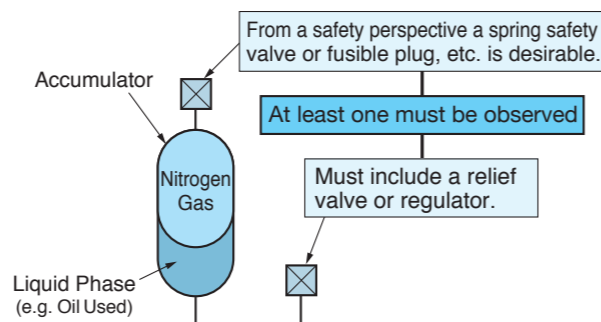Any accumulator that satisfies all the following conditions falls under "Other Production" and therefore does not require any special permission or notifications:
(1) Filled with inert gas or air;
(2) Not connected to any external gas source via pipes; and
(3) Structurally limited pressure is below the design pressure
   (The following a or b must be satisfied:)
   a. The accumulator is equipped with a spring safety valve, fusible plug, pressure release plate, etc.
   b. The pipe connected to the liquid phase of the accumulator is equipped with a relief valve or automatic pressure controller.

Example Accumulator that does not require Permission or Notifications

From a safety perspective a spring safety valve or fusible plug, etc. is desirable.
Accumulator
At least one must be observed
Nitrogen Gas
Must include a relief valve or regulator.
Liquid Phase (e.g. Oil Used)

Follow the latest regulations as they are constantly updated.

Notes (Information with regard to the asterisks)

*1. As per Article 2, Paragraph 1 of the Law.

*2. The "High Pressure Gas Safety Law" deems accumulators, unlike other regular cylinders, to be "high-pressure gas production equipment" that produces highly pressurized gas.
Those customers using the equipment or machine equipped with the accumulator are deemed to be the producers of high-pressure gas.

*3. Specified manufacturing plant
A specifiied manufacturing plant is a manufacturing plant etc. that produces high-pressure gas by using manufacturing equipment whose processing capability in the industrial complex area is 100m^3/day (300m^3/day in case of inactive gas) or more.

*4. Any accumulator not satisfying those conditions requires the permission of or notifications regarding use to the prefectural governor.
Permission or notification applications require documents concerning the accumulator. Please ensure to request any such documents when purchasing an accumulator.

Documents prepared by us: "Tested by a Qualified Tester, etc. Certification", or "Strength Calculation Document", "Material Certificate", "Structural Drawings", etc.

*5. Article 2, Paragraph 18 of General Rule: Throughput

Throughput   Q9 = V9 × 10 P9

Q9: Throughput of Accumulator (m^3/day: Converted to at 0 °C and 0 Pascal)
V9: Internal Volume of Accumulator (m^3)
P9: Maximum Compression Pressure of Accumulator (MPa)

Example Calculation: When an accumulator with a gas volume of 150 ℓ is used at the normal temperature of 50 °C and a maximum working pressure of 21 MPa:

$$\text{Throughput} = (150 \times 10^{-3}) \times (21 \times 10) \times \frac{273}{(273+50)} = 26.6 \ (\text{m}^3/\text{day})$$

*6. "Nitrogen" according to Article 5, Paragraph 1, of the Law and Article 3, Paragraph 1, of the Cabinet Order.

*7. Other Production
Accumulators that do not fall under being concerned with a Class 1 Producer or Class 2 Producer do not require permission from or notifications regarding use to the prefectural governor.
(They fall under being part of "Other Production" if they satisfy all the conditions.)

Personnel filling an accumulator with gas do not require any particular qualifications unless the accumulator is intended to be part of the sales of gas.

23. Accumulator Volume Calculation

The accumulator volume is basically calculated on the basis of $P_1V_1^n = P_2V_2^n = P_3V_3^n$, although the formula used can vary by application. See the following methods of calculation and examples.

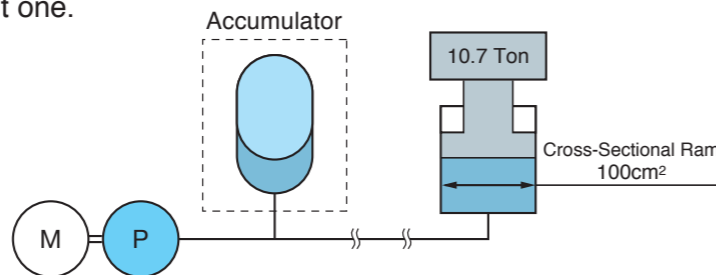[Methods of Calculation used in Individual Applications and Examples]　Page

■Example of Energy Conservation Resulting from Use of an Accumulator

The comparison between the required power with and without an accumulator included in the systems below indicates the use of an accumulator can reduce the necessary power to around a twentieth of that without one.

Accumulator

10.7 Ton

Cross-Sectional Ram 100cm²

M　P

[Operating Conditions]

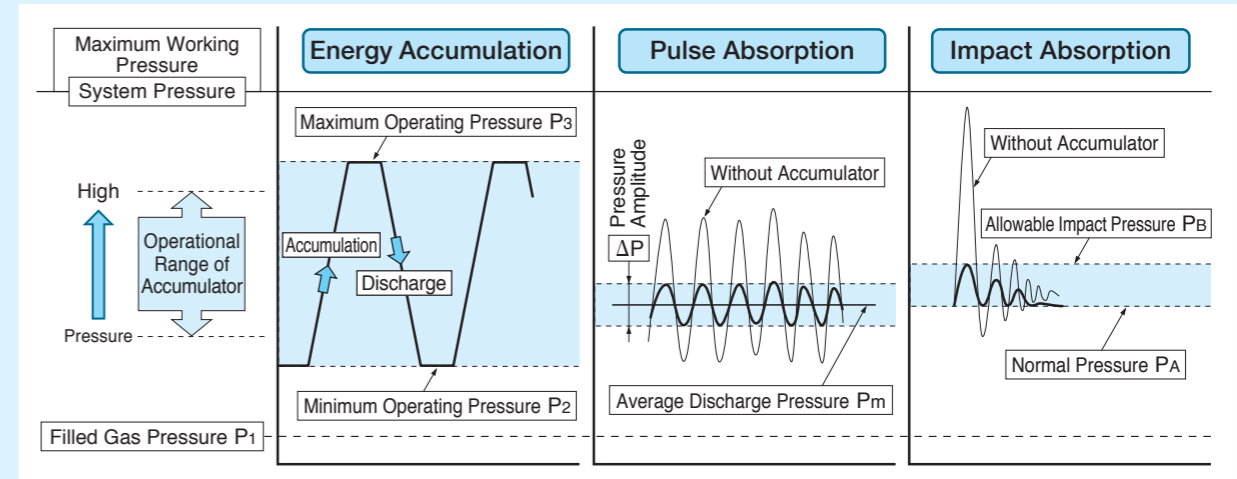|	
Ram Load	: 10.7 Ton
Load Pressure	: 10.5 MPa
Average Ram Speed	: 5 cm/s
Stroke	: 15 cm
Operating Frequency	: 0.5 cycle/m
Pump Pressure	: 21 MPa

Item	Accumulator	
	With	Without
Required Amount of Oil	$100\,cm^2 \times 15\,cm = 1500\,cm^3 = 1.5\,\ell$	
Flow Rate Required per Second	$100\,cm^2 \times 5\,cm/s = 500\,cm^3/s = 0.5\,\ell/s$	
Flow Rate Required to Accumulate Pressure in Accumulator	Necessary Discharge Flow of Accumulator $= $ Required Amount of Oil $= 1.5\,\ell$ Discharge Period $\dfrac{1.5\,\ell}{0.5\,\ell/s} = 3\,s$ Accumulation Period $120\,s - 3\,s = 117\,s$ Accumulating Flow $1.5\,\ell/117\,s = 0.013\,\ell/s$	———
Necessary Discharge Flow of Pump	$0.013\,\ell/s$	$0.5\,\ell/s$
Horsepower of Motor	$0.013\,\ell/s \times 21.0\,MPa = 0.27\,kw$	$0.5\,\ell/s \times 10.5\,MPa = 5.25\,kw$

Terms Related to Accumulator Pressure

Maximum Working Pressure: All accumulators are designed to be used at a specific pressure or lower as a pressure vessel that contains high pressure gas. 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. The primary condition when selecting an accumulator is therefore that its maximum working pressure be equal to or exceed the system pressure. Select the appropriate Model Code according to the List of Model Codes and Dimensions for each series whenever the maximum working pressure is known.

Maximum Working Pressure / System Pressure / High / Operational Range of Accumulator / Pressure / Filled Gas Pressure P₁

Energy Accumulation — Maximum Operating Pressure P₃ / Accumulation / Discharge / Minimum Operating Pressure P₂

Pulse Absorption — Pressure Amplitude / ΔP / Without Accumulator / Average Discharge Pressure Pm

Impact Absorption — Without Accumulator / Allowable Impact Pressure PB / Normal Pressure PA

Maximum Operating Pressure P₃ : The maximum applicable pressure at which gas can be compressed in an accumulator.

Minimum Operating Pressure P₂ : The minimum pressure when fluid is discharged from an accumulator.

Filled Gas Pressure P₁ : Seal pressure of nitrogen gas.

Average Discharge Pressure Pm : The average pressure of fluid discharged from a pump, etc.

Normal Pressure PA : The pressure within a pipe with no impact pressure.

Allowable Impact Pressure PB : Maximum allowable impact pressure. The higher the allowable impact pressure is the smaller in volume the accumulator can be.

Basic Formula Used with and Operating Conditions of Accumulators

$$P_1V_1^n = P_2V_2^n = P_3V_3^n$$

V₃ / P₃ / P₂ / P₁ / V₂ / V₁
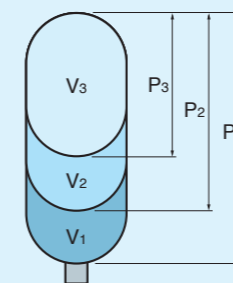
P₁ : Filled Gas Pressure
P₂ : Minimum Operating Pressure
P₃ : Maximum Operating Pressure
V₁ : Gas Volume at P₁
V₂ : Gas Volume at P₂
V₃ : Gas Volume at P₃
 n : Polytropic Index
(Index determined by fluctuation time of gas pressure)

Fill with nitrogen gas

$P_1V_1^n$　　$P_3V_3^n$　　$P_2V_2^n$

Fluid Connection Equipment Pipes / Inflow / Discharge
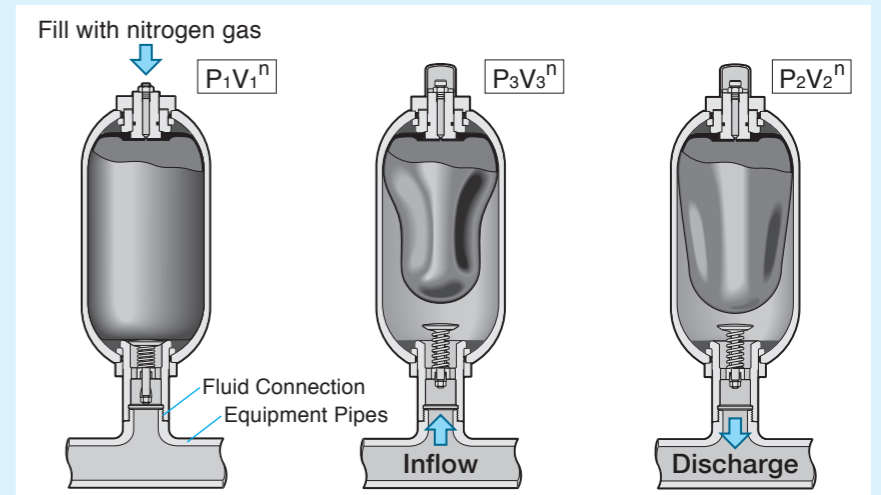
Filled with Nitrogen Gas
The bladder expands and the poppet closes.

Fluid Flowing in
When the fluid pressure reaches the filled gas pressure the poppet then opens and accumulation takes place until the pressure reaches the maximum operating pressure.

Fluid Discharged
Fluid is discharged until the minimum operating pressure is reached.

Handling and Selection

① Energy Accumulation

With intermittent operation (i.e. time available for accumulation to take place in the accumulator) the use of an accumulator can enable downsizing of the volume of the pump and motor, thus contributing to greater energy conservation.

1. Calculate the required gas volume (V_1) that fulfills the aims of the usage conditions.

■ Set Filled Gas Pressure (P_1)

Set the pressure according to either ① or ②.
$P_1 \geqq$ (1/Max. compression ratio) $\times P_3$ must still be satisfied.
(See pages 10 and 11 for the maximum compression ratios of the individual series)

① If no change in temperature: $P_1 = (0.8 \sim 0.9) \times P_2$

② Change in temperature takes place: $P_1 = \dfrac{273 + \text{Minimum temperature (Tmin)}}{273 + \text{Maximum temperature (Tmax)}} \times (0.8 \sim 0.9) \times P_2$

■ Set Polytropic Indices (m, n)

Indices m and n can be calculated using the formula below or more simply Table 1.
If the inflow time exceeds 40s then assume m = 1.

$$m \text{ or } n = \left(\frac{0.63}{\Delta t^{0.5}} + 1.01\right)\left(1.94 \times 10^{-2} \times Pm + 1.12\right)$$

$\left(\begin{array}{l}\Delta t : \text{Fluctuation Time with Inflow or Discharge (s)} \\ \text{If } \Delta t \text{ is less than 10s then use the values in Table-1 for m and n}\end{array}\right)$

■ Calculate Necessary Gas Volume (V_1)

$$V_1 = \Delta V \times \frac{P_2^{\frac{1}{n}} \cdot P_3^{\frac{1}{m}}}{P_1^{\frac{1}{m}}\left(P_3^{\frac{1}{n}} - P_2^{\frac{1}{n}}\right)}$$

Convert the value to the absolute pressure in the calculation if the accumulator only has to support a pressure of 1 MPa or less.
[Absolute Pressure = Gauge Pressure + 0.1013 (MPa)]

Description of Symbols Used

V_1 : Necessary Gas Volume $\quad \ell$
ΔV : Necessary Discharge Flow $\quad \ell$
P_1 : Filled Gas Pressure $\quad$ MPa
P_2 : Minimum Operating Pressure $\quad$ MPa
P_3 : Maximum Operating Pressure $\quad$ MPa
P_m : Average Operating Pressure $\quad$ MPa

$$P_m = \frac{(P_2 + P_3)}{2}$$

m : Polytropic Index when Fluid Flows in
n : Polytropic Index when Fluid Is Discharged

2. Select the Model Code of the accumulator

Select an accumulator from any series that satisfies all of Necessary Gas Volume (V_1) ≦ Gas Volume of Accumulator, System Pressure (P_{max}) ≦ Maximum Working Pressure, and Necessary Discharge Flow (Q_{max}) ≦ Maximum Discharge Flow.

〈Table-1〉 List of Polytropic Indices (m and n values)

Pm (MPa)		Δt (s) m / n	Less Than 10	10 or More Less Than 20	20 to 40	40 to 60	60 to 80	80 to 100	100 to 200	200 to 400	400 to 700	700 or more
						If the Inflow Time Exceeds 40s Then m = 1 can be Consistently Used.						
	2.0 less than		1.47	1.34	1.28	1.25	1.24	1.23	1.21	1.19	1.18	1.17
2.0 or more	2.9		1.51	1.37	1.31	1.28	1.27	1.26	1.24	1.22	1.21	1.20
2.9	3.9		1.53	1.39	1.33	1.31	1.29	1.28	1.26	1.24	1.23	1.22
3.9	4.9		1.56	1.41	1.36	1.33	1.31	1.30	1.28	1.26	1.25	1.24
4.9	5.9		1.58	1.44	1.38	1.35	1.33	1.32	1.30	1.28	1.27	1.26
5.9	6.9		1.61	1.46	1.40	1.37	1.35	1.34	1.32	1.30	1.29	1.28
6.9	7.8		1.63	1.48	1.42	1.39	1.37	1.36	1.34	1.32	1.31	1.30
7.8	8.8		1.66	1.50	1.44	1.41	1.39	1.38	1.36	1.34	1.33	1.32
8.8	9.8		1.68	1.53	1.46	1.43	1.41	1.40	1.38	1.36	1.35	1.34
9.8	10.8		1.70	1.55	1.48	1.45	1.43	1.42	1.40	1.38	1.37	1.36
10.8	11.8		1.73	1.57	1.51	1.47	1.45	1.44	1.42	1.40	1.39	1.38
11.8	12.7		1.75	1.59	1.53	1.49	1.47	1.46	1.44	1.42	1.41	1.40
12.7	13.7		1.78	1.61	1.55	1.51	1.49	1.48	1.46	1.44	1.43	1.42
13.7	14.7		1.80	1.64	1.57	1.53	1.51	1.50	1.48	1.46	1.45	1.44
14.7	15.7		1.83	1.66	1.59	1.55	1.54	1.52	1.50	1.48	1.47	1.46
15.7	16.7		1.85	1.68	1.61	1.58	1.56	1.54	1.52	1.50	1.49	1.48
16.7	17.7		1.88	1.70	1.63	1.60	1.58	1.56	1.54	1.52	1.51	1.50
17.7	18.6		1.90	1.73	1.66	1.62	1.60	1.58	1.56	1.54	1.53	1.52
18.6	19.6		1.93	1.75	1.68	1.64	1.62	1.60	1.58	1.56	1.55	1.54
19.6	21.6		1.96	1.78	1.71	1.67	1.65	1.64	1.61	1.59	1.58	1.57
21.6	23.5		2.01	1.83	1.75	1.71	1.69	1.68	1.65	1.63	1.62	1.61
23.5	25.5		2.06	1.87	1.79	1.75	1.73	1.72	1.69	1.67	1.66	1.64
25.5	27.5		2.11	1.91	1.84	1.79	1.77	1.76	1.73	1.71	1.70	1.68
27.5	29.4		2.16	1.96	1.88	1.84	1.81	1.80	1.77	1.75	1.75	1.72

■ Example Calculation

Select an accumulator with the necessary discharge flow [ΔV] set to be 4L for the hydraulic lines and using the maximum operating pressure [P_3: 21.0 MPa] and minimum operating pressure [P_2: 12.0 MPa]. The accumulation period [Δtm] (duration required for the oil to flow into the accumulator and reach the maximum operating pressure) will be 41s and the discharge period [Δtn] (duration required for the oil to be discharged from the accumulator and reach the minimum operating pressure) 10s. The operating temperature should be between -10 and 60 °C.

Page **69** The **Volume Calculation Sheet** on ①**Accumulator for Energy Accumulation** can be used with:

Fill in the columns within the thick frame. Consult your nearest sales contact regarding any additional inquiries.

Volume Calculation Sheet
①Accumulator for Energy Accumulation

(To be completed by NOK)
Data ．　．
Name and Section

Equipment and Machinery, Installation Position

Set Conditions of Use

Applicable Fluid		*Common Mineral Hydraulic Oil*				
Temperature Conditions	Fluid Temperature		~	℃	Normal Temperature	℃
	Ambient Temperature	−10	~	60　℃	Normal Temperature	℃
System Pressure	Pmax	22.0	MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.		
Maximum Operating Pressure	P3	21.0	MPa	Maximum pressure of accumulated fluid in the accumulator		
Minimum Operating Pressure	P2	12.0	MPa	Minimum pressure when fluid is discharged from the accumulator		
Average Operating Pressure	Pm	16.5	MPa	Pm=(P3+P2)/2		
Necessary Discharge Flow	ΔV	4	ℓ	Total amount of fluid required for piston (actuator) operation		
Accumulation Period	Δtm	41	s	Time required to accumulate ΔV in the accumulator		
Discharge Period	Δtn	10	s	Time required to discharge ΔV from the accumulator		

Calculate Necessary Gas Volume V₁

Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■Set Filled Gas Pressure (P_1)　Set the pressure according to either ① or ②. $P_1 \geqq$ (1/Max. compression ratio) × P_3 must still be satisfied.
(See pages 10 and 11 for the maximum compression ratios of the individual series)

①If no change in temperature takes place: $P_1 = (0.8\sim0.9) \times P_2$　　　$= 0.85 \times$ $\quad$ = $\quad$ MPa

②If the temperature changes: $P_1 = \dfrac{273+Tmin}{273+Tmax} \times (0.8\sim0.9) \times P_2$ $= \dfrac{273 + (-10)}{273 + 60} \times 0.85 \times 12.0 = 8.06$ MPa

■Set Polytropic Indices

Set the indices from the [List of Polytropic Indices] on page 60.

When Accumulated (m) ⋯ Pm **16.5**, Δtm **41** ; **1**
When Discharged (n) ⋯ Pm **16.5**, Δtn **10** ; **1.68**

■Calculate Necessary Gas Volume for Accumulator (V_1)

$$V_1 = \Delta V \times \frac{P_2^{\frac{1}{n}} \cdot P_3^{\frac{1}{m}}}{P_1^{\frac{1}{m}}\left(P_3^{\frac{1}{n}} - P_2^{\frac{1}{n}}\right)} = 4 \times \frac{12.0^{\frac{1}{1.68}} \times 21.0^{\frac{1}{1}}}{8.06^{\frac{1}{1}} \times \left(21.0^{\frac{1}{1.68}} - 12.0^{\frac{1}{1.68}}\right)} = 26.4 \ \ell$$

Verify Necessary Discharge Flow Qmax

$Q_{max} = \Delta V \times 60 / \Delta tn = $ **4** $\times 60 \div$ **10** $=$ **24** ℓ/min

Select a NOK Accumulator Model

Select a model that satisfies "V₁ ≦ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select an accumulator with which the necessary discharge flow Qmax will not exceed the maximum discharge flow. Select the AT series if the bladder for the 10 ℓ or larger accumulator is replaced from the gas side.

・Select the series　*AT series*　according to the relevant Pmax, V₁, Qmax. [Model Code of Selected Accumulator] [Gas Volume]

・Set the rubber material to *Standard NBR (Nitrile Rubber)* according to the fluid used and temperature.

・Set the wetted specification to *Standard Specifications* according to the fluid used.

AT25M-30-30/□□ ; **34** ℓ

・Set the joint for fluid port connecting and specifications required by the gas side.

No. of Necessary Accumulators (V₁; **26.4** ℓ/Accumulator Gas Volume; **34** ℓ/unit) [Rounded to the nearest whole number] = **1** units

Verify the Discharge Flow ΔVu of the Selected Accumulator

$$\Delta V_u = \text{Gas Volume} \times \frac{P_1^{\frac{1}{m}}\left(P_3^{\frac{1}{n}} - P_2^{\frac{1}{n}}\right)}{P_2^{\frac{1}{n}} \cdot P_3^{\frac{1}{m}}} = 34 \times \frac{8.06^{\frac{1}{1}} \times \left(21.0^{\frac{1}{1.68}} - 12.0^{\frac{1}{1.68}}\right)}{12.0^{\frac{1}{1.68}} \times 21.0^{\frac{1}{1}}} = 5.16 \ \ell$$

$(\Delta V_u \geqq \Delta V)$

Handling and Selection

② Pulse Absorption

The use of an accumulator can attenuate pulses generated by a pump and reduce noise and vibration, while also improving stability.

1. Calculate the required gas volume (V_1) that fulfills the aims of the usage conditions.

■ Set Constant (K_1) using the Type of Pump
  → Set the constant using the table on the right.

K_1 for Each Individual Type of Pump

Type of Pump		K_1	
	Number	Single-action	Double-action
Plunger Diaphragm	1	0.60	0.25
	2	0.25	0.15
	3	0.13	0.06
	4	0.10	0.06
	5	0.06	0.02
	6	0.06	
	7 or more	0.02	
Gear and Vane		0.06	

■ Set Filled Gas Pressure (P_1)

Set the pressure according to either ① or ②.

① If no change in temperature: $P_1 = (0.6 \sim 0.8) \times P_m$

② Change in temperature takes place:

$$P_1 = \frac{273 + \text{Minimum temperature }(T_{min})}{273 + \text{Maximum temperature }(T_{max})} \times (0.6 \sim 0.8) \times P_m$$

■ Set Polytropic Indices (n)

Calculate the value using $n = 1.41$

■ Calculate the Discharge (q) per Pump Rotation

$$q = \frac{\text{Pump Discharge }(\ell/\text{min})}{\text{No. of Pump Rotations (rpm)}}$$

■ Set the Maximum Target Line Pressure (P_3)

$$P_3 = P_m + \frac{\Delta P}{2}$$

$$P_3 = \left(1 + \frac{\text{Target Ripple Factor}}{100}\right) \times P_m$$

ΔP : Pressure Amplitude with Accumulator

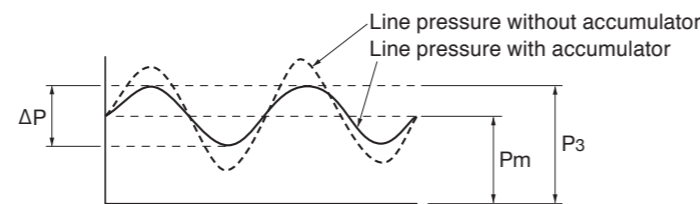$$\text{Ripple Factor} = \frac{P_3 - P_m}{P_m} \times 100 \; (\%)$$

■ Calculate Necessary Gas Volume (V_1)

$$V_1 = \frac{q \cdot K_1 \cdot \left(\frac{P_m}{P_1}\right)^{\frac{1}{n}}}{1 - \left(\frac{P_m}{P_3}\right)^{\frac{1}{n}}}$$

Convert the value to the absolute pressure in the calculation if the accumulator only has to support a pressure of 1 MPa or less.
[Absolute Pressure = Gauge Pressure + 0.1013 (MPa)]

Line pressure without accumulator
Line pressure with accumulator

Description of Symbols Used

V_1 : Necessary Gas Volume ℓ
P_1 : Filled Gas Pressure MPa
P_m : Average Discharge Pressure MPa
P_3 : Maximum Target Line Pressure MPa
q : Discharge per Pump Rotation $\ell/\text{Rotation}$
K_1 : Constant that Varies by Type of Pump
n : Polytropic Index 1.41 (Nitrogen gas)

2. Select the Model Code of the accumulator

Select an accumulator from any series that satisfies all of Necessary Gas Volume (V_1) ≦ Gas Volume of Accumulator, System Pressure (P_{max}) ≦ Maximum Working Pressure, and Necessary Discharge Flow (Q_{max}) ≦ Maximum Discharge Flow.

Absorbing the pulses from high frequency cycles and pipelines can be taken into account if the operating pressure conditions, the pulses and frequency at which they are generated, and the fluid pipe conditions are provided in thereby allowing the result of the accumulator to be increased. Contact your nearest sales contact for more details.

■**Example Calculation**

Select an accumulator that attenuates the pulses generated by the following pumps:
  Type of Pump: Triple Single-Action Plunger Pump   Average Discharge Pressure P_m: 17.0 MPa
  Pump Discharge: 750 ℓ/min   Target Ripple Factor: ± 3%
  No. of Pump Rotations: 1000 rpm

Page **70** The **Volume Calculation Sheet** on ②**Accumulator Used to Absorb Pulses** can be used with:

Fill in the columns within the thick frame. Consult your nearest sales contact regarding any additional inquiries.

Volume Calculation Sheet

②**Accumulator Used to Absorb Pulses**

Data . .
Name and Section
(To be completed by NOK)

| Equipment and Machinery, Installation Position | |

Set Conditions of Use

Applicable Fluid		Common Mineral Hydraulic Oil		
Temperature Conditions	Fluid Temperature	~ ℃	Normal Temperature	℃
	Ambient Temperature	~ ℃	Normal Temperature	Room Temperature ℃

System Pressure	P_{max}	**20.0** MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.
Average Discharge Pressure	P_m	**17.0** MPa	The average pressure of fluid discharged from a pump, etc.

Target Ripple Factor **± 3** %

Type of Pump:
- ☑ Plunger Number **3** ☑ Single-action
- ☐ Diaphragm   ☐ Double-action
- ☐ Gear No.of Teeth pcs.
- ☐ Vane No.of Blades pcs.
- ☐ Other

Pump Specifications	Discharge	**750** ℓ/min
	Rotations	**1000** rpm

[Constant K_1 for Each Individual Type of Pump]

Type of Pump		K_1	
	Number	Single-action	Double-action
Plunger Diaphragm	1	0.60	0.25
	2	0.25	0.15
	3	0.13	0.06
	4	0.10	0.06
	5	0.06	0.02
	6	0.06	
	7 or more	0.02	
Gear and Vane		0.06	

Calculate Necessary Gas Volume V_1 Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■ Set Constant (K_1) that will Vary with the Type of Pump Set the constant from the list of [Constant K_1 for Each Individual Type of Pump] from above. **0.13**

■ Set Filled Gas Pressure (P_1) Set the pressure according to either ① or ②. $P_1 \geqq$ (1/Max. compression ratio) × P_3 must still be satisfied. (See pages 10 and 11 for the maximum compression ratios of the individual series)

① If no change in temperature takes place: $P_1 = (0.6 \sim 0.8) \times P_m$ = 0.7 × **17.0** = **11.9** MPa

② If the temperature changes: $P_1 = \frac{273 + T_{min}}{273 + T_{max}} \times (0.6 \sim 0.8) \times P_m = \frac{273 + }{273 + } \times 0.7 \times \quad = \quad$ MPa

■ Calculate Discharge (q) per Pump Rotation q = Discharge/Rotations = **750** ÷ **1000** = **0.75** ℓ/Rotation

■ Set Polytropic Indices (n) Calculate the value using n = 1.41 (nitrogen gas)

■ Calculate Maximum Target Line Pressure (P_3) $P_3 = (1 + \text{Ripple Factor}/100) \times P_m = (1 + $ **3** $/100) \times$ **17.0** = **17.51** MPa

■ Calculate Necessary Gas Volume (V_1) for Accumulator

$$V_1 = \frac{q \cdot K_1 \cdot \left(\frac{P_m}{P_1}\right)^{\frac{1}{n}}}{1 - \left(\frac{P_m}{P_3}\right)^{\frac{1}{n}}} = \frac{\mathbf{0.75} \times \mathbf{0.13} \times \left(\frac{\mathbf{17.0}}{\mathbf{11.9}}\right)^{\frac{1}{1.41}}}{1 - \left(\frac{\mathbf{17.0}}{\mathbf{17.51}}\right)^{\frac{1}{1.41}}} = \mathbf{6.05} \; \ell$$

Select a NOK Accumulator Model Select a model that satisfies "V_1 ≦ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select the AT series if the bladder for the 10 ℓ or larger accumulator is replaced from the gas side.

- ・Select the series **AT series** according to the relevant P_{max}, V_1.
- ・Set the rubber material to **Standard NBR (Nitrile Rubber)** according to the fluid used and temperature.
- ・Set the wetted specification to **Standard Specifications** according to the fluid used.
- ・Set the joint for fluid port connecting and specifications required by the gas side.

[Model Code of Selected Accumulator] [Gas Volume]

AT25M-10-30/□□   **10** ℓ

No. of Necessary Accumulators (V_1; **6.05** ℓ/Accumulator Gas Volume; **10** ℓ/unit) [Rounded to the nearest whole number] = **1** units
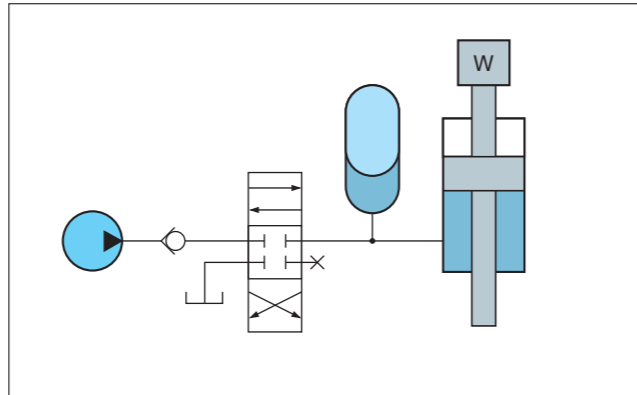
③ Impact Absorption

The use of an accumulator can enable valves to be rapidly closed or to mitigate the impact pressure resulting from a sudden change in load, thus preventing the equipment from being damaged.

Examples of Impact Absorption

a. Shock buffering when a solenoid valve is switched
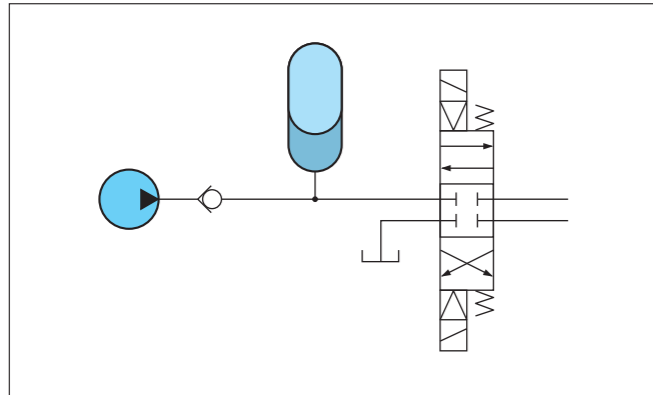
b. Shock buffering when a ram suddenly stops

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1. Calculate the required gas volume (V₁) that fulfills the aims of the usage conditions.

■ Set Filled Gas Pressure (P₁)

Set the pressure according to either ① or ②.
Ensure $P_1 \geqq$ (1/Max. compression ratio) $\times P_3$ must still be satisfied.
(See pages 10 and 11 for the maximum compression ratios of the individual series)

① If no change in temperature: $P_1 = (0.8 \sim 0.9) \times P_A$

② Change in temperature takes place: $P_1 = \dfrac{273 + \text{Minimum temperature (Tmin)}}{273 + \text{Maximum temperature (Tmax)}} \times (0.8 \sim 0.9) \times P_A$

■ Set Allowable Impact Pressure P_B

The value is generally set to be 110% of the normal pressure P_A. $P_B = 1.1 \times P_A$

■ Set Polytropic Indices (n)

Calculate the value using n = 1.41

■ Calculate Necessary Gas Volume (V₁)

$$V_1 = V \times \dfrac{P_A}{P_1}$$

Gas Volume at Normal Pressure P_A (V)

$$V = \dfrac{W \cdot v^2 \cdot (n-1)}{2000 \cdot P_A \cdot \left(\left(\dfrac{P_B}{P_A} \right)^{\frac{n-1}{n}} - 1 \right)}$$

This formula is used to calculate the volume required to make the impact absorption of the accumulator completely efficient. In reality, however, the effect could be the same with a smaller volume due to pipe resistance and other factors.

Convert the value to the absolute pressure in the calculation if the accumulator only has to support a pressure of 1 MPa or less.
[Absolute Pressure = Gauge Pressure + 0.1013 (MPa)]

Description of Symbols Used

V₁	: Necessary Gas Volume	ℓ
V	: Gas Volume at P_A	ℓ
P₁	: Filled Gas Pressure	MPa
P_A	: Normal Pressure	MPa
P_B	: Allowable Impact Pressure	MPa
n	: Polytropic Index 1.41 (Nitrogen gas)	
ρ	: Fluid Density	kg/m³
d	: Pipe Diameter (Inside Diameter)	mm
L	: Pipe Length	m
Q	: Fluid Flow Rate	ℓ/min
ν	: Fluid Velocity	m/s
W	: Fluid Mass	kg

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2. Select the Model Code of the accumulator

Select an accumulator from the appropriate series that satisfies Necessary Gas Volume (V₁) ≦ Gas Volume and the Maximum Working Pressure being equal to or exceeding the System Pressure.

■ Example Calculation

Select an accumulator that can be used to buffer shocks generated when the direction of the flow is changed using a solenoid valve on a hydraulic line.

Pipe Diameter d : 3/4 B Schedule 160 (Inside Diameter: 16.2 mm)
Pipe Length L : 15 m   Normal Pressure P_A : 11.0 MPa
Flow Rate Q : 250 ℓ/min   Fluid Density ρ : 900 kg/m³

Page **71** The **Volume Calculation Sheet** on ③**Accumulator Used to Absorb Impact** can be used with:

Fill in the columns within the thick frame. Consult your nearest sales contact regarding any additional inquiries.

Volume Calculation Sheet

③Accumulator Used to Absorb Impact

(To be completed by NOK)
Data   ·   ·
Name and Section

Equipment and Machinery, Installation Position	

Set Conditions of Use

Applicable Fluid			*Common Mineral Hydraulic Oil*	
Temperature Conditions	Fluid Temperature	~	℃	Normal Temperature ℃
	Ambient Temperature	~	℃	Normal Temperature *Room Temperature* ℃

System Pressure	Pmax	**14.0**	MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.
Normal Pressure	P_A	**11.0**	MPa	The pressure within a pipe with no impact pressure.
Allowable Impact Pressure	P_B	**12.1**	MPa	Maximum supported impact pressure. The higher the value the smaller in volume the accumulator can be. The value is generally set to be 110% of the normal pressure. ($P_3 = 11.0 \times 1.1 = 12.1$ MPa)
Fluid Density	ρ	**900**	kg/m³	Be careful with the units used. The unit used for water is in [1000].
Inside Pipe Diameter	d	**16.2**	mm	
Pipe Length	L	**15**	m	
Flow Rate	Q	**250**	ℓ/min	
Flow Velocity	v	—	m/s	Not required if the "pipe diameter" and "flow rate" are provided.

Calculate Necessary Gas Volume V₁ Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■Calculate Fluid Mass (W) within the Line

$$W = \frac{\pi}{4} \cdot d^2 \cdot L \cdot \rho \cdot 10^{-6} = \boxed{\frac{\pi}{4} \times \mathbf{16.2}^2 \times \mathbf{15} \times \mathbf{900} \times 10^{-6} = \mathbf{2.78}} \text{ kg}$$

■Calculate Flow Velocity (v)

$$v = 21.23 \times Q / d^2 = \boxed{21.23 \times \mathbf{250} \div \mathbf{16.2}^2 = \mathbf{20.22}} \text{ m/s}$$

■Set Filled Gas Pressure (P₁) Set the pressure according to either ① or ②. $P_1 \geqq$ (1/Max. compression ratio) $\times P_3$ must still be satisfied. (See pages 10 and 11 for the maximum compression ratios of the individual series)

①If no change in temperature takes place: $P_1 = (0.8 \sim 0.9) \times P_A$ $\boxed{= 0.9 \times \mathbf{11.0} = \mathbf{9.9}}$ MPa

②If the temperature changes: $P_1 = \dfrac{273 + Tmin}{273 + Tmax} \times (0.8 \sim 0.9) \times P_A = \boxed{\dfrac{273 +}{273 +} \times 0.9 \times \quad = \quad}$ MPa

■Set Polytropic Indices (n) Calculate the value using n = 1.41 (nitrogen gas)

■Calculate Maximum Supported Impact Pressure (P_B) $P_B = 1.1 \times P_A = \boxed{1.1 \times \mathbf{11.0} = \mathbf{12.1}}$ MPa

■Calculate Accumulator Gas Volume (V_A) when Pressure is P_A

$$V_A = \frac{W \cdot v^2 \cdot (n-1)}{2000 \cdot P_A \times \left(\left(\frac{P_B}{P_A} \right)^{\frac{n-1}{n}} - 1 \right)} = \boxed{\frac{\mathbf{2.78} \times \mathbf{20.22}^2 \times (1.41 - 1)}{2000 \times \mathbf{11.0} \times \left(\left(\frac{\mathbf{12.1}}{\mathbf{11.0}} \right)^{\frac{1.41-1}{1.41}} - 1 \right)} = \mathbf{0.75}} \text{ ℓ}$$

■Calculate Necessary Gas Volume (V₁) for Accumulator

$$V_1 = V_A \times \frac{P_A}{P_1} = \boxed{\mathbf{0.75} \times \frac{\mathbf{11.0}}{\mathbf{9.9}} = \mathbf{0.84}} \text{ ℓ}$$

Select a NOK Accumulator Model Select a model that satisfies "V₁ ≦ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select the MC series or AL series for 1L accumulator.

· Select the series **MC series** according to the relevant Pmax, V₁. [Model Code of Selected Accumulator] [Gas Volume]

· Set the rubber material to *Standard NBR (Nitrile Rubber)* according to the fluid used and temperature. **MC210-1000-30/□□** **0.98 ℓ**

· Set the wetted specification to *Standard Specifications* according to the fluid used.

· Set the joint for fluid port connecting and specifications required by the gas side.

No. of Necessary Accumulators (V₁; **8.38** ℓ/Accumulator Gas Volume; **10** ℓ/unit) [Rounded to the nearest whole number] = **1** units

④ Thermal Expansion Compensation

Both the fluid and the pipes will expand in volume when a closed circuit consisting of pipes full of fluid heats up.

The thermal expansion coefficient for almost all fluids is typically a lot larger than that of most materials pipes are made of, and with the thermally-expanded portion of the fluid being greater than that of the pipe material, thus raising the pressure within the system (i.e. pipes). A rise in pressure within the system may exceed the design limits and thus damage the equipment used in the system. Any such system therefore requires a compensator to allow for the thermal expansion, with an accumulator being very effective.

1. Calculate the required gas volume (V_1) that fulfills the aims of the usage conditions.

■ Set Filled Gas Pressure (P_1)

Ensure $P_1 \geqq$ (1/Max. compression ratio) $\times P_3$ must still be satisfied.

(See pages 10 and 11 for the maximum compression ratios of the individual series)

$$P_1 = \frac{273 + \text{Minimum temperature (Tmin)}}{273 + \text{Maximum temperature (Tmax)}} \times (0.8 \sim 0.9) \times P_2$$

■ Set Allowable Pressure (P_3)

(Pressure at System Temperature Increase of t_2)

■ Calculate Necessary Gas Volume (V_1)

$$V_1 = \frac{Va\,(t_2 - t_1)\,(\beta - 3\alpha)\,(P_2/P_1)}{1 - (P_2/P_3)}$$

Convert the value to the absolute pressure in the calculation if the accumulator only has to support a pressure of 1 MPa or less.
[Absolute Pressure = Gauge Pressure + 0.1013 (MPa)]

Description of Symbols Used

V_1 : Necessary Gas Volume		ℓ
Va : Total Amount of Fluid in Pipes (at t_1)		ℓ
P_1 : Filled Gas Pressure		MPa
P_2 : System Pressure at Temperature t_1		MPa
P_3 : System Pressure at Temperature t_2		MPa
t_1 : Initial System Temperature		°C
t_2 : Increased System Temperature		°C
α : Coefficient of Linear Expansion of Piping		1/°C
β : Coefficient of Volume Expansion of Fluid		1/°C

2. Select the Model Code of the accumulator

Select an accumulator from the appropriate series that satisfies Necessary Gas Volume (V_1) $\leqq$ Gas Volume and the Maximum Working Pressure being equal to or exceeding the System Pressure.

■ **Example Calculation**

Select an accumulator that can be used to raise the pressure of a closed-circuit steel pipe 16 meters long with a diameter of ϕ125 (Schedule 40) from 0.07 MPa at 20 °C to 0.4 MPa at 55 °C.

$P_1 = P_2 \times 0.85 = (0.07 + 0.1013) \times 0.85 = 0.1456$ MPa abs   abs: Absolute Pressure

$P_2 = 0.07 + 0.1013 = 0.1713$ MPa abs

$P_3 = 0.4 + 0.1013 = 0.5013$ MPa abs

$t_1 = 20$ °C

$t_2 = 55$ °C

$\alpha = 10 \times 10^{-6}$ 1/°C (Steel)

$\beta = 7.5 \times 10^{-4}$ 1/°C (Common Mineral Hydraulic Oil)

Bore Area of ϕ125 (Schedule 40) Steel Pipe
Outside Diameter of Steel Pipe: 139.8 mm
Thickness: 6.6 mm
Area $= \pi/4 \times (13.98 - 0.66 \times 2)^2 = 125.88$ cm²

$Va = 125.88 \times 1600 = 201408$ cm³ $= 201.41\ \ell$

$$V_1 = \frac{201.41 \times (55 - 20) \times (7.5 \times 10^{-4} - 3 \times 10 \times 10^{-6}) \times (0.1713/0.1456)}{1 - (0.1713/0.5013)} = 9.06\ \ell$$

The accumulator **AT18M-10-30** (gas volume: 10 ℓ) would be the most appropriate.

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The appropriate documents **[Accumulator Selection Request]** and **[Volume Calculation Sheet]** can be found on following pages.

Please photocopy any pages you require.

Accumulator Selection Request

☑Check the applicable boxes. Please consult your nearest sales contact regarding anything you do not understand.

Company and Section	
Contact Person	Tel. Fax. E-mail
Equipment and Machinery, Installation Position	
Purpose of Accumulator		Specifications	☐ Without ☐ With *

(To be completed by NOK)

Date Received

Branch, Agent, and Person in Charge

*Write the Specification No. in the last column if anything specific is required.

1. Usage Conditions

Installation Site	☐ Indoors ☐ Outdoors	Operating Time Required of Equipment		Hours/Days
Temperature Conditions	Fluid Temperature	~ ℃	Normal Temperature	℃
	Ambient Temperature	~ ℃	Normal Temperature	℃
Applicable Fluid	☐ Common Mineral Hydraulic Oil ☐ Phosphoric Ester Operating Oil ☐ Industrial Water ☐ Other Types			

Direction of Accumulator Installation	☐ Vertical ☐ Horizontal ☐ Other

Consult your nearest sales contact for any cases where the accumulator will not be installed vertically with the gas side upward. If the accumulator is not installed vertically the possibility of "the necessary discharge not occurring" or "a shortened lifespan of the bladder" exist.

System Pressure	MPa

Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve used with the equipment or machinery.

2. Application and Operating Conditions

☐ ① Energy Accumulation Only fill in the applicable columns.

Maximum Operating Pressure	MPa	Maximum pressure of accumulated fluid in the accumulator
Minimum Operating Pressure	MPa	Minimum pressure when fluid is discharged from the accumulator
Necessary Discharge Flow ΔV	ℓ	
Accumulation Period	s	Time required to accumulate ΔV in the accumulator
Discharge Period	s	Time required to discharge ΔV from the accumulator

☐ ② Pulse Absorption

Average Discharge Pressure	MPa	Average pressure of fluid discharged from pumps
Target Ripple Factor	± %	

Type of Pump:
☐ Plunger / ☐ Diaphragm — Number — ☐ Single-action / ☐ Double-action
☐ Gear — No. of Teeth — pcs.
☐ Vane — No. of Blades — pcs.
☐ Other

Pump Specifications	Discharge	ℓ/min
	Rotations	rpm

☐ ③ Impact Absorption

Normal Pressure	MPa	Pressure in pipes with no impact pressure
Allowable Impact Pressure	MPa	Maximum supported impact pressure. The higher the value the smaller in volume the accumulator can be.
Fluid Density	kg/m³	Be careful with the units used. The unit used for water is in [1000].
Inside Pipe Diameter	mm	
Pipe Length	m	
Flow Rate	ℓ/min	
Flow Velocity	m/s	Not required if the "pipe diameter" and "flow rate" are provided.

☐ Thermal Expansion Compensation ☐ Equilibrium Action
☐ Transfer Barrier ☐ Gas Spring ⇒ Consult your nearest sales contact
☐ Leak Compensation ☐ Other

3. Specifications

Regulatory Test
☐ No Test Required (Eagle Industry Standard)
☐ High Pressure Gas Safety Law ☐ Chinese Regulations
☐ Class-2 Pressure Vessel ☐ CE Mark
☐ ASME
☐ Other

Joint for Fluid Port Connecting
☐ No Joint Required
☐ Bushing — Connection Thread Rc
☐ Flange — Connection Diameter A
Type: ☐ Eagle Industry ☐ F type ☐ H type ☐ D type
☐ Other — Provide us with the necessary specifications

Specifications Required by the Gas Side
☐ With TR Cap (Standard Eagle Industry Specification)
☐ Without TR Cap
Safety Valve: ☐ Fuse Metal Type ☐ Spring Type
☐ Gas Control Valve
Pressure Gauge — Unit of Scale: ☐ MPa (Eagle Industry Standard) ☐ Other — Please inform us of the necessary unit
Max.Scale

4. Additional Specifications

Nameplate	☐ No Designation (Standard Eagle Industry Specification) ☐ Designated Nameplate (Specifications Attached)
Paint	☐ No Paint Required (Standard Eagle Industry Specification) ☐ Painted — ☐ Painted According to Eagle Industry Standards — Basecoat: One Coat of Synthetic Resin / Topcoat: One Coat of Phthalic Acid Resin (JPMA No.B57-700) ☐ Designated Paint (Specifications Attached)
Internal Cleanliness	☐ Not Designated (Eagle Industry Standards NAS 10 class) ☐ Designated NAS class
Filled with Gas before Shipment	☐ Not Required ☐ Required MPa at ℃
Other	
Specification No.	

(To be completed by NOK)

Result of Selection	Date of Response · ·	Name and Department
Model Code		
Product Code		× units
Recommended Filled Gas Pressure	MPa at ℃	

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Fill in the columns within the thick frame. Consult your nearest sales contact regarding any additional inquiries.

Volume Calculation Sheet
① Accumulator for Energy Accumulation

(To be completed by NOK)
Data · ·
Name and Section

Equipment and Machinery, Installation Position	

Set Conditions of Use

Applicable Fluid				
Temperature Conditions	Fluid Temperature	~ ℃	Normal Temperature	℃
	Ambient Temperature	~ ℃	Normal Temperature	℃

System Pressure	P_{max}	MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.
Maximum Operating Pressure	P_3	MPa	Maximum pressure of accumulated fluid in the accumulator
Minimum Operating Pressure	P_2	MPa	Minimum pressure when fluid is discharged from the accumulator
Average Operating Pressure	P_m	MPa	$P_m = (P_3 + P_2)/2$
Necessary Discharge Flow	ΔV	ℓ	Total amount of fluid required for piston (actuator) operation
Accumulation Period	Δt_m	s	Time required to accumulate ΔV in the accumulator
Discharge Period	Δt_n	s	Time required to discharge ΔV from the accumulator

Calculate Necessary Gas Volume V₁

Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■Set Filled Gas Pressure (P_1) Set the pressure according to either ① or ②. $P_1 \geq (1/\text{Max. compression ratio}) \times P_3$ must still be satisfied. (See pages 10 and 11 for the maximum compression ratios of the individual series)

①If no change in temperature takes place: $P_1 = (0.8 \sim 0.9) \times P_2$ $= 0.85 \times \quad = \quad$ MPa

②If the temperature changes: $P_1 = \dfrac{273 + T_{min}}{273 + T_{max}} \times (0.8 \sim 0.9) \times P_2$ $= \dfrac{273 + }{273 + } \times 0.85 \times \quad = \quad$ MPa

■Set Polytropic Indices

Set the indices from the [List of Polytropic Indices] on page 60.

When Accumulated (m) ··· P_m , Δt_m ;
When Discharged (n) ··· P_m , Δt_n ;

■Calculate Necessary Gas Volume for Accumulator (V_1)

$$V_1 = \Delta V \times \frac{P_2^{\frac{1}{n}} \cdot P_3^{\frac{1}{m}}}{P_1^{\frac{1}{m}}\left(P_3^{\frac{1}{n}} - P_2^{\frac{1}{n}}\right)} = \quad \times \frac{\quad \times \quad}{\quad \times \left(\quad - \quad\right)} = \quad \ell$$

Verify Necessary Discharge Flow Qmax

$$Q_{max} = \Delta V \times 60 / \Delta t_n = \quad \times 60 \div \quad = \quad \ell/\text{min}$$

Select a NOK Accumulator Model

Select a model that satisfies "$V_1 \leq$ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select an accumulator with which the necessary discharge flow Qmax will not exceed the maximum discharge flow. Select the AT series if the bladder for the 10 ℓ or larger accumulator is replaced from the gas side.

· Select the series [____] according to the relevant P_{max}, V_1, Qmax.
· Set the rubber material to [____] according to the fluid used and temperature.
· Set the wetted specification to [____] according to the fluid used.
· Set the joint for fluid port connecting and specifications required by the gas side.

[Model Code of Selected Accumulator] [____] ; [Gas Volume] [____] ℓ

No. of Necessary Accumulators (V_1; ℓ/Accumulator Gas Volume; ℓ/unit) [Rounded to the nearest whole number] = [____] units

Verify the Discharge Flow ΔVu of the Selected Accumulator

$$\Delta V_u = \text{Gas Volume} \times \frac{P_1^{\frac{1}{m}}\left(P_3^{\frac{1}{n}} - P_2^{\frac{1}{n}}\right)}{P_2^{\frac{1}{n}} \cdot P_3^{\frac{1}{m}}} = \quad \times \frac{\quad \times \left(\quad - \quad\right)}{\quad \times \quad} = \quad \ell \quad (\Delta V_u \geq \Delta V)$$

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Volume Calculation Sheet
②Accumulator Used to Absorb Pulses

(To be completed by NOK)

Data　　·　　·

Name and Section

Equipment and Machinery,
Installation Position

Set Conditions of Use

Applicable Fluid						
Temperature Conditions	Fluid Temperature	～	℃	Normal Temperature		℃
	Ambient Temperature	～	℃	Normal Temperature		℃

System Pressure	Pmax	MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.
Average Discharge Pressure	Pm	MPa	The average pressure of fluid discharged from a pump, etc.
Target Ripple Factor		%	

Type of Pump
- ☐ Plunger
- ☐ Diaphragm — Number — ☐ Single-action ☐ Double-action
- ☐ Gear — No. of Teeth — pcs.
- ☐ Vane — No. of Blades — pcs.
- ☐ Other

Pump Specifications	Discharge	ℓ/min	
	Rotations	rpm	

[Constant K_1 for Each Individual Type of Pump]

Type of Pump		K_1	
	Number	Single-action	Double-action
Plunger Diaphragm	1	0.60	0.25
	2	0.25	0.15
	3	0.13	0.06
	4	0.10	0.06
	5	0.06	0.02
	6		0.06
	7 or more		0.02
Gear and Vane			0.06

Calculate Necessary Gas Volume V_1

Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■Set Constant (K_1) that will Vary with the Type of Pump　Set the constant from the list of [Constant K_1 for Each Individual Type of Pump] from above.

■Set Filled Gas Pressure (P_1)　Set the pressure according to either ① or ②. $P_1 \geqq (1/\text{Max. compression ratio}) \times P_3$ must still be satisfied. (See pages 10 and 11 for the maximum compression ratios of the individual series)

①If no change in temperature takes place:　$P_1 = (0.6 \sim 0.8) \times Pm$　$= 0.7 \times \quad = \quad$ MPa

②If the temperature changes: $P_1 = \dfrac{273 + Tmin}{273 + Tmax} \times (0.6 \sim 0.8) \times Pm = \dfrac{273 +}{273 +} \times 0.7 \times \quad = \quad$ MPa

■Calculate Discharge (q) per Pump Rotation　q = Discharge/Rotations = $\quad \div \quad = \quad \ell$/Rotation

■Set Polytropic Indices (n)　Calculate the value using　n = 1.41 (nitrogen gas)

■Calculate Maximum Target Line Pressure (P_3)　$P_3 = (1 + \text{Ripple Factor}/100) \times Pm = (1 + \quad /100) \times \quad = \quad$ MPa

■Calculate Necessary Gas Volume (V_1) for Accumulator

$$V_1 = \dfrac{q \cdot K_1 \cdot \left(\dfrac{Pm}{P_1}\right)^{\frac{1}{n}}}{1 - \left(\dfrac{Pm}{P_3}\right)^{\frac{1}{n}}} = \dfrac{\quad \times \quad \times \left(\dfrac{1}{\quad}\right)^{\frac{1}{1.41}}}{1 - \left(\dfrac{1}{\quad}\right)^{\frac{1}{1.41}}} = \quad \ell$$

Select a NOK Accumulator Model
Select a model that satisfies "$V_1 \leqq$ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select the AT series if the bladder for the 10 ℓ or larger accumulator is replaced from the gas side.

· Select the series 　 according to the relevant Pmax, V_1.

· Set the rubber material to 　 according to the fluid used and temperature.

· Set the wetted specification to 　 according to the fluid used.

· Set the joint for fluid port connecting and specifications required by the gas side.

【Model Code of Selected Accumulator】　【Gas Volume】

ℓ

No. of Necessary Accumulators (V_1; 　 ℓ/Accumulator Gas Volume; 　 ℓ/unit) [Rounded to the nearest whole number] = 　 units

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Volume Calculation Sheet
③Accumulator Used to Absorb Impact

(To be completed by NOK)

Data　　·　　·

Name and Section

Equipment and Machinery,
Installation Position

Set Conditions of Use

Applicable Fluid						
Temperature Conditions	Fluid Temperature	～	℃	Normal Temperature		℃
	Ambient Temperature	～	℃	Normal Temperature		℃

System Pressure	Pmax	MPa	Maximum possible pressure applied to an accumulator in a circuit, and typically used to refer to the release pressure of a relief valve with the equipment or machinery.
Normal Pressure	PA	MPa	The pressure within a pipe with no impact pressure.
Allowable Impact Pressure	PB	MPa	Maximum supported impact pressure. The higher the value the smaller in volume the accumulator can be. The value is generally set to be 110% of the normal pressure. ($P_3 = 11.0 \times 1.1 = 12.1$MPa)
Fluid Density	ρ	kg/m³	Be careful with the units used. The unit used for water is in [1000].
Inside Pipe Diameter	d	mm	
Pipe Length	L	m	
Flow Rate	Q	ℓ/min	
Flow Velocity	v	m/s	Not required if the "pipe diameter" and "flow rate" are provided.

Calculate Necessary Gas Volume V_1
Convert the value to the absolute pressure for use in calculation if the accumulator is used at 1 MPa or less. [Absolute Pressure (MPa) = Gauge Pressure + 0.1013]

■Calculate Fluid Mass (W) within the Line　$W = \dfrac{\pi}{4} \cdot d^2 \cdot L \cdot \rho \cdot 10^{-6} = \dfrac{\pi}{4} \times \quad^2 \times \quad \times \quad \times 10^{-6} = \quad$ kg

■Calculate Flow Velocity (v)　$v = 21.23 \times Q / d^2 = 21.23 \times \quad \div \quad^2 = \quad$ m/s

■Set Filled Gas Pressure (P_1)　Set the pressure according to either ① or ②. $P_1 \geqq (1/\text{Max. compression ratio}) \times P_3$ must still be satisfied. (See pages 10 and 11 for the maximum compression ratios of the individual series)

①If no change in temperature takes place:　$P_1 = (0.8 \sim 0.9) \times PA$　$= 0.9 \times \quad = \quad$ MPa

②If the temperature changes: $P_1 = \dfrac{273 + Tmin}{273 + Tmax} \times (0.8 \sim 0.9) \times PA = \dfrac{273 +}{273 +} \times 0.9 \times \quad = \quad$ MPa

■Set Polytropic Indices (n)　Calculate the value using　n = 1.41 (nitrogen gas)

■Calculate Maximum Supported Impact Pressure (P_B)　$P_B = 1.1 \times PA = 1.1 \times \quad = \quad$ MPa

■Calculate Accumulator Gas Volume (V_A) when Pressure is P_A

$$V_A = \dfrac{W \cdot v^2 \cdot (n-1)}{2000 \cdot PA \times \left(\left(\dfrac{P_B}{P_A}\right)^{\frac{n-1}{n}} - 1\right)} = \dfrac{\quad \times \quad^2 \times (1.41 - 1)}{2000 \times \quad \times \left(\left(\dfrac{1}{\quad}\right)^{\frac{1.41-1}{1.41}} - 1\right)} = \quad \ell$$

■Calculate Necessary Gas Volume (V_1) for Accumulator　$V_1 = V_A \times \dfrac{PA}{P_1} = \quad \times \dfrac{\quad}{\quad} = \quad \ell$

Select a NOK Accumulator Model
Select a model that satisfies "$V_1 \leqq$ Accumulator Gas Volume" from the individual series listed on pages 12 to 31

Select the MC series or AL series for 1L accumulator.

· Select the series 　 according to the relevant Pmax, V_1.

· Set the rubber material to 　 according to the fluid used and temperature.

· Set the wetted specification to 　 according to the fluid used.

· Set the joint for fluid port connecting and specifications required by the gas side.

【Model Code of Selected Accumulator】　【Gas Volume】

ℓ

No. of Necessary Accumulators (V_1; 　 ℓ/Accumulator Gas Volume; 　 ℓ/unit) [Rounded to the nearest whole number] = 　 units

Handling and Selection

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The units within the thick frames represent SI units.

Length

	m	in
Length	1	39.37
	2.54×10^{-2}	1

Volume

	m^3	ℓ	in^3	U.S.gal.	U.K.gal.
	1×10^{-3}	1	61.0271	0.26419	0.2200
Volume	1	1×10^3	61027.1	264.19	220.0
	1.64×10^{-5}	0.01639	1	0.00433	0.0036
	3.79×10^{-3}	3.78543	231	1	0.8327
	4.55×10^{-3}	4.54596	277.413	1.2010	1

Mass

	kg	lb
Mass	1	2.20462
	0.45359	1

Force

	N	dyn	kgf
	1	1×10^5	$1.019\,72 \times 10^{-1}$
Force	1×10^{-5}	1	$1.019\,72 \times 10^{-6}$
	9.806 65	9.80665×10^5	1

Pressure

	Pa	MPa	kgf/cm^2	bar	psi
	1	1×10^{-6}	1.0197×10^{-5}	1×10^{-5}	1.4504×10^{-4}
	1×10^6	1	1.0197×10	1×10	1.4504×10^2
Pressure	9.80665×10^4	9.80665×10^{-2}	1	9.80665×10^{-1}	1.4223×10
	1×10^5	1×10^{-1}	1.0197	1	1.4504×10
	6894.757	6.8948×10^{-3}	7.0307×10^{-2}	6.8948×10^{-2}	1

Stress

	Pa or N/m^2	MPa or N/mm^2	kgf/mm^2	kgf/cm^2
	1	1×10^{-6}	1.0197×10^{-7}	1.0197×10^{-5}
Stress	1×10^6	1	1.0197×10^{-1}	1.0197×10
	9.80665×10^6	9.8067	1	1×10^2
	9.80665×10^4	9.8067×10^{-2}	1×10^{-2}	1

Process Energy Cal.

	J	kW·h	kgf·m	kcal
	1	2.7778×10^{-7}	1.0197×10^{-1}	2.3889×10^{-4}
Process Energy Cal.	3.6×10^6	1	3.6710×10^5	8.6000×10^2
	9.8067	2.7241×10^{-6}	1	2.3427×10^{-3}
	4.1861×10^3	1.1628×10^{-3}	4.2686×10^2	1

Power (Rate of Production, Motive Power) Heat Flow

	W	kgf·m/s	PS	kcal/h
	1	1.0197×10^{-1}	1.3596×10^{-3}	8.6000×10^{-1}
Power (Rate of Production, Motive Power) Heat Flow	9.8067	1	1.3333×10^{-2}	8.4337
	7.355×10^2	7.5×10	1	6.3253×10^2
	1.1628	1.1857×10^{-1}	1.5810×10^{-3}	1

Viscosity

	Pa·s	cP	P
	1	1×10^3	1×10
Viscosity	1×10^{-3}	1	1×10^{-2}
	1×10^{-1}	1×10^2	1

Kinematic Viscosity

	m^2/s	cSt	St
	1	1×10^6	1×10^4
Kinematic Viscosity	1×10^{-6}	1	1×10^{-2}
	1×10^{-4}	1×10^2	1

Thermal Conductivity

	W/(m·K)	kcal/(h·m·°C)
Thermal Conductivity	1	8.6000×10^{-1}
	1.1628	1

Heat Transfer Coefficient

	$W/(m^2 \cdot K)$	$kcal/(h \cdot m^2 \cdot °C)$
Heat Transfer Coefficient	1	8.6000×10^{-1}
	1.1628	1

Specific Heat

	J/(kg·K)	kcal/(kg·°C) cal/(g·°C)
Specific Heat	1	2.3889×10^{-4}
	4.1861×10^3	1

Temperature Conversion Table

	°C	°F	°C	°F
	-40	-40	$+80$	$+176$
	-20	-4	$+100$	$+212$
	0	$+32$	$+120$	$+248$
Temperature	$+20$	$+68$	$+140$	$+284$
	$+40$	$+104$	$+160$	$+320$
	$+60$	$+140$	$+180$	$+356$

$$°C = \frac{5}{9} \times (°F - 32) \qquad °F = \frac{9}{5} \times °C + 32$$