Shock Absorbers - Oil Type

Overview

■Shock Absorbers - Oil Type

For this system, oil is mainly utilized.Compared with other cushioning materials (rubber, spring, air etc.), they are compact and capable of repeatedly absorbing large impact energy softly without rebound. Internal structure and basic principle of oil type shock absorbers are shown as follows.

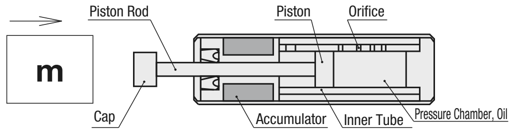
When an object collides with a piston rod, the oil in the pressure chamber is compressed by a piston. The clearance between inner tube and piston is so small that compressed oil is forced out of the orifices. At this point, the impact energy is converted into heat energy by dynamic resistance.

The piston rod sinks into the shock absorber body so that the oil equal in volume to the piston moves into the accumulator.

This mechanism provides an ideal shock absorbing action.

Various absorption characteristics can be obtained depending on the number and size of orifices. (Refer to classification according to absorption characteristics structures on **P.372**.)

Please note that when the wrong collision speed is selected, some abnormal reaction may occur during collision or the impact energy may not be absorbed in an ideal manner.



Procedure of Selection

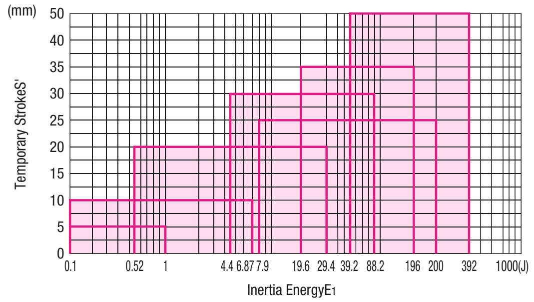
① Calculation of Inertial Energy (E_1)

According to examples of calculation for selection, calculate inertial energy based on collision mass (m), collision velocity (V), moment of inertia (I) and collision angular velocity (ω).

② Temporary Decision of Absorber Stroke

Obtain the temporary stroke (S') based on Fig. 1.

Fig. 1 Calculate the temporary stroke S' with the Inertial Energy E_1. (Adjustable / Fixed Force Type)



③ Calculation of Additional Energy (E_2')

Confirm whether there is propulsion (F) or not and calculate the additional energy according to examples of calculation for selection.

④ Calculation of Total Energy

Calculate the total energy from the sum of inertial energy (E_1) and additional energy (E_2').

⑤ Check Equiv. Mass

According to examples of calculation for selection, calculate the equivalent mass and confirm whether it is less than the max. equivalent mass in the catalog (me').

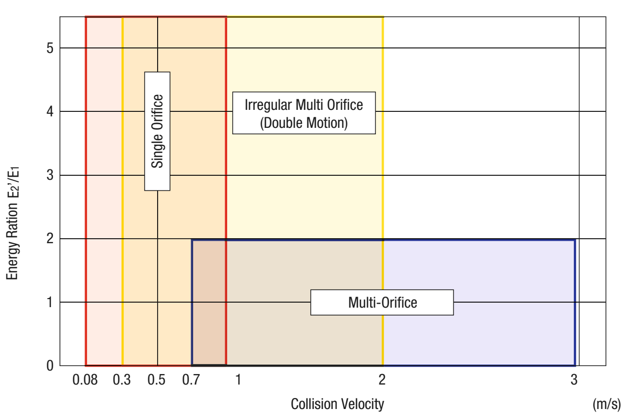
⑥ Select Absorption Characteristics Structures from Energy Ratio.

Select an orifice type from Fig. 2 temporarily.

⑦ Check Max. Absorbed Energy per Minute

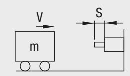
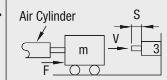
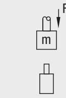
Calculate the energy corresponding to one minute (E_T) from the operating cycle (time/min) and total energy, and confirm whether or not the value is within the operating range.

Fig. 2 Select the orifice type from energy ratio (additional energy E_2' / inertial energy E_1)

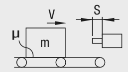
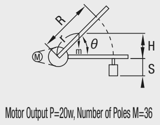
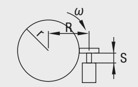


For Single, Irregular Multi, Multi Orifice Types, these are the values of Adjustable / Fixed Types.

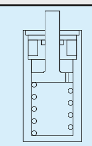
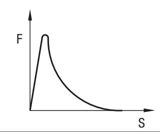
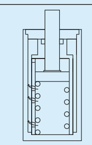
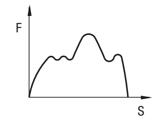
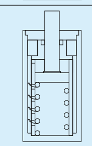
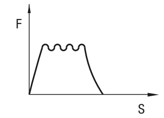
* If both Single Orifice and Multi-Orifice are applicable, select irregular Multi-Orifice.
* If both Irregular Multi-Orifice and Multi-Orifice are applicable, select Multi-Orifice.
* For Speed S Type, the collision velocity is 0.08 ~ 0.5m/s.

Examples of Calculation for Selection		Ex.) Pure Inertial Collision (Horizontal Collision without Thrust Force)	Ex.) Horizontal Collision with Air Cylinder Thrust Force	Ex.) Soft Stop in the Cylinder Falling
Example and Collision Conditions		 <Collision Conditions> m=25kg V=0.6m/s F=0N N=30 times/min	 Air Cylinder I.D. Ø40 Operating Pressure 0.5MPa <Collision Conditions> m=30kg V=0.6m/s N=20 times/min	 Air Cylinder I.D. Ø25 Operating Pressure 0.5MPa <Collision Conditions> m=15kg V=0.2m/s N=10 times/min
Collision Velocity V[m/s]		V=0.6m/s	V=0.6m/s	V=0.2m/s (* Collision velocity V is actual measurements or 1.5 ~ 2 times the average speed.)
Absorbed Energy	Inertial Energy E_1 [J]	$E_1=\frac{mxV^2}{2}=\frac{25x0.6^2}{2}=4.5J$	$E_1=\frac{mxV^2}{2}=\frac{30x0.6^2}{2}=5.4J$	$E_1=\frac{mxV^2}{2}=\frac{15x0.2^2}{2}=0.3J$
	Temporary Stroke S'[mm]	From Fig. 1, S'=20mm (Select Adjustable Type)	From Fig. 1, S'=15mm (Select Adjustable Type)	From Fig. 1, S'=10mm (Select Adjustable Type)
	Additional Energy E_2' [J]	E_2'=0J	Thrust of the cylinder is F=628.4N E_2'=FxS'=628.4x0.015=9.4J	Thrust of the cylinder is F=245.4N E_2'=(F+mg)xS'=(245.4+15x9.8)x0.01=3.92J
	Total Energy E'[J]	E'=E_1+E_2'=4.5+0=4.5J	E'=E_1+E_2'=5.4+9.4=14.8J	E'=E_1+E_2'=0.3+3.92=4.22J
Equiv. Mass me' [kg]		$me'=\frac{2xE'}{V^2}=\frac{2x4.5}{0.6^2}=25kg$	$me'=\frac{2xE'}{V^2}=\frac{2x14.8}{0.6^2}=82.2kg$	$me'=\frac{2xE'}{V^2}=\frac{2x4.22}{0.2^2}=211kg$
Temporary Selection		Select Adjustable Type Select L from the collision velocity. Select MAC1612 from E and me'. (Stroke S=12mm)	Select Adjustable Type Select medium speed M from the collision velocity. Select MAC2016M from E' and me'. (Stroke S=16mm)	Select Adjustable Type Select ultra low speed S from Fig. 2. Select MAC1612S from E' and me'. (Stroke S=12mm)
Recalculation		E_2=0J E=E_1+E_2=4.5J $me=\frac{2\times E}{V^2}=25kg$	E_2=FxS=10.1J E=E_1+E_2=15.5J $me=\frac{2xE}{V^2}=86.1kg$	E_2=(F+mg)xS=4.71J E=E_1+E_2=0.3+4.71=5.01J $me=\frac{2xE}{V^2}=250kg$
Energy per Minute E_T		E_T=ExN=4.5x30=135J/min	E_T=ExN=15.5Jx20=310J/min	E_T=ExN=5.01x10=50.1J/min
Confirmation		E, me, N and E_T are OK. Select MAC1612L	E, me, N and E_T are OK. Select MAC2016M	E, me, N and E_T are OK. Select MAC1612S

* For horizontal collision without thrust force, select the Orifice Type only by collision velocity.

		Ex.) Horizontal Collision with Belt Conveyor Thrust Force	Ex.) Collision with Synchronous Motor Driven Load	Ex.) Horizontal Rotary Collision with Torque
Example and Collision Conditions		 Dynamic Friction Coefficient μ=0.4 <Collision Conditions> m=5kg V=0.5m/s N=20 times/min	 Motor Output P=20w, Number of Poles M=36 Power Supply Frequency f=50Hz, Deceleration Ratio K=20 <Collision Conditions> m=1kg R=0.4m r=0.3m θ=20° N=10 times/min $I=\frac{4}{3}mr^2$ $3mr^2$=0.12kg・m^2 ω=5.6rad/s F=59.3N	 <Collision Conditions> I=125.5kg・m^2 ω=1.8rad/s R=1.25m N=6 times/min T=68.6N・m
Collision Velocity V[m/s]		V=0.5m/s	V=Rω=0.4x5.6=2.24m/s	V=Rω=1.25x1.8=2.25m/s
Absorbed Energy	Inertial Energy E_1 [J]	$E_1=\frac{mxV^2}{2}=\frac{5x0.5^2}{2}=0.625J$	$E_1=\frac{I\omega^2}{2}=\frac{0.12x5.6^2}{2}=1.88J$	$E_1=\frac{I\omega^2}{2}=\frac{125.5x1.8^2}{2}=203.31J$
	Temporary Stroke S'[mm]	From Fig. 1, S'=5mm (Select Fixed Force Type)	From Fig. 1, S'=10mm (Select Adjustable Type)	From Fig. 1, S'=50mm (Select Adjustable Type)
	Additional Energy E_2' [J]	F=μmg=0.4x5x9.8=19.6N E_2'=F・S'=19.6x0.005=0.098J	E_2'=(F+mg)xS'=(59.3+1x9.8)x0.01=0.69J	$E_2'=\frac{T}{R}\cdot S'=\frac{68.6}{1.25}x0.05=2.74J$
	Total Energy E'[J]	E'=E_1+E_2'=0.625+0.098=0.723J	E'=E_1+E_2'=1.88+0.69=2.57J	E'=E_1+E_2'=203.31+2.74=206.05J
Equiv. Mass me' [kg]		$me'=\frac{2xE'}{V^2}=\frac{2x0.723}{0.5^2}=5.8kg$	$me'=\frac{2xE'}{V^2}=\frac{2x2.57}{2.24^2}=1.0kg$	$me'=\frac{2xE'}{V^2}=\frac{2x206.05}{2.25^2}=81.4kg$
Temporary Selection		Select Fixed Force Type Select Single Orifice from V Select MAKC1005B from E' and me'. (Stroke S=5mm)	Select Adjustable Type Select Multi-Orifice from Fig. 2. Select MAC1210H from E' and me'. (Stroke S=10mm)	Select Adjustable Type Select Speed H Type from Fig. 2. Select MAC3650H from E' and me'. (Stroke S=50mm)
Recalculation		E_2=E_2'=0.098J E=E_1+E_2=0.723J $me=\frac{2xE}{V^2}=5.8kg$	E_2=0.69J E=E_1+E_2=2.57J me=1.0kg	$E_2=\frac{T}{R}\cdot S=2.74J$ E=E_1+E_2=206.05J $me=\frac{2xE}{V^2}=81.4kg$
Energy per Minute E_T		E_T=ExN=0.723x20=14.46J/min	E_T=ExN=2.57x10=25.7J/min	E_T=ExN=206.05x6=1236.3J/min
Confirmation		E, me, N and E_T are OK. Select MAKC1005B	E, me, N and E_T are OK. Select MAC1210H	E, me, N and E_T are OK. Select MAC3650H

■Shock Absorbers (P.373~378) Classification according to absorption characteristics structures

Structure	Adjustable * Fixed Force Type			
Single Orifice	S Type A Type B Type L Type		Single orifice structure has the same resistance properties as forms of a dashed pot structure with a space between the piston and cylinder tube, a single tube structure with an orifice in the piston, and a double tube single orifice structure. Ex. Description of a Single Tube Structure A piston with a single orifice slides into an oil-filled cylinder tube. Because the office area is constant over the entire stroke, as the shock absorption characteristics shown in the right graph, the resistance is the largest immediately after a collision but gradually reduces speed as the stroke continues.	
Irregular Multi Orifice	Medium Speed M Type		In this double-tube structure, the piston slides in the inner tube. This inner tube has several orifices along the direction of strokes, and not only constant energy but energy depending on various purposes can be absorbed. It is designed to absorb kinetic energy during the first half of stroke and control speed during the second half. Therefore, it is well suited to absorb energy against air cylinder thrust.	
Multi Orifice	High Speed H Type		In this double-tube structure, the piston slides in the inner tube. This inner tube has several orifices along the direction of strokes. Because the orifice area becomes small gradually as the stroke speed slows down, drag remains largely constant, though the drag fluctuates like a ripple.	

* Adjustable Type No.0806M is single orifice structure and No.3625L Type is multi-orifice structure.