Related Components

FCK

Shock Absorber, Adjustable Type

CONTENTS

Shock Absorber FCK Series

Selectable from 3 stages: Low, Medium, High Speed

3 stages of impact speed, 3 types of mechanism
By changing the orifice structure, it is equipped with absorption functions suitable for low, medium, and high impact speeds.

With Rotation Stopper
Lock screw adopted to prevent adjuster from becoming misaligned during use. (Not available on some compact models)

Easy mounting with outer diameter thread
Outer diameter threads M10 to M27 for low speed, M10 to M42 for medium/high speed, with nut. Mounting and position adjustment are easy.

Presence or absence of tip cap can be selected
(Excluding some sizes)

High-efficiency thread machining
Since the outer pipe is threaded, the surface area is large, enhancing heat dissipation.

Hard chrome plated Piston Rod

Usable at -5 to 70°C
Adoption of special oil allows use over a wide temperature range.

With Adjuster
Adjuster allows adjustment of shock absorption according to impact conditions.

Shock Absorber 5 Merits

- Safely stops the colliding object
- Increases manufacturing cycle.
- Life of machinery is extended
- Reduces noise and improves the environment around machinery
- Prevents machine breakdown

Shock Absorber FCK Series with 32 models available

Optimal shock absorption matching impact conditions/ characteristics is possible

8 Low Speed Models

- Colliding speed range: 0.3 to 1 m/s
- Max absorbed energy 1.5 to 79.3 J
- Single-hole Orifice Structure

12 Medium Speed Models

- Colliding speed range: 0.3 to 2 m/s
- Max absorbed energy 1.8 to 720 J
- Multi-hole Irregular Orifice Structure

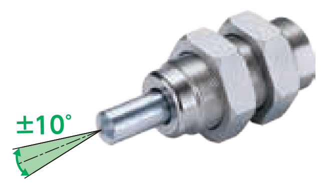
12 High Speed Models

- Colliding speed range: 0.7 to 3 m/s
- Max absorbed energy 1.8 to 720 J
- Multi-hole Orifice Structure

Option

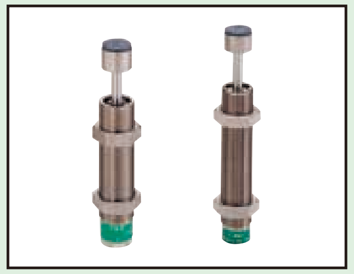
Stopper Nut
Positioning is possible with stopper nut.

Offset Angle Adapter
Absorbs offset angle of Max ±10° at workpiece impact.



FCK Series

● Max Absorbed Energy: 1.5 to 720 J



RoHS

Model Number Notation

●Low Speed Type: FCK-L - 0.15 - C (1, 2, 3)

● Medium Speed Type: FCK-M - 0.18 - C (1, 2, 3)

● High Speed Type: FCK-H - 0.18 - C

1 Model No.
2 Series (Max Absorption Energy)
3 Option

Rechargeable Battery Compatible Specification (Catalog No. CC-1226AA)

●Design compatible with rechargeable battery manufacturing process

FCK - . . . . - P4*

* Please contact us for details.

1 Model No.

Code	Content
FCK-L	Low Speed Type
FCK-M	Medium Speed Type
FCK-H	High Speed Type

3 Option

Code	Content	
Blank	Without Tip Cap	
C	With Tip Cap	

2 Series (Max Absorption Energy)

	Code	Content	Low Speed Type FCK-L	Medium Speed Type FCK-M	High Speed Type FCK-H
	0.15	1.5J	●		
	0.18	1.8J		●	●
	0.3	2.9J	●		
	0.4	3.9J	●		
	0.5	4.9J		●	●
	0.6	5.9J		●	●
	1	9.8J	●	●	●
	3	29.4J	●	●	●
	5	49J	●	●	●
*1	6.5	63.7J	●	●	●
	8.1	79.3J	●	●	●
	20	196J		●	●
	40	392J		●	●
*1	45	441J		●	●
*1	73.5	720J		●	●

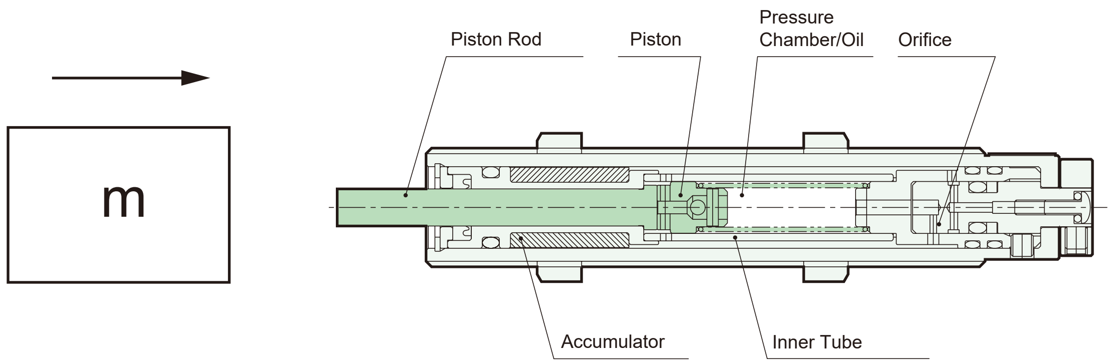
*1: Without cap is not available for 6.5 (63.7J), 45 (441J), 73.5 (720J) .

(grey) indicates not manufacturable.

Specifications

Item		FCK														
Series		0.15	0.18	0.3	0.5	0.4	0.6	1	3	5	6.5	8.1	20	40	45	73.5
Model / Classification		Adjustable spring return type														
Maximum absorption energy J		1.5	1.8	2.9	4.9	3.9	5.9	9.8	29.4	49	63.7	79.3	196	392	441	720
Outer diameter thread size mm		M10×1.0		M12×1.0		M14×1.5		M16×1.5	M20×1.5	M25×1.5		M27×1.5	M30×1.5	M36×1.5	M42×1.5	
Stroke mm		8		10				12	16	30	40	25	35	50		80
Max Absorption Energy per Hour kJ/hour		3.5		5.9		8.8		14.1	20.6	29.4	38.2	32.3	70.5	141.1	164.6	264.6
Maximum collision speed	L m/s	0.3 to 1	-	0.3 to 1	-	0.3 to 1	-	0.3 to 1					-	-	-	-
	M m/s	-	0.3 to 2	-	0.3 to 2	-	0.3 to 2	0.3 to 2					0.3 to 2			
	H m/s	-	0.7 to 3	-	0.7 to 3	-	0.7 to 3	0.7 to 3					0.7 to 3			
Max Repetition Frequency (20°C) cycles/min		60											30		10	6
Ambient Temperature °C		-5 to 70 (provided there is no freezing)														
Max Load (Resistance Force Value)	L N	637		1,470		1.813		2.646	4.900			6.370	16.660	23.520	27.028	
	M N								3.528	3.920						
	H N															
Return Time s		0.5 or less											1 or less		2 or less	
Weight	Without cap g	26.5		44		68		108	180	406	-	411	710	1300	-	-
	With cap g	27		47		73		117	202	436	459	460	760	1410	1560	2010
Return Spring Force	At Extension N	2.9		4.9		4.5		5.4	12.0	16.6	23.8	16.2	19.6	22.5	24.5	
	At Compression N	5.9		9.8				14.7	18.0	33.1	71.4	27.2	44.1	68.6	83.3	98.0

Operational Principle



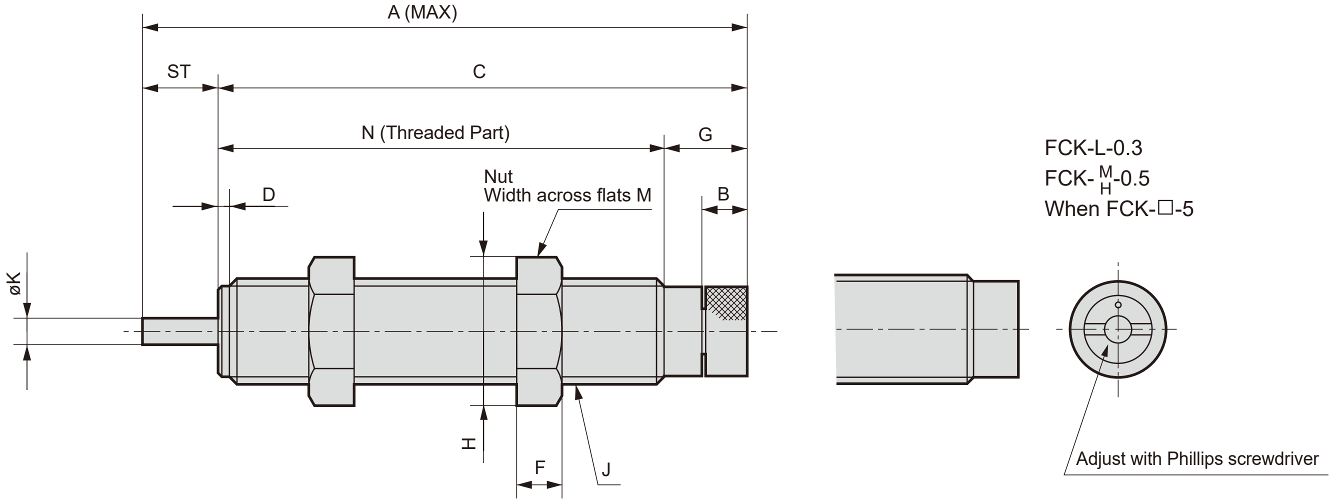
When an object collides with the Piston Rod, its motion is transmitted to the oil in the pressure chamber enclosed by the piston and inner tube. The oil in the pressure chamber flows out from the orifice provided in the inner tube. At that time, a resistance force F represented by the following formula is generated.

$F = av^2+bv+cx$ (v indicates impact speed, x indicates travel stroke. a, b, c are constants)

The first term represents velocity squared resistance and accounts for a large weight within the resistance force.
The second term represents viscous resistance and accounts for a large proportion when the impact speed is small.
The third term represents the Piston Rod return force. (Since it is extremely small compared to the first and second terms, it can usually be ignored.) The product of this generated reaction force and the stroke of the Piston Rod becomes the absorption energy of the shock absorber. The shock absorber achieves ideal shock absorption by controlling the first and second terms.

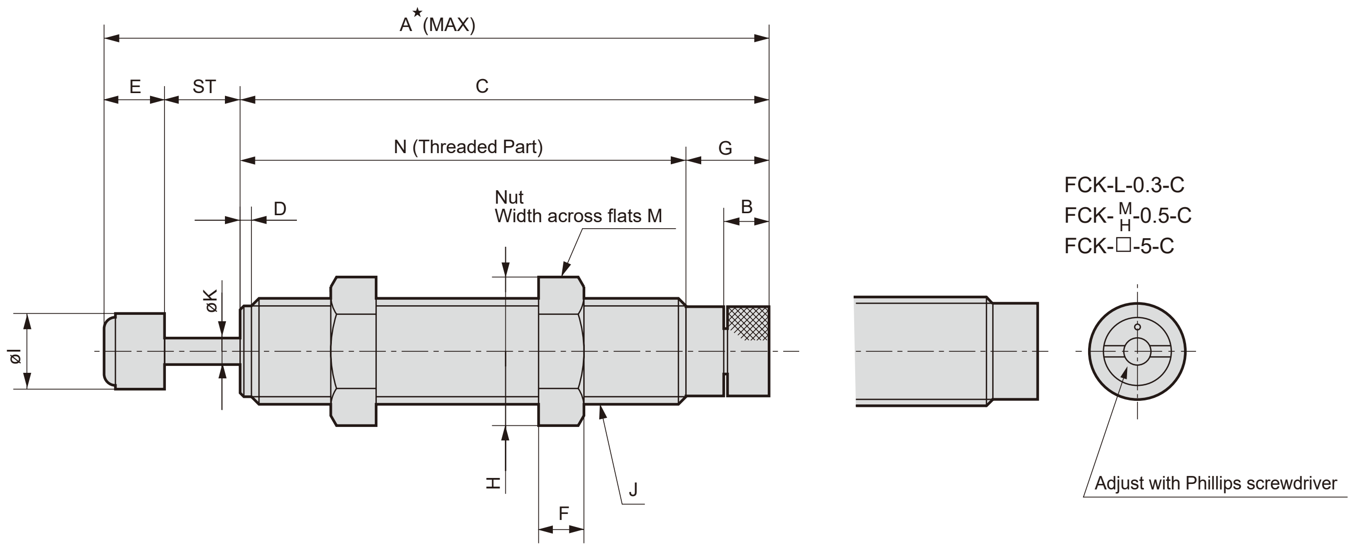
Dimensional Drawings

● Standard (FCK-□-□)



FCK-L-0.3
FCK-$^{M}_{H}$-0.5
When FCK-□-5

● Capped (FCK-□-□-C)



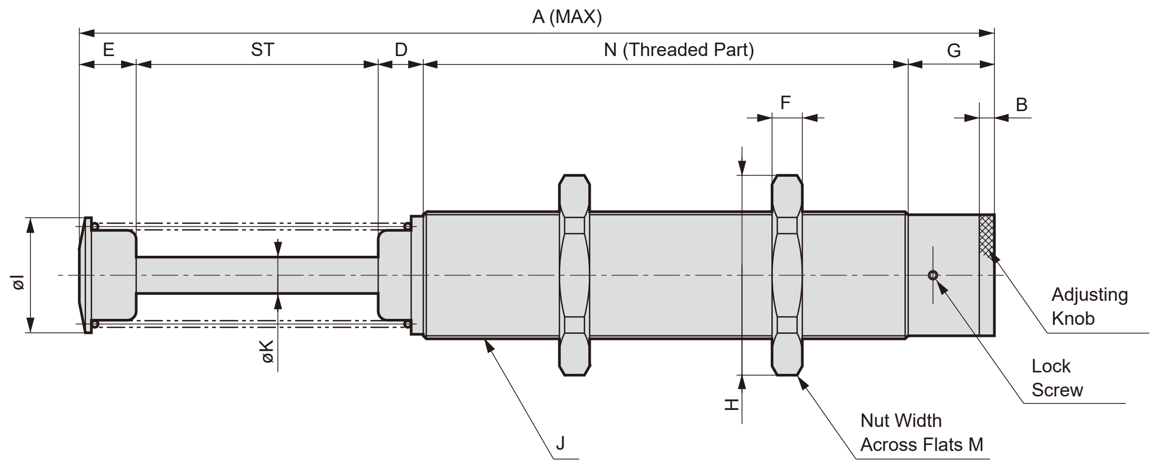
FCK-L-0.3-C
FCK-$^{M}_{H}$-0.5-C
FCK-□-5-C

Model No.	A	A★	B	C	ST	D	E	F	G	H	I	J	K	N	M
FCK-L-0.15 FCK-$^{M}_{H}$-0.18	58.9	65.2	3.5	50.9	8	1.5	6.3	3	8.7	14.2	6	M10×1	2.4	42.2	13
FCK-L-0.3 FCK-$^{M}_{H}$-0.5	76	84	-	66	10	1.5	8	4	5	16.2	8	M12×1	3.5	61	14
FCK-L-0.4 FCK-$^{M}_{H}$-0.6	80	88	6	70	10	1.5	8	6	11	19.6	10	M14×1.5	3.5	59	17
FCK-□-1	102	117	4.5	90	12	-	15	6	14.5	20	13.5	M16×1.5	5	75.5	19
FCK-□-3	110	127	4	94	16	-	17	8	18	27.7	18	M20×1.5	6	76	24
FCK-□-5	155	173	-	125	30	-	18	10	15	37	22	M25x1.5	8	110	32
FCK-□-8.1	136	156	5	111	25	-	20	10	20	37	24	M27x1.5	8	91	32
FCK-$^{M}_{H}$-20	188	206.5	5	153	35	-	18.5	14	25	41.6	27	M30×1.5	10	128	36
FCK-$^{M}_{H}$-40	235	254.5	5	185	50	-	19.5	15	25	53.1	33	M36x1.5	12	160	46

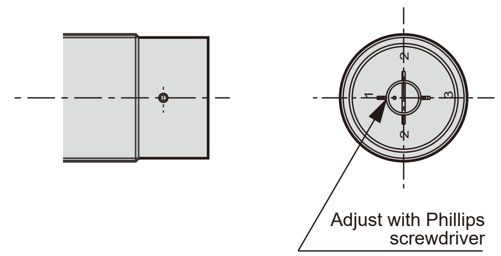
Note: In the table above □ indicates Low speed (L), Medium speed (M), High speed (H).

Dimensional Drawings

● FCK-□-6.5/45/73.5-C



FCK-□-6.5-C
When FCK-$^{M}_{H}$-45-C



Model No.	A	B	ST	D	E	F	G	H	I	J	K	N	M
FCK-□-6.5-C	200.5	–	40	6.5	29	10	15	37	22	M25x1.5	8	110	32
FCK-$^{M}_{H}$-45-C	212.5	–	50	7	19	25	23	66	38	M42×1.5	12	113.5	60
FCK-$^{M}_{H}$-73.5-C	302.5	5	80	15	19	25	28.5	66	38	M42×1.5	12	160	60

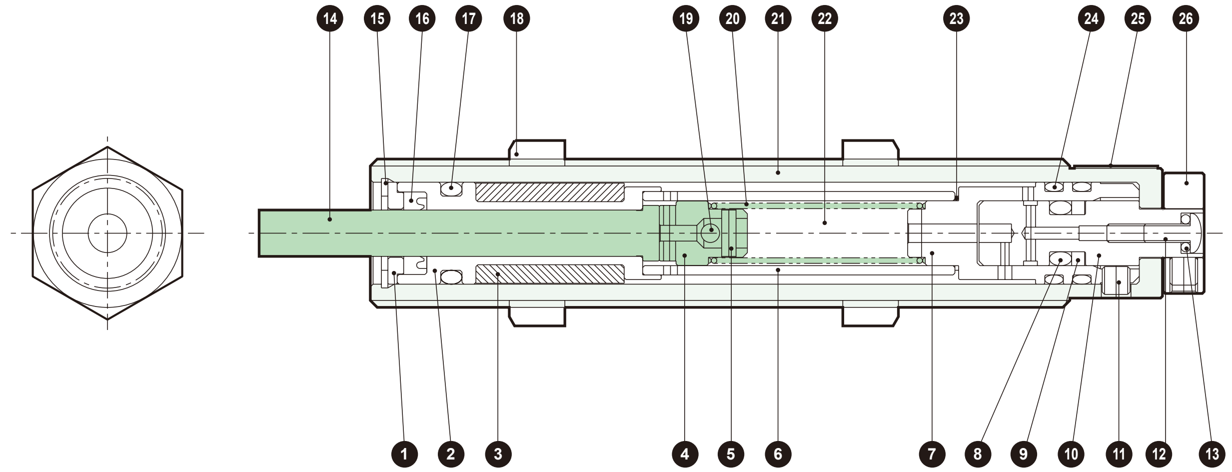
Note: In the table above □ indicates Low speed (L), Medium speed (M), High speed (H).

Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

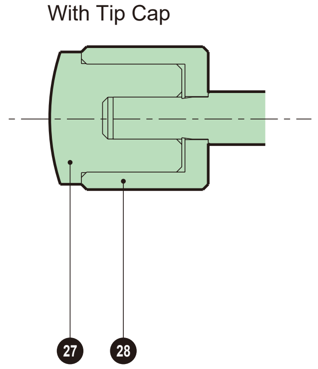
Internal Structure Diagram/Material

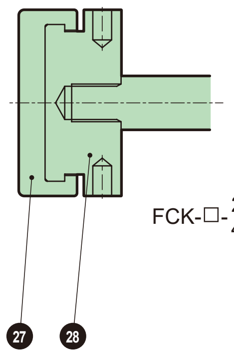
● FCK-□-□

Basic Type (Without Tip Cap)



With Tip Cap





FCK-□-20/40-C

Do not disassemble

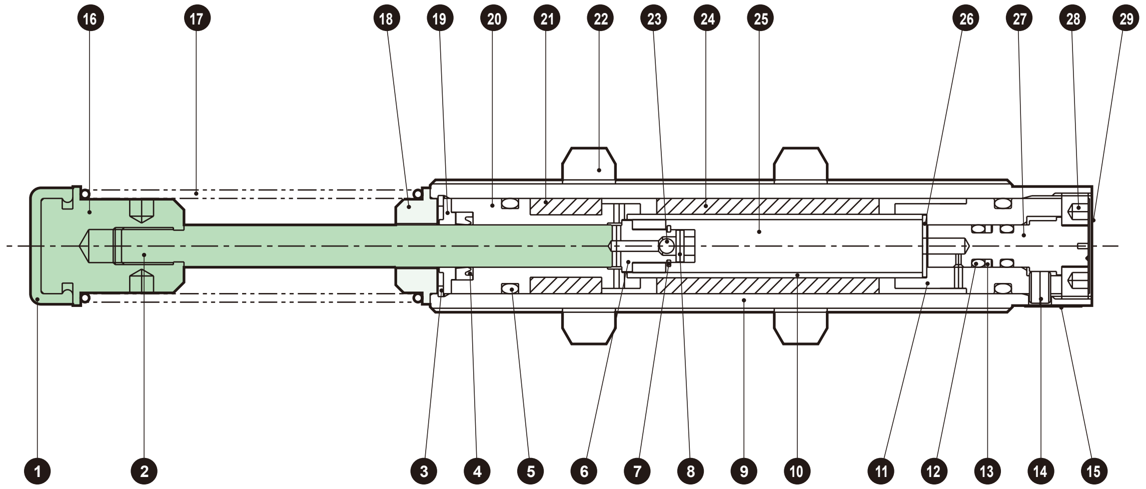
Part No.	Part Name	Material	Part No.	Part Name	Material
1	Packing Retainer	Copper Alloy	15	Retaining Ring	Steel
2	Guide	Copper Alloy	16	U-Packing	Nitrile Rubber
3	Accumulator	Nitrile Rubber	17	O-ring	Nitrile Rubber
4	Piston	Copper Alloy	18	Hexagon Nut	Steel
5	Spring pin	Stainless Steel	19	Steel ball	Bearing Steel
6	Inner Tube	Steel	20	Spring	Piano Wire
7	Bottom	Copper Alloy	21	Outer Tube	Steel
8	O-ring	Nitrile Rubber	22	Oil	Oil
9	Backup Ring	Resin	23	Spacer	Nitrile Rubber
10	Adjusting Shaft	Copper Alloy	24	O-ring	Nitrile Rubber
11	Hexagon Socket Set Screw	Alloy Steel	25	Product Nameplate	
12	Phillips Head Set Screw	Alloy Steel	26	Knob	Copper Alloy
13	O-ring	Nitrile Rubber	27	Rod Cap	Resin *2
14	Piston Rod	Alloy Steel	28	Reinforcing Ring	Steel

*1: Structure varies slightly depending on the model.
*2: Size 20, 40 are Urethane Rubber.

Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

Internal Structure Diagram/Material

● FCK-□-6.5/45/73.5-C (Capped)



Do not disassemble

Part No.	Part Name	Material	Part No.	Part Name	Material
1	Rod Cover	Urethane Rubber (*2)	16	Spring Guide	Steel
2	Piston Rod	Alloy Steel	17	Spring	Piano Wire
3	Retaining Ring (Round R Type)	Steel	18	Spring Guide	Steel
4	U-Packing	Nitrile Rubber	19	Packing Retainer	Copper Alloy
5	O-ring	Nitrile Rubber	20	Guide	Copper Alloy
6	Piston	Copper Alloy	21	Accumulator	Nitrile Rubber
7	Retaining Ring (E-type)	Steel	22	Hexagon Nut	Steel
8	Spring pin	Stainless Steel	23	Steel ball	Bearing Steel
9	Outer Tube	Steel	24	Accumulator	Nitrile Rubber
10	Inner Tube	Steel	25	Oil	Oil
11	Bottom	Copper Alloy	26	Washer	Steel
12	O-ring	Nitrile Rubber	27	Adjusting Shaft	Copper Alloy
13	Backup Ring	Resin	28	Retainer Screw	Steel
14	Hexagon Socket Set Screw	Alloy Steel	29	Adjustment Label	Steel
15	Product Nameplate				

*1: Structure varies slightly depending on the model.
*2: Size 45, 73.5 do not come with a rod cover (resin) cap.

Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

Shock Absorber **FCK Series** Optional Parts

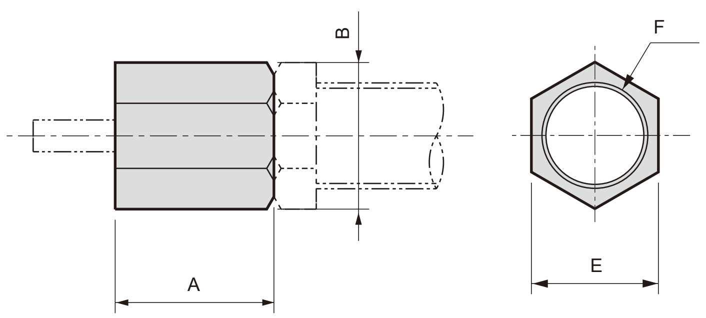
FCK-□-N1, FCK-□-C-N1

(Stopper Nut)

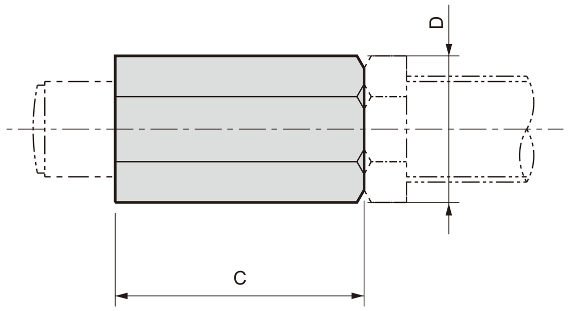
RoHS

Dimensional Drawings

● FCK-□-N1 (standard)
Material: Steel



● FCK-□-C-N1 (capped)
Material: Steel



(For Standard Type)

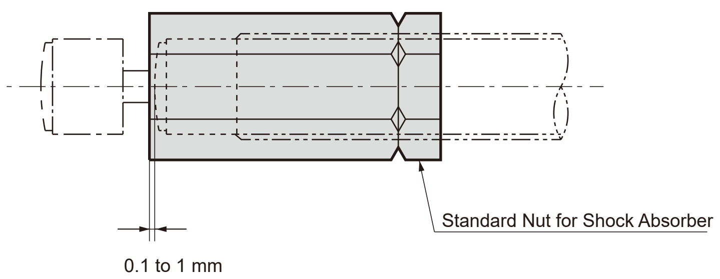
Model No.	Applicable Models	A	B	Weight (g)
FCK-0.18-N1	FCK-L-0.15 FCK-M-0.18 FCK-H-0.18	10	15	5
FCK-0.5-N1	FCK-L-0.3 FCK-M-0.5 FCK-H-0.5	12	16.2	5
FCK-0.6-N1	FCK-L-0.4 FCK-M-0.6 FCK-H-0.6	12	19.6	9
FCK-1-N1	FCK-L-1 FCK-M-1 FCK-H-1	15	21.9	13
FCK-3-N1	FCK-L-3 FCK-M-3 FCK-H-3	30	27.7	43
FCK-5-N1	FCK-L-5 FCK-M-5 FCK-H-5	20	37	62
FCK-8.1-N1	FCK-L-8.1 FCK-M-8.1 FCK-H-8.1	35	37	86
FCK-20-N1	FCK-M-20 FCK-H-20	38	41.6	123
FCK-40-N1	FCK-M-40 FCK-H-40	45	53.1	286

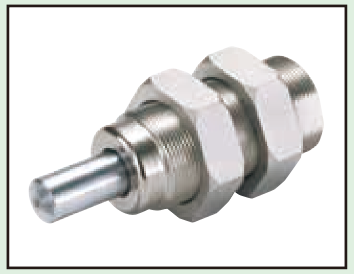
(For Type with Cap)

Model No.	Applicable Models	C	D	E	F	Weight (g)
FCK-0.18-C-N1	FCK-L-0.15-C FCK-M-0.18-C FCK-H-0.18-C	16	15	13	M10×1	8
FCK-0.5-C-N1	FCK-L-0.3-C FCK-M-0.5-C FCK-H-0.5-C	16	16.2	14	M12×1	7
FCK-0.6-C-N1	FCK-L-0.4-C FCK-M-0.6-C FCK-H-0.6-C	20	19.6	17	M14×1.5	15
FCK-1-C-N1	FCK-L-1-C FCK-M-1-C FCK-H-1-C	30	21.9	19	M16×1.5	26
FCK-3-C-N1	FCK-L-3-C FCK-M-3-C FCK-H-3-C	47	27.7	24	M20×1.5	68
FCK-5-C-N1	FCK-L-5-C FCK-M-5-C FCK-H-5-C	32	37	32	M25x1.5	99
FCK-6.5-C-N1	FCK-L-6.5-C FCK-M-6.5-C FCK-H-6.5-C	50	37	32	M25x1.5	154
FCK-8.1-C-N1	FCK-L-8.1-C FCK-M-8.1-C FCK-H-8.1-C	55	37	32	M27x1.5	135
FCK-20-C-N1	FCK-M-20-C FCK-H-20-C	58	41.6	36	M30×1.5	188
FCK-40-C-N1	FCK-M-40-C FCK-H-40-C	65	53.1	46	M36x1.5	413

1 When using a stopper nut, please note the following points.

- For types without cap, attach the stopper nut so that it protrudes 0.1mm to 1 mm outward along the Shock Absorbers rod from the piston body (cylinder top). For capped types, attach the stopper nut so that it protrudes 0.5 mm to 1 mm plus the cap length outward along the Piston Rod from the shock absorber body (cylinder section).
- Fix with the standard nut for Shock Absorbers after installing the stopper nut.
- Cannot be used with a deflection angle adaptor.





Shock Absorber **FCK Series** Optional Parts

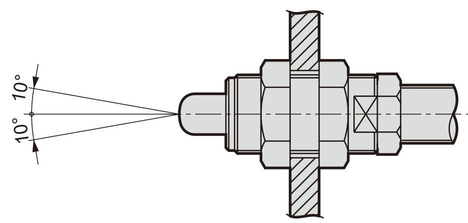
FCK-□-A

(Offset Angle Adapter)

RoHS

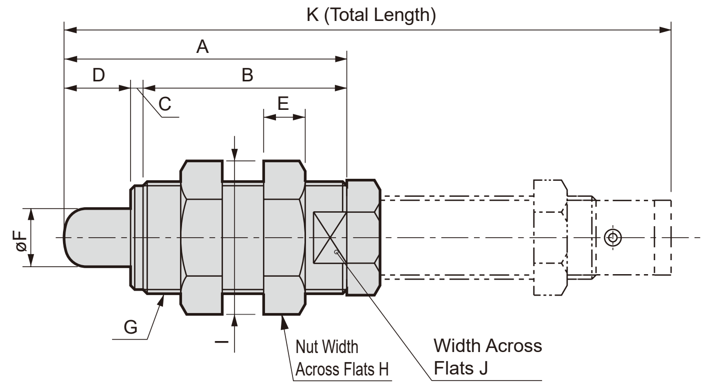
Specifications

Max Operating Offset Angle ±10°



Dimensional Drawings

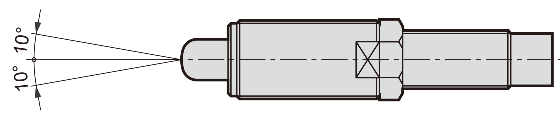
● FCK-□-A



Model No.	Applicable Models	A	B	C	D	E	F	G	H	I	J	K	Tip Part Material	Weight (g)
FCK-0.18-A	FCK-L-0.15 FCK-M-0.18 FCK-H-0.18	38	28	2	8	-	8	M16×1.5	19	20	13	75.7	Polyacetal	37
FCK-0.5-A	FCK-L-0.3 FCK-M-0.5 FCK-H-0.5	48	35	3	10	5	10	M18×1.5	21	24.3	14	97.8	Polyacetal	49
FCK-0.6-A	FCK-L-0.4 FCK-M-0.6 FCK-H-0.6	51	38	3	10	7	11	M22×1.5	24	27.7	19	103	Polyacetal	83
FCK-1-A	FCK-L-1 FCK-M-1 FCK-H-1	60	45	3	12	7	12	M22×1.5	24	27.7	19	129	Polyacetal	81
FCK-3-A	FCK-L-3 FCK-M-3 FCK-H-3	68	49	3	16	10	14	M27x1.5	32	37	24	146	Ferrous	214
FCK-5-A	FCK-L-5 FCK-M-5 FCK-H-5	107.5	67.5	10	30	15	16	M36x1.5	46	53.1	32	212	Ferrous	630
FCK-8.1-A	FCK-L-8.1 FCK-M-8.1 FCK-H-8.1	97	62	10	25	15	16	M36x1.5	46	53.1	32	188	Ferrous	582
FCK-20-A	FCK-M-20 FCK-H-20	127	82	10	35	15	18	M40x1.5	50	57.7	36	255	Ferrous	838
FCK-40-A	FCK-M-40 FCK-H-40	167	107	10	50	15	20	M45×1.5	55	63.5	41	322	Ferrous	1265

1 When using an offset angle adapter, please note the following points.

- Keep the angle within ±10° of the center line of the deflection angle adaptor cap.
- Cannot be used with stopper nut.
- Cannot be used with cap.



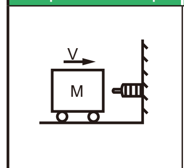
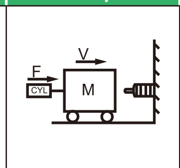
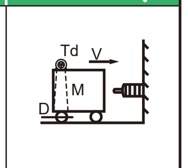
Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

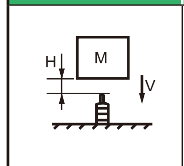
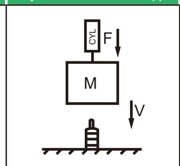
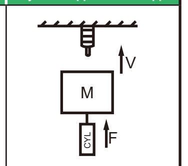
Model Selection Flowchart

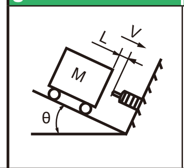
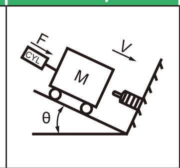
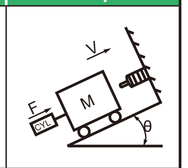
1. Confirmation of Impact Pattern
2. Confirmation of Impact Conditions
3. Determine Kinetic Energy E_1
4. Does thrust/self-weight, etc. act?
   - No. → E = El, Me = M
   - YES → Determine temporary stroke S' from kinetic energy E_1(refer to Figure 1) → Calculate additional energy E2, and determine energy per time $E = E_1+E_2$
5. Select orifice according to speed Vo and energy ratio E_2/ E_1 in Fig.2
6. Temporarily select model
7. Calculate E·Me and Max energy absorption Et per minute from stroke of provisionally selected model
8. Is E·Me within specification range?
   - No. → Recalculate with one size larger model
   - YES
9. Is Et within specification range?
   - No. → Recalculate with one size larger model
   - YES
10. Selection Complete

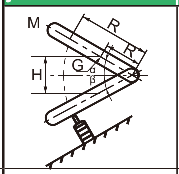
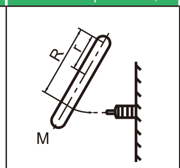
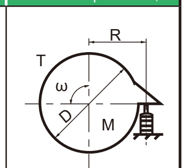
Code	Operating Conditions	Unit
E	Absorption Energy	J
E_1	Kinetic Energy	J
E_2	Thrust/Self-weight Energy	J
G	Center of Gravity Position	
S	FCK Stroke	m
g	Gravitational Acceleration (9.8)	m/s^2
N	Rotations	rpm
Me	Equivalent Weight	kg
Td	Motor Starting Torque	N·m
K	Reduction Ratio	

Impact Pattern Diagram Examples

	Horizontal Impact		
	a. Simple Horizontal Impact	b. When there is cylinder thrust	c. When there is motor driving force
Usage Example			
Kinetic Energy E_1 (J)	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$
Thrust/Self-generated Energy E_2 (J)	――――	$E_2 = F\cdot S$	$E_2=2\cdot\frac{K}{D}\cdot Td\cdot S$
Total Absorption Energy E (J)	$E = E_1$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent Weight Me (kg)	Me = M	$Me=\frac{2\cdot E}{V^2}$	$Me=\frac{2\cdot E}{V^2}$
Absorption Energy per Hour Et (J/h)	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$

	Vertical Impact		
	d. Free Fall	e. Cylinder Lower Limit Stopper	f. Cylinder Upper Limit Stopper
Usage Example			
Kinetic Energy E_1 (J)	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$
Thrust/Self-generated Energy E_2 (J)	$E_2=M\cdot g\cdot S$	$E_2=(M\cdot g+F)\cdot S$	$E_2=(F-M\cdot g)\cdot S$
Total Absorption Energy E (J)	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent Weight Me (kg)	$Me=\frac{2\cdot E}{V^2}(V=\sqrt{2\cdot g\cdot H})$	$Me=\frac{2\cdot E}{V^2}$	$Me=\frac{2\cdot E}{V^2}$
Absorption Energy per Hour Et (J/h)	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$

	Inclined Impact		
	g. Free Fall	h. When there is cylinder thrust	i. When there is cylinder thrust
Usage Example			
Kinetic Energy E_1 (J)	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{1}{2}\cdot M\cdot V^2$
Thrust/Self-generated Energy E_2 (J)	$E_2=M\cdot g\cdot S\cdot\sin\theta$	$E_2=(M\cdot g\cdot\sin\theta+F)\cdot S$	$E_2=(F-M\cdot g\cdot\sin\theta)\cdot S$
Total Absorption Energy E (J)	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent Weight Me (kg)	$Me=\frac{2\cdot E}{V^2}(V=\sqrt{2\cdot g\cdot L\cdot\sin\theta})$	$Me=\frac{2\cdot E}{V^2}$	$Me=\frac{2\cdot E}{V^2}$
Absorption Energy per Hour Et (J/h)	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$

	Oscillating Impact		Rotational Impact
	j. Free Fall	k. When there is torque from motor, etc.	l. When there is torque from motor, etc.
Usage Example			
Kinetic Energy E_1 (J)	$E_1=M\cdot g\cdot H$	$E_1=\frac{J\cdot\omega^2}{2}$ or $\frac{1}{2}\cdot M\cdot V^2$	$E_1=\frac{J\cdot\omega^2}{2}=\frac{M\cdot D^2\cdot\omega^2}{16}$
Thrust/Self-generated Energy E_2 (J)	$E_2=\frac{r}{R}\cdot M\cdot g\cdot S$	$E_2=\frac{T}{R}\cdot S$	$E_2=\frac{T}{R}\cdot S$
Total Absorption Energy E (J)	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent Weight Me (kg)	$Me=\frac{2\cdot E}{V^2}(V=\frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}})$	$Me=\frac{2\cdot E}{V^2}(V=\omega\cdot R)$	$Me=\frac{2\cdot E}{V^2}(V=\omega\cdot R,\omega=\frac{2\pi\cdot N}{60})$
Absorption Energy per Hour Et (J/h)	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$	$E_t=60\cdot E\cdot n$

Shock Absorber Model Selection Guide

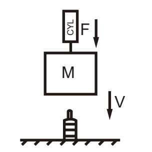
1 Clarify the equipment impact

- Horizontal Motion
  - a. Simple Horizontal Impact
  - b. Collision with cylinder thrust
  - c. Collision with drive force of motor
- Vertical Motion
  - d. Collision due to free fall
  - e. Collision with cylinder thrust (downward)
  - f. Collision with cylinder thrust (upward)
- Inclined Motion
  - g. Collision due to free sliding
  - h. Collision with cylinder thrust (downward)
  - i. Collision with cylinder thrust (upward)
- Oscillating/Rotational Motion
  - j. Collision due to free oscillating fall
  - k. Collision with motor torque, etc., (oscillation)
  - l. Collision with motor torque, etc., (rotation)

*1: Refer to "Impact Pattern Diagram Examples."

Selection Examples

Clarify the equipment impact pattern.

	Vertical Impact e. Cylinder Lower Limit Stopper
Usage Example	
Kinetic Energy E_1 (J)	$E_1=\frac{1}{2}\cdot M\cdot V^2$
Thrust/Gravity Energy E_2 (J)	$E_2=(Mg+F)\cdot S$
Total Absorption Energy E (J)	$E = E_1+E_2$
Equivalent Weight Me (kg)	$Me=\frac{2\cdot E}{V^2}$
Absorption Energy per Hour Et (J/h)	$E_t=60\cdot E\cdot n$

2 Clarify conditions/items necessary for energy calculation

Horizontal Impact

Code	Operating Conditions	Unit
M	Impact Material Weight	kg
V	Collision speed	m/s
F	Pushing Force	N
n	Repetition Frequency	cycles/min
t	Ambient Temperature	°C
RT	Return time	s

Vertical Impact

Code	Operating Conditions	Unit
M	Impact Material Weight	kg
V	Collision speed	m/s
F	Pushing Force	N
n	Repetition Frequency	cycles/min
t	Ambient Temperature	°C
RT	Return time	s
H	Fall Height	m

Inclined Impact

Code	Operating Conditions	Unit
M	Impact Material Weight	kg
V	Collision speed	m/s
F	Pushing Force	N
n	Repetition Frequency	cycles/min
t	Ambient Temperature	°C
RT	Return time	s
L	Impact Object Travel Distance	m
θ	Inclination Angle	deg

Vibrational/Rotational Impact

Code	Operating Conditions	Unit
M	Impact Material Weight	kg
V	Collision speed	m/s
T	Torque	N·m
n	Repetition Frequency	cycles/min
t	Ambient Temperature	°C
RT	Return time	s
ω	Angular Velocity	rad/s
J	Moment of inertia	$kg\cdot m^2$
R	Distance from Center of Rotation to Impact Point	m
r	Distance from Center of Rotation to Center of Gravity	m
α·β	Inclination Angle	deg
H	Fall Height	m
D	Diameter of Rotating Body	m

Colliding object weight : M=15 kg
Colliding speed : V=1.42 m/s
Pushing force : F=245.5 N
Frequency : n=10 cycles/Min
Ambient Temperature : t=23°C
Return time : Rt=2s (time up to re-collision)

3 Calculation of kinetic energy E_1 according to "Impact Pattern Diagram Examples"

- Calculate kinetic energy E_1 according to "Example of colliding pattern" (P. 1422).

$E=\frac{1}{2}M\cdot V^2=\frac{1}{2}\times15\times1.42^2$

$= 15.1$ J

4 Select temporary stroke from temporary selection graph

- Fig. 1 (P. 1425) and select the temporary stroke.

S'=30

Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

5 Calculation of absorption energy E according to "Impact Pattern Diagram Examples"

Selection Examples

- Calculate thrust/self-weight energy E_2 according to "Example of colliding pattern". S (FCK stroke) in the calculation formula is calculated with the temporary stroke S' selected in item 4. Calculate absorption energy E according to "Impact Pattern Diagram Examples."

$E_2 = (M \cdot g+F) \cdot S = (15 \times 9.8 + 245.5) \times 0.03 = 11.8J$

$E=E_1+E_2=15.1+11.8=26.9J$

6 Shock Absorber Temporary Selection

- Select orifice type according to energy ratio (thrust/self-weight energy, kinetic energy) and colliding speed on Fig. 2 (P. 1425) , then select a model provisionally according to calculated absorbed energy E.

*1: Allowable energy absorption may vary depending on colliding speed. Please refer to P. 1426, 1427.

$\frac{E_2}{E_1}=\frac{11.8}{15.1}=0.8$

From models with E=26.9 or more
Temporarily select multi-hole orifice (FCK-H-3)

7 Recalculation of absorption energy E with temporarily set model

- Calculate absorbed energy E_2 according to "Example of colliding pattern". S (FCK stroke) during calculation is calculated with the stroke of the model selected in item 6.

$E_2 = (15\times9.8+245.5) \times 0.016 = 6.28$ J
$E = 15.1+6.28 = 21.4$ J

- Calculate absorption energy E according to "Impact Pattern Diagram Examples."

8 Calculation of Energy per Hour Et

- Calculate energy per hour Et according to "Example of colliding pattern".

$Et = 60\cdot E\cdot n = 60\times21.4\times10 = 1284$ J/h

9 Confirmation of Equivalent Weight M

- Calculate equivalent weight M according to "Example of colliding pattern".

$Me=\frac{2E}{V^2}=\frac{2\times21.4}{1.42^2}=21.2$ kg

10 Selection Confirmation

- If calculated absorbed energy, energy per hour, equivalent weight, frequency of usage, Ambient Temperature and return time are in accordance with specifications of the selected Shock Absorbers, there is no problem. If outside the specification range, select a shock absorber one rank larger than the previously selected model and recalculate.

*1: The specified equivalent weight depends on the speed. For details, refer to P. 1426, 1427.

		Calculated Value	FCK-H-3 Specification Value	Judgment
E	J	21.4	29.4 or less	OK
Et	J/h	1284	20580 or less	OK
Me	kg	21.2	29 or less	OK
n	cycles/min	10	60 or less	OK
t	°C	23	-5 to 70	OK
Rt	S	2	0.5 or more	OK

[Note]
The impact speed used in shock absorber selection calculation is the speed immediately before impact with the shock absorber. It is different from the cylinder average speed (cylinder stroke / travel time) . When performing selection calculation, calculate or actually measure the speed immediately before impact, or use a value 1.5 to 2 times the average speed.

Figure 1. Temporary Selection Graph

Determine temporary stroke S' from kinetic energy E_1.

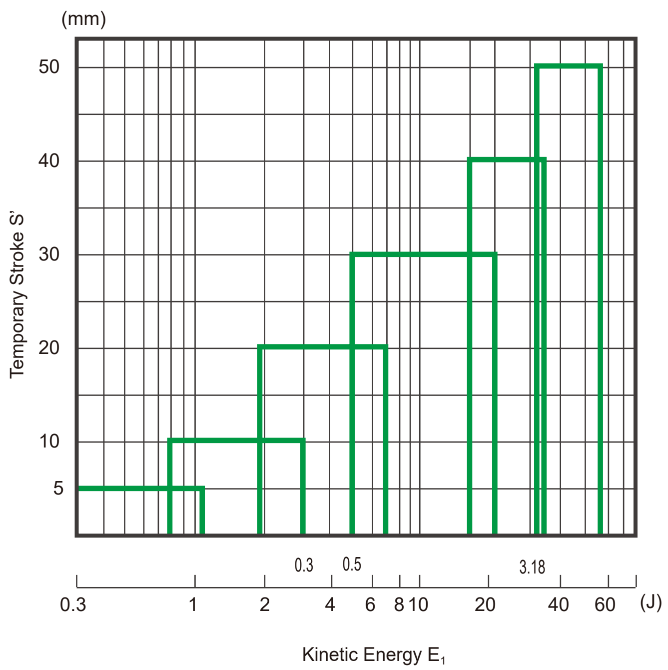
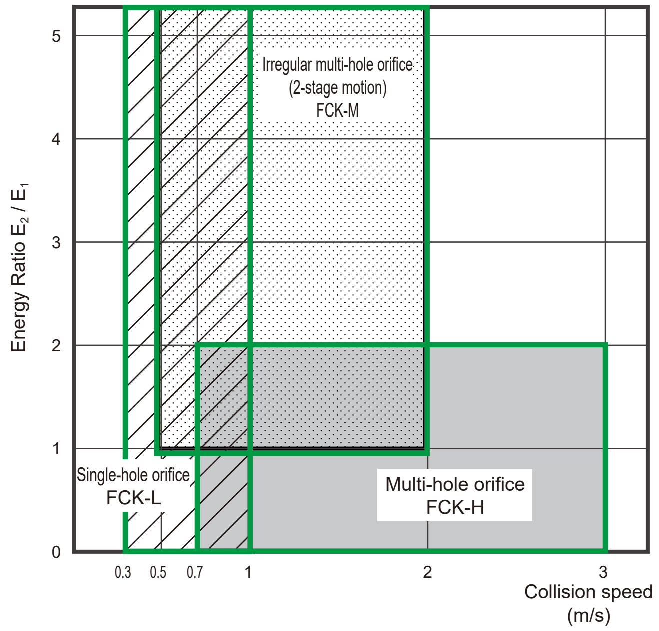
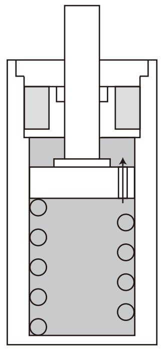
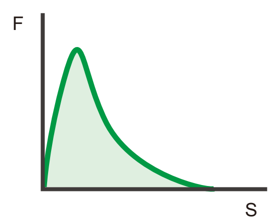
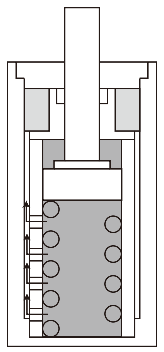
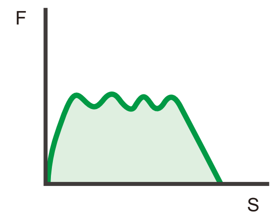
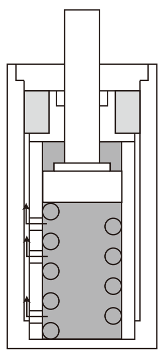
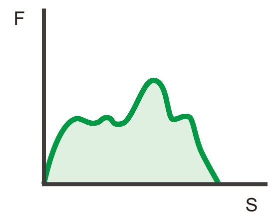


Figure 2. Energy Ratio (Thrust/Self-weight Energy E_2 / Inertial Energy E_1)

Select orifice type from this figure



Absorption Characteristic Structure

Constant Orifice	Single-hole Orifice Structure	FCK-L		Single-hole orifice structures include a dashpot structure utilizing the clearance between the piston and cylinder tube, a single tube structure with an orifice in the piston, and a double tube type single-hole orifice structure (adjustable type) , all of which exhibit similar resistance force characteristics. Here, the single tube structure will be explained as a representative. It is structured so that a piston slides inside an oil-filled cylinder tube, and a single-hole orifice is provided in the piston. Since the orifice area is constant over the entire stroke, the absorption characteristic is such that the resistance force immediately after impact is large, and as the stroke progresses and the speed decreases, the resistance force also decreases, as shown in the right figure.	
Displacement-dependent Orifice	Multi-hole Orifice Structure	FCK-H		It has a double structure of an outer tube and an inner tube, and the piston slides on the inner wall of the inner tube. This inner tube is provided with multiple orifices along the stroke direction. As the stroke progresses and the speed decreases, the orifice area decreases stepwise, so the resistance force fluctuates in a ripple pattern, but the Max resistance force can be kept low. Also, it is easy to match the absorption characteristics to individual impact conditions by designing the orifice.	
	Multi-hole Irregular Orifice Structure	FCK-M		Structurally, it is basically the same as the multi-hole orifice above, but by changing the orifice, energy absorption according to the purpose can be performed instead of constant damping force. For example, the orifice adopted in the FCK-M series is designed to absorb kinetic energy in the first half of the stroke and perform speed control in the latter half. Therefore, it ideally absorbs energy against cylinder thrust.	

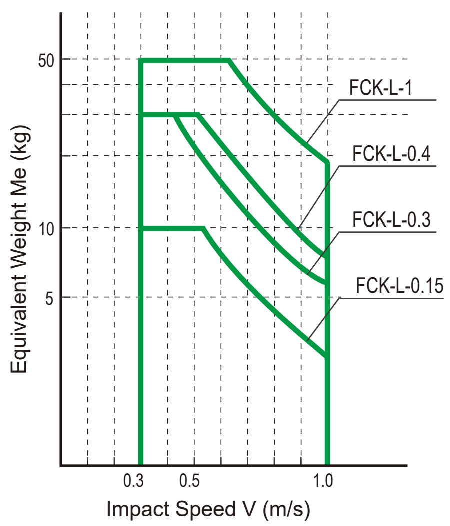
Equivalent Weight/Impact Speed Characteristic Graph

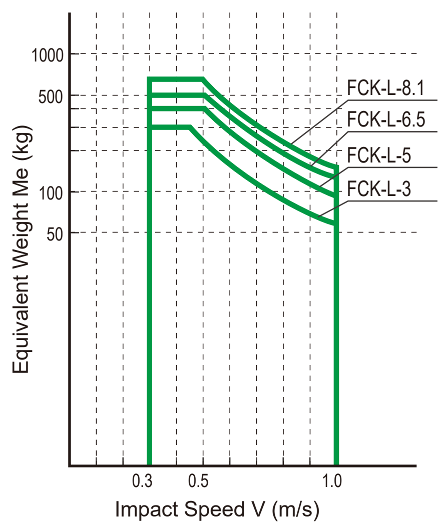
Equivalent Weight:
Weight converted by assuming all cylinder thrust and weight weight as inertial energy.

$\frac{1}{2}MV^2+F \cdot S=E=MeV^2$

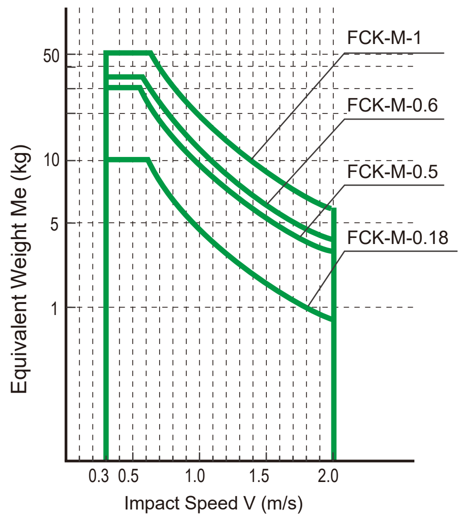
M: Impact Material Weight
F: Cylinder thrust or weight self-weight
Me Equivalent Weight

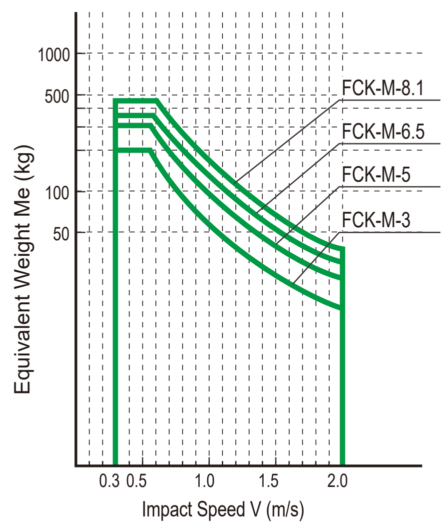
Single-hole Orifice (FCK-L)

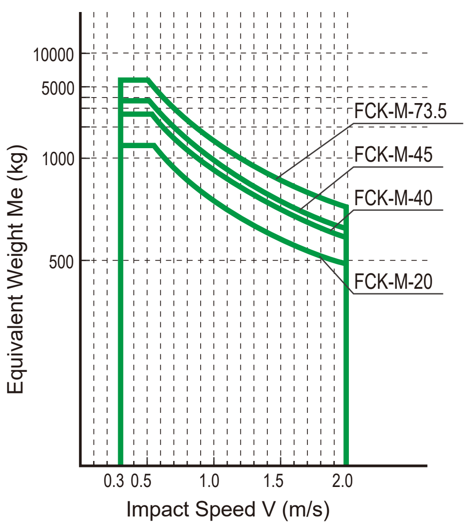




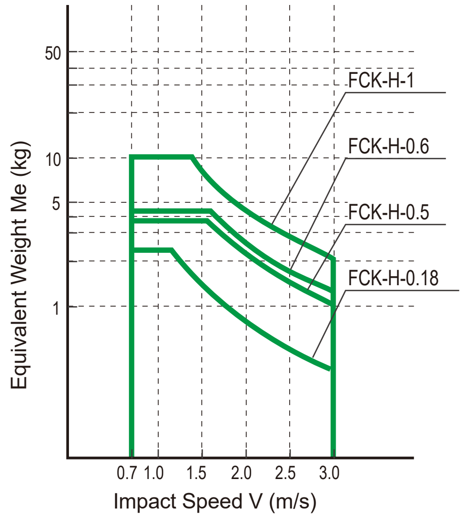
Multi-hole Irregular Orifice (FCK-M)

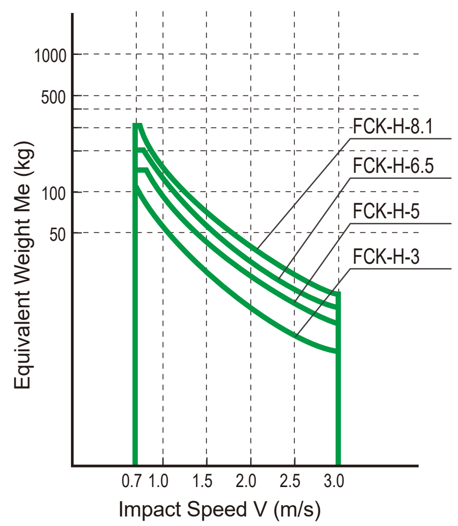


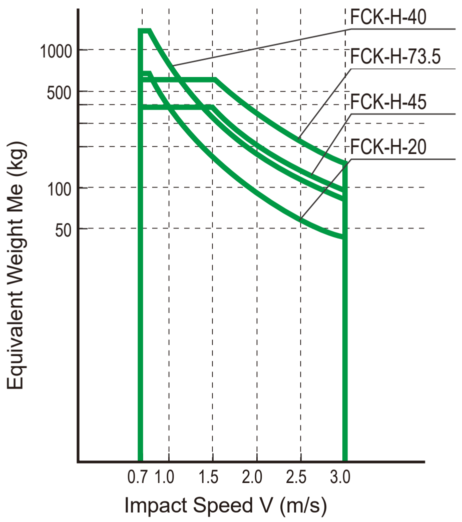




Multi-hole Orifice (FCK-H)

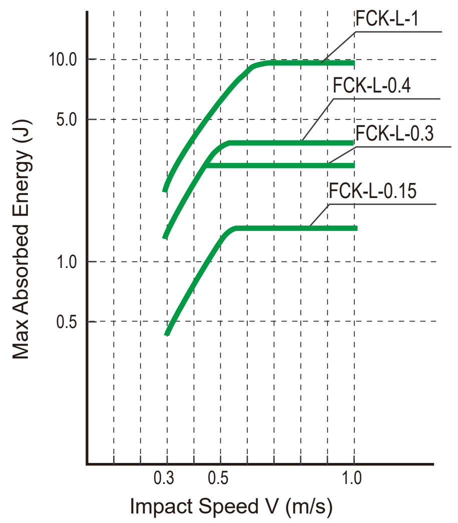


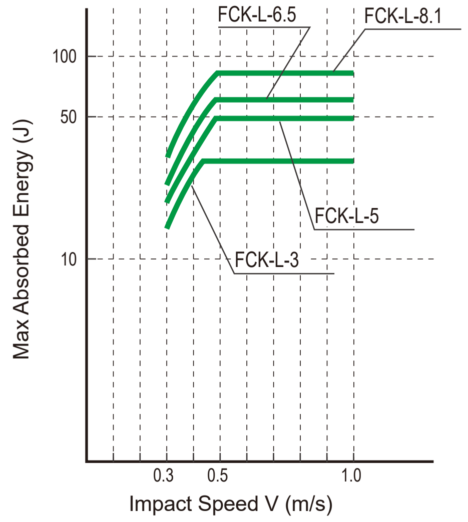




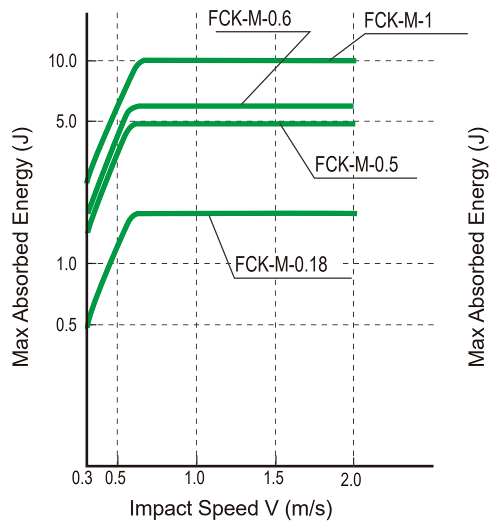
Absorption Energy/Impact Speed Characteristic Graph

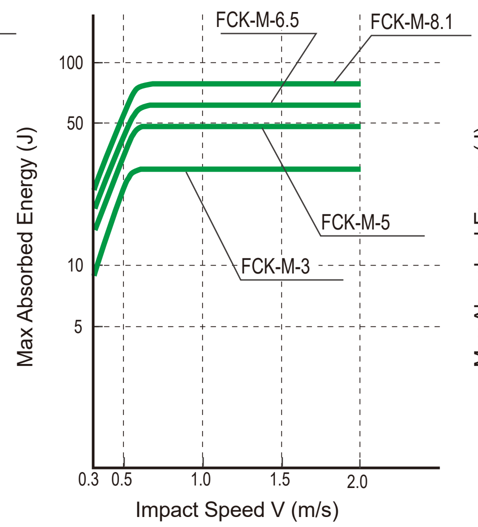
Single-hole Orifice (FCK-L)

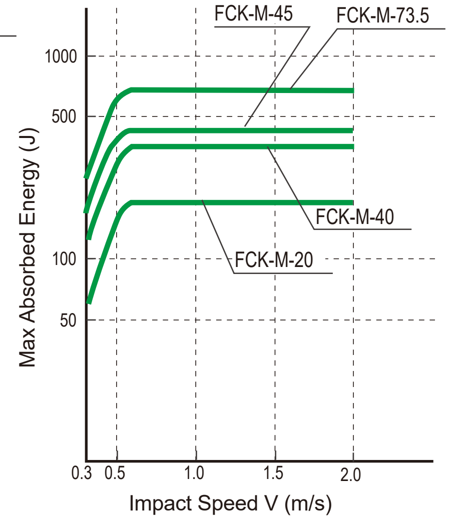




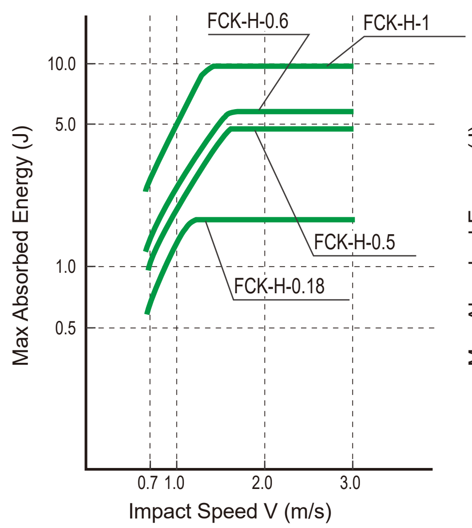
Multi-hole Irregular Orifice (FCK-M)

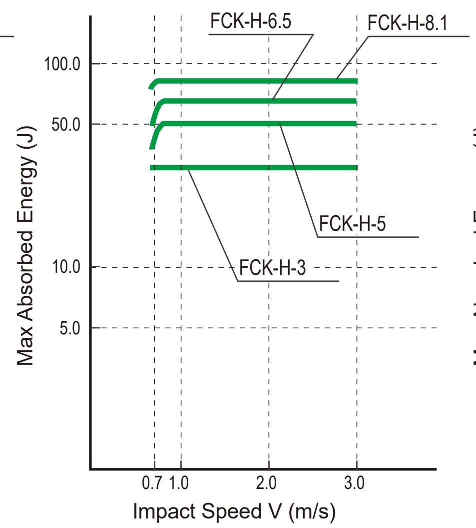


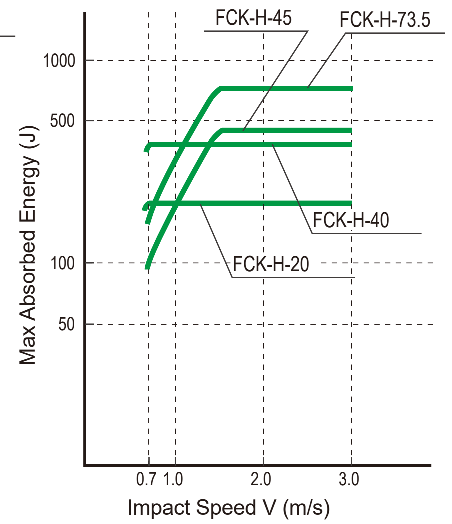




Multi-hole Orifice (FCK-H)

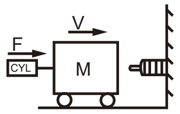
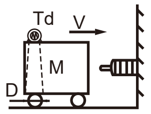
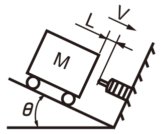
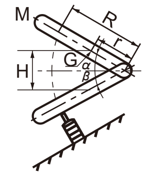






Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

Selection Calculation Example

	Selection Example 1	Selection Example 2	Selection Example 3	Selection Example 4
1. Applications	Horizontal impact with cylinder thrust  Cylinder Bore = ø40 Pressure = 0.5 MPa	Horizontal impact with motor driving force  Motor Starting Torque Td = 0.196 N·m Cart Wheel Diameter D = 50 mm Cart Reduction Ratio K = 10	Cart falling down a slope  L = 1 m θ = 2°	Object undergoing rotational free fall  α = 15° β = 5°
2. Colliding conditions	M = 30 kg V = 0.6 m/s F = 628.3 N $(F=\frac{\pi}{4}\times40^2\times0.5=628.4\ N)$ n = 20 cycles/min t = 23°C Rt=3S	M = 150 kg V = 0.785 m/s F = 78.4 N $(F=2\cdot\frac{K}{D}\cdot Td=2\times\frac{10}{0.05}\times0.196=78.4\ N)$ n = 5 cycles/min t = 23°C Rt=2S	M = 100 kg V = 0.83 m/s $(V=\sqrt{2\cdot g\cdot L\cdot \sin\theta}=\sqrt{2\times9.8\times1\times\sin2°}=0.83\ m/s)$ n = 10 cycles/min t = 23°C Rt=5S	M = 2 kg R = 0.5 m H = 0.1 m r = 0.3 m $(V=\frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}}=\frac{0.5}{0.3}\sqrt{\frac{3\times9.8\times0.1}{2}}=2.02\ m/s)$ n = 50 cycles/min t = 20°C Rt=0.6S
3.Kinetic energy E_1	$E_1=\frac{1}{2}MV^2=\frac{1}{2}\times30\times0.6^2=5.4J$	$E_1=\frac{1}{2}MV^2=\frac{1}{2}\times150\times0.785^2=46.2J$	$E_1=\frac{1}{2}\cdot M\cdot V^2=\frac{1}{2}\times100\times0.83^2=34.4\ J$	$E_1=M\cdot g\cdot H=2\times9.8\times0.1=1.96\ J$
4. Temporary stroke S'	From Figure 1, S' = 20 mm	From Figure 1, S' = 50 mm	From Figure 1, S' = 50 mm	From Figure 1, S' = 10 mm
5. Thrust/self-weight energy E_2 Absorbed energy E	$E_2=F\cdot S=628.3\times0.02=12.57\ J$ $E=E_1+E_2=5.4+12.57=17.97\ J$	$E_2=2\cdot\frac{K}{D}\cdot Td\cdot S=2\times\frac{10}{0.05}\times0.196\times0.05$ $=3.92\ J$ $E=E_1+E_2=46.2+3.92=50.12\ J$	$E_2=M\cdot g\cdot S\cdot\sin\theta=100\times9.8\times0.05\times\sin2°=1.71\ J$ $E=E_1+E_2=34.4+1.71=36.1\ J$	$E_2=\frac{r}{R}\cdot M\cdot g\cdot S\cdot\cos\beta=\frac{r}{R}\times2\times9.8\times0.01\times\cos5°C=0.11\ J$ $E=E_1+E_2=1.96+0.11=2.07J$
6. Temporary selection	$\frac{E_2}{E_1}=\frac{12.57}{5.4}=2.3$ Temporarily select multi-hole irregular orifice (FCK-M-3)	$\frac{E_2}{E_1}=\frac{3.92}{46.2}=0.08$ Temporarily select multi-hole orifice (FCK-H-6.5)	$\frac{E_2}{E_1}=\frac{1.71}{34.4}=0.05$ Temporarily select multi-hole orifice (FCK-H-5)	$\frac{E_2}{E_1}=\frac{0.11}{1.96}=0.06$ Temporarily select multi-hole orifice (FCK-H-0.5)
7. Recalculation of absorbed energy	$E_2=F\cdot S=628.3\times0.016=10.05\ J$ $E=E_1+E_2=15.45\ J$	$E_2=2\cdot\frac{K}{D}\cdot Td\cdot S=2\times\frac{10}{0.05}\times0.196\times0.04$ $=3.14\ J$ $E=E_1+E_2=49.34\ J$	$E_2=M\cdot g\cdot S\cdot\sin\theta=100\times9.8\times0.03\times\sin2°=1.03\ J$ $E=E_1+E_2=35.4\ J$	$E_2=\frac{r}{R}\cdot M\cdot g\cdot S\cdot\cos\beta=0.11J$ $E=E_1+E_2=1.96+0.11=2.07J$
8. Energy per hour Et	Et = 60·E·n = 60×15.45×20 = 18540 J/h	Et = 60×E·n = 60×49.34×5 = 14802 J/h	Et = 60·E·n = 60×35.4×10 = 21240 J/h	Et = 60·E·n = 60×2.07×50 = 6210 J/h
9. Equivalent weight Me	$Me=\frac{2E}{V^2}=85.8\ kg$	$Me=\frac{2E}{V^2}=\frac{2\times49.34}{0.785^2}=160\ kg$	$Me=\frac{2E}{V^2}=\frac{2\times35.4}{0.83^2}=102.7\ kg$	$Me=\frac{2E}{V^2}=\frac{2\times2.07}{2.02^2}=1.0\ kg$
10. Confirmation	E, Et, Me, n, t, Rt all OK Decided on FCK-M-3	E, Et, Me, n, t, Rt all OK Decided on FCK-H-6.5	E, Et, Me, n, t, Rt all OK Decided on FCK-H-5	E, Me, n, t, Rt are OK. However, since Et is over, recalculate with one size larger FCK-H-0.6.

Related Equipment
SKL
NCK
SCK
FCK
FJ
FK
Cylinder Switch
Ending

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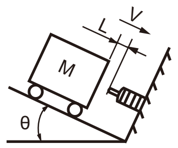
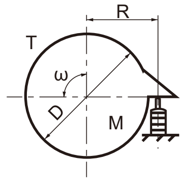
Selection Example 5	Selection Example 6
Object rolling down a slope  L = 0.45 m θ = 5°	Horizontal rotational impact with torque applied 
M = 1.0 kg V = 0.88 m/s (V = $\sqrt{2 \cdot g \cdot L \cdot \sin\theta} = \sqrt{2 \times 9.8 \times 0.45 \times \sin 5^\circ}$ = 0.88 m/s) n = 15 cycles/min t = 23°C Rt=2S	J=204.1 kgm² ω = 0.6 rad/s R = 1.25 m n = 10 cycles/min T = 68.6 N·m t = 20°C Rt = 3s
$E_1 = \frac{1}{2} \cdot M \cdot V^2 = \frac{1}{2} \times 1.0 \times 0.88^2 = 0.387$ J	$E_1 = \frac{J \cdot \omega^2}{2} = \frac{204.1 \times 0.6^2}{2} = 36.7$ J
From Figure 1, S' = 5 mm	From Figure 1, S' = 50 mm
$E_2 = M \cdot g \cdot S \cdot \sin\theta = 1 \times 9.8 \times 0.005 \times \sin 5^\circ = 0.004$ J $E = E_1 + E_2 = 0.387 + 0.004 = 0.391$ J	$E_2 = \frac{T}{R} \cdot S = \frac{68.6}{1.25} \times 0.05 = 2.74$ J $E = E_1 + E_2 = 36.7 + 2.74 = 39.44$ J
$\frac{E_2}{E_1} = \frac{0.004}{0.387} = 0.01$ Temporarily select single-hole orifice (FCK-L-0.15)	$\frac{E_2}{E_1} = \frac{2.74}{36.7} = 0.07$ V = ω·R = 0.6×1.25 = 0.75 m/s Temporarily select multi-hole orifice (FCK-H-5)
$E_2 = M \cdot g \cdot S \cdot \sin\theta = 1 \times 9.8 \times 0.008 \times \sin 5^\circ = 0.007$ J $E = E_1 + E_2 = 0.394$ J	$E_2 = \frac{T}{R} \cdot S = \frac{68.6}{1.25} \times 0.03 = 1.65$ J $E = E_1 + E_2 = 38.6$ J
Et = 60·E·n = 60×0.394×15 = 354.6 J/h	Et = 60·E·n = 60×38.6×10 = 23160 J/h
$Me = \frac{2E}{V^2} = \frac{2 \times 0.394}{0.88^2} = 1.02$ kg	$Me = \frac{2E}{V^2} = \frac{2 \times 38.6}{0.75^2} = 137.2$ kg
E, Et, Me, n, t, Rt all OK Decided on FCK-L-0.15	E, Et, Me, n, t, Rt are OK. Decided on FCK-H-5.

MEMO

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