HRN

Series

Hydraulic HI-Rotor

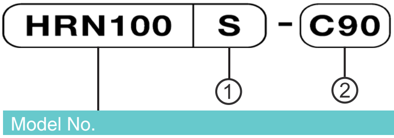
HRN Series

Hydraulic HI-Rotor with cushion

Single vane

HRN10S-C (Port size Rc⅛)
HRN15S-C (Port size Rc⅛)
HRN20S-C (Port size Rc⅛)
HRN30S-C (Port size Rc⅛)
HRN100S-C (Port size Rc¼)
HRN200S-C (Port size Rc⅜)
HRN400S-C (Port size Rc⅜)
HRN700S-C (Port size Rc½)

Representation



Model No.

HRN10 HRN20 HRN100 HRN400
HRN15 HRN30 HRN200 HRN700

① Vane type

S: Single vane

② Cushion

C90: Oscillation angle 90° with cushion
C180: Oscillation angle 180° with cushion

Specificiations

Model No.	Port size	Max. oscillation angle degree	Rated Pressure MPa[kgf/cm^2]	Min. operated pressure MPa[kgf/cm^2]	Proof pressure MPa[kgf/cm^2]	Internal volume cc	Fluid temperature °C	Internal leakage cc/min (at 40°C)	Mass kg	Allowable load Radial	Allowable load Thrust
HRN10S-C	Rc⅛	180^{+3}_{0}	7(70)	1(10)	10.5(105)	6.5	0~60	10	1.2	9.8(1)	4.9(0.5)
		90^{+3}_{0}				3.3					
HRN15S-C		180^{+3}_{0}				11		15	2.4	19.6(2)	9.8(1)
		90^{+3}_{0}				5.5					
HRN20S-C		180^{+3}_{0}				16		20	3.3	49.0(5)	24.5(2.5)
		90^{+3}_{0}				8					
HRN30S-C		180^{+3}_{0}				34		30	4.7	78.4(8)	39.2(4)
		90^{+3}_{0}				17			4.8		
HRN100S-C	Rc¼	180^{+3}_{0}				74		50	13.5	147(15)	68.6(7)
		90^{+3}_{0}				37			13.8		
HRN200S-C	Rc⅜	180^{+3}_{0}				147		100	25.7	294(30)	137.2(14)
		90^{+3}_{0}				73.5			26.4		
HRN400S-C		180^{+3}_{0}				290		100	34	343(35)	166.6(17)
		90^{+3}_{0}				145			35		
HRN700S-C	Rc½	180^{+3}_{0}				520		100	44	343(35)	166.6(17)
		90^{+3}_{0}				260			46		

Cushion Specifications

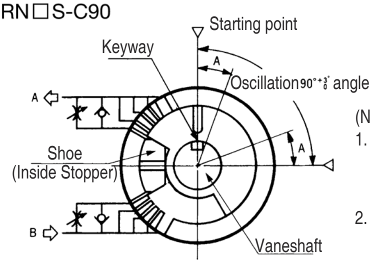
Model No.	Max. inertia moment kg·m[kgf·m·s^2]	Max. inrush angular velocity rad/s(degree/s)	Cushion angle rad	Max. absorbed energy J(kgf·m)					
				Operating pressure MPa(kgf/cm^2)					
				1.96(20)	2.94(30)	3.92(40)	4.90(50)	5.88(60)	6.86(70)
HRN10S-C	0.098(1x10^{-2})	10.4720(600)	0.3491(20)	2.06(0.21)	1.76(0.18)	1.47(0.15)	1.18(0.12)	0.88(0.09)	0.59(0.06)
HRN15S-C	0.196(2x10^{-2})		0.4363(25)	4.80(0.49)	4.12(0.42)	3.43(0.35)	2.74(0.28)	2.06(0.21)	1.37(0.14)
HRN20S-C	0.294(3x10^{-2})			7.55(0.77)	6.47(0.66)	5.39(0.55)	4.31(0.44)	3.23(0.33)	2.16(0.22)
HRN30S-C	0.588(6x10^{-2})			15.09(1.54)	12.94(1.32)	10.78(1.10)	8.62(0.88)	6.47(0.66)	4.31(0.44)
HRN100S-C	1.47(15x10^{-2})	8.7266(500)		30.87(3.15)	26.46(2.70)	22.05(2.25)	17.64(1.80)	13.23(1.35)	8.82(0.90)
HRN200S-C	3.92(40x10^{-2})	6.9813(400)		78.89(8.05)	67.62(6.90)	56.35(5.75)	45.08(4.60)	33.81(3.45)	22.54(2.30)
HRN400S-C	6.86(70x10^{-2})	5.2360(300)		137.20(14.00)	117.60(12.00)	98.00(10.00)	78.40(8.00)	58.80(6.00)	39.20(4.00)
HRN700S-C	13.72(140x10^{-2})	4.3633(250)		250.39(25.55)	214.62(21.90)	178.85(18.25)	143.08(14.60)	107.31(10.95)	71.54(7.30)

Note: Operating the product at working pressure of more than 1.96MPa is recommended; in consideration of torque efficiency, if operating the product at less than 1.96MPa from necessity, the maximum absorbing energy will be the same as at 1.96MPa.

⚠ Please equip a shock-absorbing mechanism outside of HI-ROTOR when the inertia energy by load exceeds allowable inertia energy after taken the inertia energy absorbed by cushion inside HI-ROTOR into consideration, so that the vaneshaft and cushion can be protected from damaging and product's usage life may be prolonged as the inertia energy would be absorbed and reduced to the level within allowable inertia energy range.

Oscillation starting point

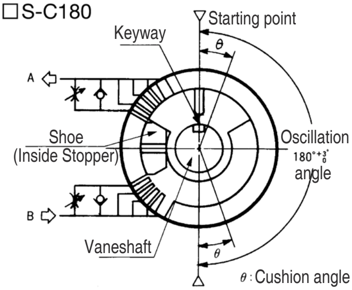
HRN□S-C90



(Note)
1. Figures show stroke end position with B port pressurized.

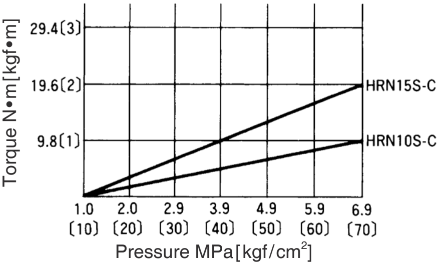
2. It is a view from shaft-with-key side.

HRN□S-C180

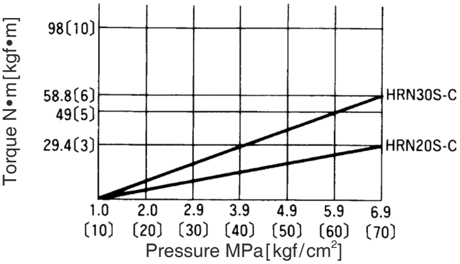


Output (Effective torque)

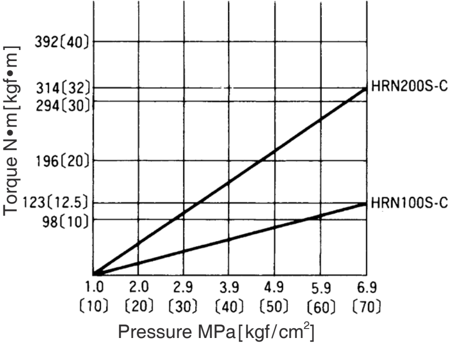
HRN10, 15S-C



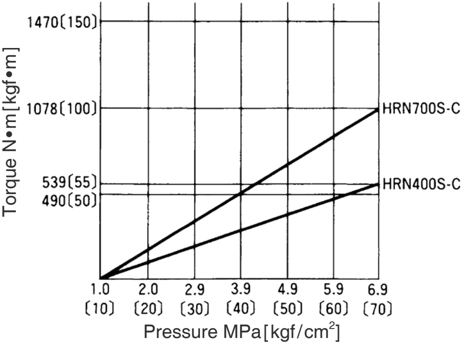
HRN20, 30S-C



HRN100, 200S-C



HRN400, 700S-C



Allowable inertia energy for HI-ROTOR shaft

Model No.	Allowable energy J[kgf·m]
HRN10S-C	0.013[1.3×10^{-3}]
HRN15S-C	0.025[2.6×10^{-3}]
HRN20S-C	0.046[4.7×10^{-3}]
HRN30S-C	0.088[9.0×10^{-3}]
HRN100S-C	0.255[26×10^{-3}]
HRN200S-C	0.510[52×10^{-3}]
HRN400S-C	0.755[77×10^{-3}]
HRN700S-C	0.911[93×10^{-3}]

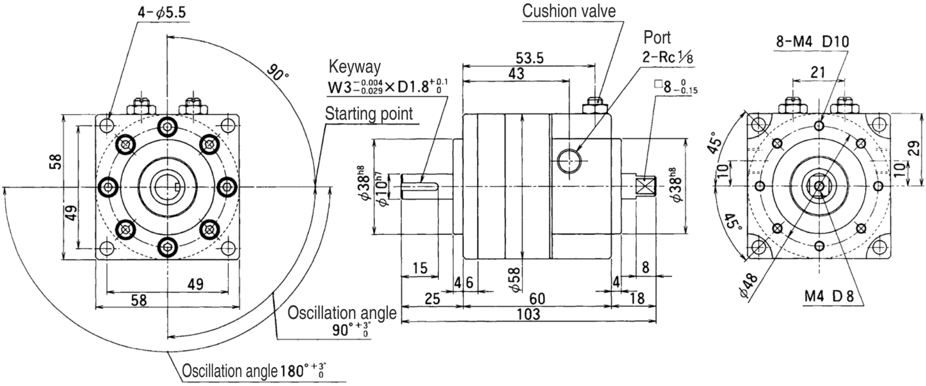
Note: When the load was installed on the side of shaft-with-key, the allowable inertia energy shown in the above table is applicable.

Oscillating angle before cushion process

Model No.	Oscillation angle rad (degree)	
	90°	180°
HRN10S-C	1.2217(70)	2.7925(160)
HRN15S-C	1.1345(65)	2.7053(155)
HRN20S-C		
HRN30S-C		
HRN100S-C		
HRN200S-C		
HRN400S-C		
HRN700S-C		

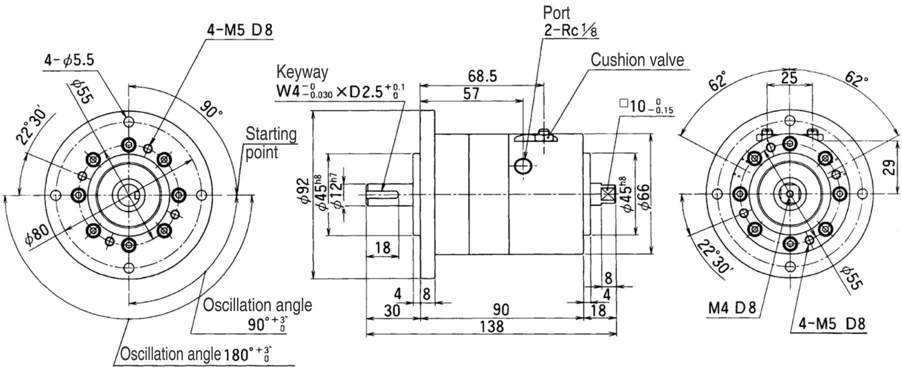
HRN10S-C

(Unit : mm)



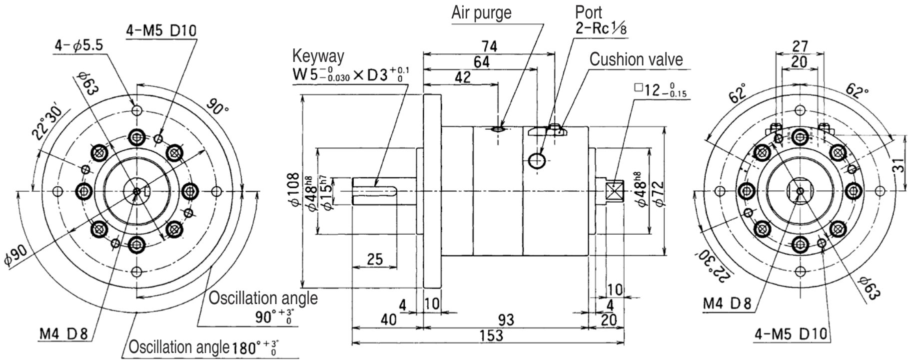
HRN15S-C

(Unit : mm)



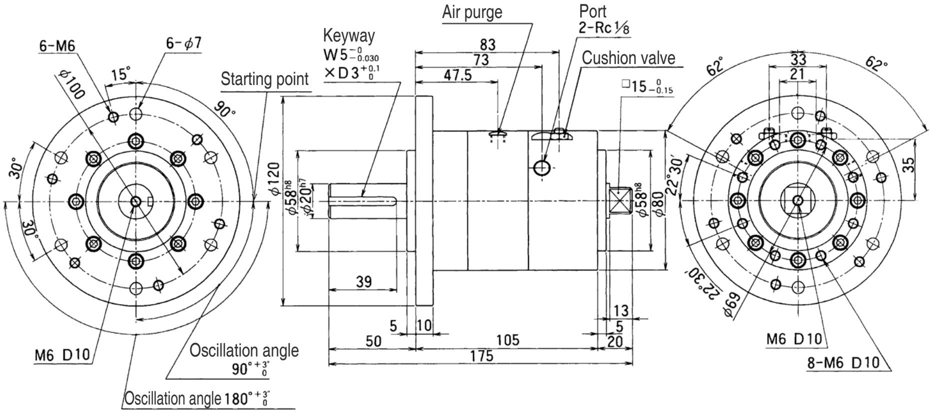
HRN20S-C

(Unit: mm)



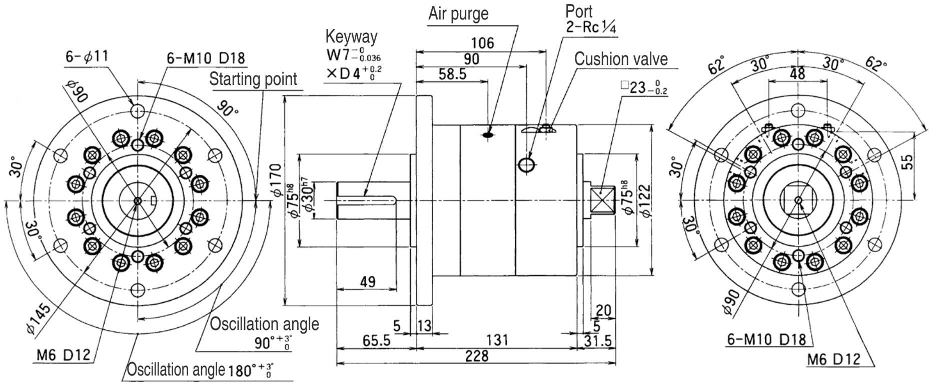
HRN30S-C

(Unit: mm)



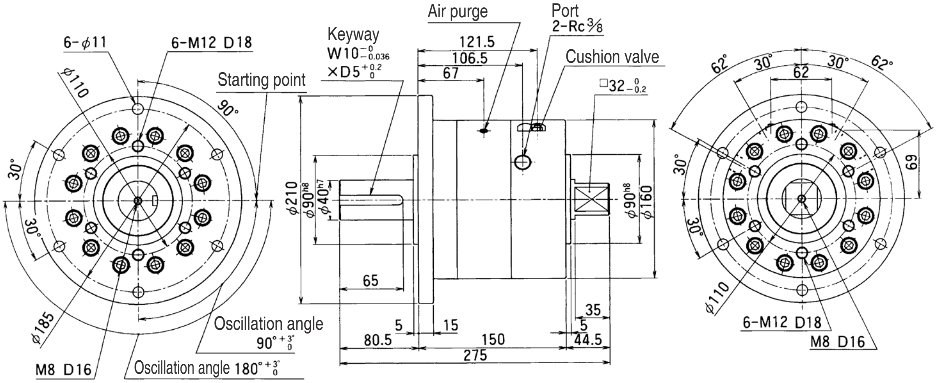
HRN100S-C

(Unit : mm)



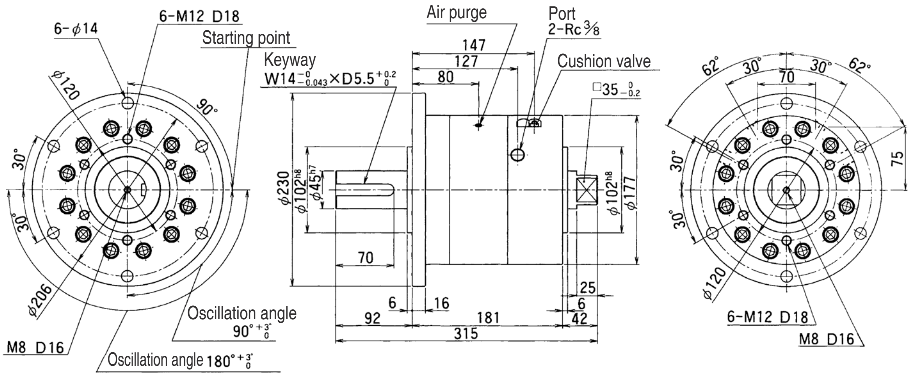
HRN200S-C

(Unit : mm)



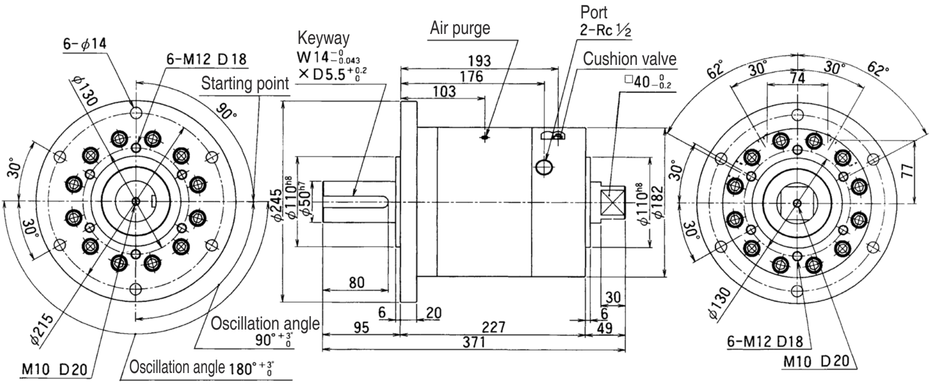
HRN400S-C

(Unit : mm)



HRN700S-C

(Unit : mm)

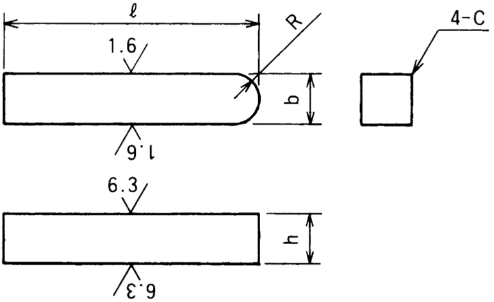


Key for hydraulic Hi-rotor

Hi-rotors with keyways are accompanied by the following keys, respectively.

Hydraulic Hi-rotor	Model No.	Quantity
		With cushion
HRN10	3×3×15	1
HRN15	4×4×18	1
HRN20	5×5×25	1
HRN30	5×5×39	1
HRN100	7×7×49	1
HRN200	10×8×65	1
HRN400	14×9×70	1
HRN700	14×9×80	1

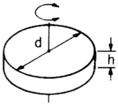
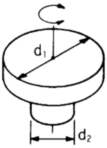
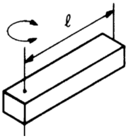
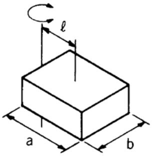
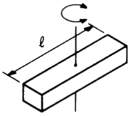
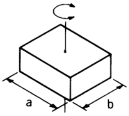
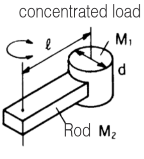
JIS B 1301 Parallel key b×h×ℓ, one end rounded S45C



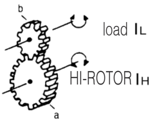
(Unit : mm)

Model No.	b	h	ℓ	C	R
3×3×15	$3^{\,0}_{-0.05}$	$3^{\,0}_{-0.025}$	$15^{\,0}_{-0.18}$	0.16～0.25	1.5
4×4×18	$4^{\,0}_{-0.03}$	$4^{\,0}_{-0.03}$	$18^{\,0}_{-0.18}$	0.16～0.25	2
5×5×25	$5^{\,0}_{-0.03}$	$5^{\,0}_{-0.03}$	$25^{\,0}_{-0.21}$	0.25～0.40	2.5
5×5×39	$5^{\,0}_{-0.03}$	$5^{\,0}_{-0.03}$	$39^{\,0}_{-0.25}$	0.25～0.40	2.5
7×7×49	$7^{\,0}_{-0.036}$	$7^{\,0}_{-0.036}$	$49^{\,0}_{-0.025}$	0.25～0.40	3.5
10×8×65	$10^{\,0}_{-0.036}$	$8^{\,0}_{-0.09}$	$65^{\,0}_{-0.3}$	0.4～0.6	5
14×9×70	$14^{\,0}_{-0.043}$	$9^{\,0}_{-0.09}$	$70^{\,0}_{-0.3}$	0.4～0.6	7
14×9×80	$14^{\,0}_{-0.043}$	$9^{\,0}_{-0.09}$	$80^{\,0}_{-0.3}$	0.4～0.6	7

Calculating moment of inertia

Shape	Sketch	Necessary information	Moment of inertia I (kg · m^2)	Radius of gyration K_1^2	Note
Disk		• Diameter: d(m) • Weight: M(kg)	$I=M\cdot\frac{d^2}{8}$	$\frac{d^2}{8}$	
Stopped disk		• Diameter: d_1(m) d_2(m) • Weight: Portion d_1 M_1(kg) Portion d_2 M_2(kg)	$I=M_1\cdot\frac{d_1^2}{8}+M_2\cdot\frac{d_2^2}{8}$	—	When d_2 is greatly smaller than d_1, it can then be neglected.
Rod (Center of gyration is located at the end)		• Rod length: ℓ(m) • Weight: M(kg)	$I=M\cdot\frac{\ell^2}{3}$	$\frac{\ell^2}{3}$	When the width is greater than 30% of the length, calculate the moment of inertia as if it is a rectangular cuboid.
Rectangular cuboid		• Length: a(m) b(m) • Distance to the center of gravity Weight : M(kg)	$I=M\cdot\left[\ell^2+\frac{(a^2+b^2)}{12}\right]$	$\ell^2+\frac{(a^2+b^2)}{12}$	
Rod (Center of gyration is located at the center)		• Rod length: ℓ(m) • Weight: M(kg)	$I=M\cdot\frac{\ell^2}{12}$	$\frac{\ell^2}{12}$	When the width is greater than 30% of the length, calculate the moment of inertia as if it is a rectangular cuboid.
Rectangular cuboid		• Length: a(m) b(m) • Weight: M(kg)	$I=M\cdot\frac{(a^2+b^2)}{12}$	$\frac{(a^2+b^2)}{12}$	
Concentrated load		• Shape of the concentrated load: Disk • Disk diameter: d(m) • Rod length: ℓ(m) • Weight of the concentrated load: M_1(kg) • Rod weight: M_2(kg)	$I=M_1\cdot\ell^2+M_1\cdot K_1^2+M_2\cdot\frac{\ell^2}{3}$	K_1^2 (Please refer to other above-mentioned shapes, $K_1^2=\frac{d^2}{8}$)	When M_2 is greatly smaller than M_1, it can be neglected and plug in as 0 in calculation.

How to convert load inertia to gear applications

Gear		• Gear HI-ROTOR side: a Load side: b • Load inertia: I_L(kg · m^2)	Load inertia of the HI-ROTOR shaft $I_H=(\frac{a}{b})^2 I_L$	—	When the shape of the gear is large, moment of inertia of the gear should also be considered.

Select hydraulic Hi-rotor

Step 1: Selecting a size

When only static force such as clamping is required

1. Determine working pressure P(MPa)
2. Determine required force F(N)
3. Determine rod length from Hi-rotor. L(m)

→

Calculate required torque
$T_S = F \times L$ (N·m)

→

Determine the size of Hi-rotor which satisfies $T_S <= T_H$ by referring to the output torque table.

T_H: Effective torque of Hi-rotor

When moving a load

Resistance load

When external force such as frictional force, gravity, etc.is applied:

1. Determine working pressure P (MPa)
2. Determine required force F_R(N)
3. Determine rod length from Hi-rotor. L (m)

→

Calculating resistance torque
$T_R = K \times F_R \times L$ (N·m)
K: Safety factor
When there is load variation
K = 2
When there is no load variation
K = 3
When there is load variation, assume K<3 that angular velocity will have a huge change.

↓

Required torque
$T = T_R + T_A$

→

Determine the size of Hi-rotor which satisfies $T <= T_H$ by referring to the output torque table.
T_H: Effective torque of Hi-rotor.

↑

Inertial load

When rotating an object:

1. Determine oscillating angle, oscillating time and working pressure.

oscillating angle	θ (rad)
oscillating time	t (s)
working pressure	P (MPa)
	90° = 1.5708rad
	180° = 3.1416rad
	270° = 4.7124rad

2. Calculate the moment of inertia of the load by its shape and weight. Calculation formula may be referred to the table of moment of inertia.

   I (kg·m^2)

3. Calculate average angular acceleration,

$$\alpha = \frac{\theta}{t^2} (\mathrm{rad/s^2})$$

θ = oscillating angle.
t = oscillating time .

Note: For hydraulic Hi-rotor with cushion, use angle(θ_C) up to the cushioning process as oscillating angle(θ), and use time(t_C) up to the cushioning angle as oscillating time t.
$\theta_C = \theta - A$
θ : Oscillating angle
A: Cushion angle

→

Calculating accelerating torque
$T_A = 5 \times I \times \alpha$ (N·m)
T_A: Torque required to accelerate inertial load up to certain speed

Select hydraulic Hi-rotor

Step 2: Checking allowable energy

The load inertial energy should be less than the allowable energy of Hi-rotor in case of load inertia.

1. Calculate mean angular acceleration.

$\omega=\theta/t$ (rad/s)

θ: oscillating angle (rad)
t: oscillating time (s)

2. Calculate collision angular velocity

$\omega_0=1.2\omega$ (rad/s)

3. Calculate inertial energy of load

$E=1/2\,I\omega_0^2$ (J)   I: Inertial moment of load   ($kg\cdot m^2$)

4. Assure that inertial energy E of load is less than allowable energy for Hi-rotor. Select a larger size of Hi-rotor or use an external shock-absorbing device if allowable energy is exceeded.

Step 3: Checking allowable energy (WHEN cushion is provided)

1. Based on the shape of load and its weight to calculate its moment of inertia, confirm whether it is within allowable load range.

$I \leqq I_{max}$ I ($kg\cdot m^2$)

2. Please assure that collision angular velocity should be less than the maximum collision angular velocity when rushing into collision.

$\omega = \dfrac{\theta_C}{t_C}$
$\omega_0 \fallingdotseq 1.2\omega$
$\omega_0 \leqq \omega_{max}$

θ_C: Angle made to reach cushion process (degree)
t_C : Time required to reach cushion process (s)
ω : Mean angular velocity (angle/s)
ω_0: collision angular velocity (angle/s)

3. Calculate collision energy from moment of inertia of load and collision angular velocity. (Convert degree/s into rad/s.)

$E_1=1/2\,I\omega_0^2$ (J)

I: Inertial moment of load ($kg\cdot m^2$)
ω_0: collision angular velocity (rad/s) 1° = 0.0174rad

4. Calculate energy caused by external force applied during cushion stroke.

$E_2 = (M_g+M_f)A$ (J) E_2: Energy by external force

M_g: Gravitational moment by unbalanced load
M_g: $L\times F_g$ (N·m) F_g: Force by load gravity (N)
When moving on unbalanced load or horizontal plane, set as follows: $M_g=0$

M_f: Moment generated by other thrust force (for example, when cylinder force acts.)
M_f: $L\times F_f$ (N·m) F_f: Thrust force (N)
When there is no other thrust force, set as follows: $M_f=0$

A : Cushion angle (rad)

5. Check that E1+E2 is less than the maximum absorbable energy.

6. If all of the above-mentioned criteria is matched, the process of selection is complete. If any of the above-mentioned condition is observed, please do not use the items. Consult FONTAL to select a correct model.

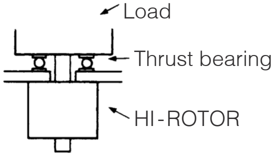
⚠ HANDLING PRECAUTIONS

When using hydraulic equipment, be sure to obey “General Rules for Hydraulic Systems” JIS B8361-1982(ISO4413) before use. Also, read the following precautions carefully before use.

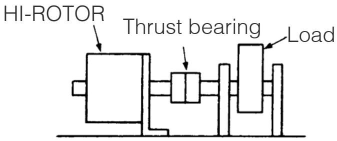
Mounting a load

- Equip the load onto the shaft-with-key side. If the load is intended to be equipped onto the shaft-with-square side, please consult FONTAL first.
  The following examples are shown in the case that load are equipped on the shaft-with-key side.

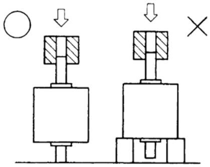
- Mount a load with its thrust load not directly applied to the shaft of HI-ROTOR to avoid malfunction caused by water freezing (lowest allowable temperature is -5 degree).



- Mount a load with its bending load indirectly applied to the shaft of HI-ROTOR. In an unavoidable case, build a mechanism to allow only rotating force to be transmitted as shown in the figure below.



- When connecting a load or coupling to the shaft, doing so in such as manner that the force is not applied to the body is shown as in the figure below.



- If the loading inertia energy exceeds allowable inertia energy, equipments may be damaged as the internal stopper cannot absorb excessive energy.
  Please equip a shock-absorbing mechanism, hydraulic HI-ROTOR with cushion for examples, outside of HI-ROTOR when the inertia energy by load exceeds allowable inertia energy, so that product's usage life may be prolonged and stability may be assured as the inertia energy would be absorbed and reduced to the level within allowable inertia energy range.

Stopper

- Stopper cannot endure severe collision over a long-period of time. It can only absorb limited energy or endure collision with low-speed. It cannot be used as a shock-absorbing mechanism.

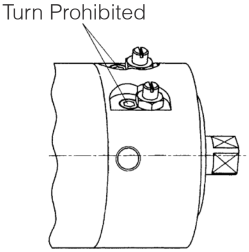
- When the inertia energy by load exceeds allowable range, pleaes have an outside stopper or a shock-absorber in place.

Adjusting the cushion valve

- Adjust the cushion according to operating conditions as follows
  1. Loosen the lock nut.
  2. Adjust the cushion while opening the tightened cushion valve gradually.
  3. after completion of adjustment, fix the lock nut.

- Turning the screw set below the cushion valve is prohibited as doing so may result in oil leak which may cause personal casualties or product damages.

Stopping halfway



- Internal leak may occur in hydraulic HI-ROTOR. Therefore, HI-ROTOR cannot be stopped halfway by it self.

- To stop HI-ROTOR halfway continuously for long period of time, simply install an external stopper.

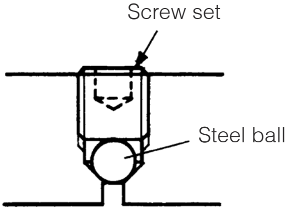
Air purge

- When mounting HI-ROTOR or operating it after out of service for long time, please confirm whether residual air is depleted and cleared.

- Incomplete air purge may cause a maifuntion. Set HI-ROTOR with the airvent coming the most upward.

- Purge air collected in the pipe as wall as HI-ROTOR.
  (How to purge air)
  When air is collected in HI-ROTOR, loosen the screw sets with pressure supplied. A mixture of air and oil flows out from the slit between the screw and body. Tighten the screw set when there is only oil flowing out. In addition, conduct this air removal process for both ports A and B. Slowly turn the set screw 1 or 2 revolutions. If it is excessively loosened,it may come off causing hazardous situation with oil projecting out.

- HRN10S-C, HRN15S-C in need of removing redundant air, please slowly turn the fittings on port A or B as they do not have air vent.



- After air removal is completed, operate at low pressure first, and then gradually raise to operating pressure to prevent hazards.

Piping

- Flush thoroughly inside of the pipes and tubes to clean out cuttings, coolant, dust, etc., and use care to prevent foreign matters from entering which may cause malfunctions.

Hydraulic oil

- Hydraulic oil of VG32~56, ISO, mineral oil are recommended in order to protect seal materials of NBR and the body from rust. Consult FONTAL beforehand if water base type hydraulic fluid or fire-resistant hydraulic fluid (phosphate esters hydraulic fluid and chlorinated hydrocarbons hydraulic fluid) shall be used.

Operating tempurature

- Use the hydraulic oil within the temperature shown in the specifications. If operating outside of the allowable temperature range, damage of seals malfunction may occur.

Maintenance

- When you encounter any problem in doing maintenance, please consult FONTAL directly. Never disassemble the product to avoid product damages and hazardous situations.

- Hydraulic HI-ROTOR is intended for use in general machinery and equipment. When using it for medical equipment, plants, nuclear power plant and related, be sure to consult FONTAL beforehand.