Synchronized SYNCHRO-CYLINDER
SGB series

COSMIC INDUSTRY CO., LTD.
SYNCHRO-CYLINDER Working in Full-synchronized Motion

The SGB Series Synchro-cylinder is an epoch-making linear driving actuator which enables the high-speed synchronized operation and has a wide variety in the choice of driving source. This Synchro-cylinder is an extremely simple and high-efficiency full-closed mechanical linear actuator with a construction incorporating high-precision uni-flex type bevel gear, ball screws, inner tubes, etc. Plural number of cylinders can be synchronized perfectly by linking the input shaft with them via the linking rods.

Ball Screw

The photo shows various kinds of the large size ball screws manufactured by our company. Ball screws of up to the maximum Φ 200 mm in dia. and 8000 mm in length are available as options.

Advantages

1. Full-synchronization
   Since the cylinders are linked mechanically by plural number of the cylinder input shafts, full synchronized operation is realized.

2. Tilting
   In this Synchro-cylinder, the input shaft and the trunnion bearing are connected coaxially.
   Moreover, it has such a unique construction that the transmission input shaft does not move even when the cylinder is tilted around the trunnion shaft.

3. High-speed and heavy duty operation are possible.
   The ball screw and bevel gear enable the cylinder to be operated at high speed ranging normally from 150 mm/sec. to 200 mm/sec. The speed can be set in a wide range, slow to super-high.
4. High efficiency and low cost
Owing to the combination of the ball screw and bevel gear, an extremely high linear motion conversion rate of 85% has been attained. The Synchro-cylinder has the efficiency two times higher than that of hydraulic cylinder and three to four times higher than that of worm jack. For this reason, the motor capacity is reduced to 1/3 and also the cost for equipment is reduced accordingly.

5. Wide-ranged motor selection
Every type of motors with reduction gears, such as motors with cyclo-reduction gears, worm gears, etc. can be used for the prime mover. Besides, other rotary driving sources such as DC motor, variable speed motor, etc. can be also used. A brake must be equipped because of this high efficiency cylinder.

6. Load holding
By use of a motor with brake, the load is held at any desired position on the stroke.

7. Compact, full-closed and strong
The Synchro-cylinder is made compact and straight in its shape. Besides, it, being of full-closed type, endures well for the use in severe environment such as in the out door or in the vicinity of steel mill machine, etc. Ductile cast iron is used for the main frame.

8. Easy-to-control and least noises
Link motion of several cylinders by only one motor dispenses with any control device for synchronized operation. The sequence is simple and sure because only one motor is required.

9. Easy maintenance and long service life
The part of the ball screw is maintained easily. Its simple rolling friction removes worry about wear, and the employment of ball screw ensures an extremely long service life of the cylinder free from troubles such as oil leak caused by hydraulic cylinder.
Applications of synchro-cylinder

Horizontal motion

Fig. 5

Positioning device for thick steel plate in steel mill.
One DC motor is used for the speed control. 24 sets of Synchro-cylinders are operated by link motion.

Fig. 6

Roll rearrangement device in rolling mill in steel mill
Thrust power: 30 ton, Stroke: 500 mm

Fig. 7
3 sets of Synchro cylinders are linked. They perform a swing motion. We also manufacture a special reducer for the driving unit.

The cylinder can be tilted around the trunnion shaft.

Tilting the base for welding a cylindrical tank  Thrust power: 20 ton. Stroke: 2,500 mm
Fig. 11

Up-down motion

Fig. 12

For opening/closing water gate

Fig. 13

For lifting the working cart in steel mill
Thrust power: 50 ton × 2, Stroke: 1,500 mm
For lifter of theater stage
Thrust power: 5 ton, Stroke: 100 mm
2 sets of cylinders are linked. This linking method is effective for keeping a position and accurate stopping.

Steel mill machinery: Conveyor and walking beam driving unit
Thrust power: 100 ton, Stroke: 1,300 mm, Motor: 110 kW
This equipment is for an extremely heavy duty of 24-hour continuous reciprocating operation. Oil bath is used for lubrication.

Steel mill machinery: Conveyor and lifter
Thrust power: 30 ton, Stroke: 1,500 mm, Motor: 37 kW
The equipment in the photo is a conveyor in seamless steel pipe arranging line. It is of heavy-duty type for 24-hour continuous operation. Oil bath is used for lubrication.
Model Selection Procedure

1. Obtain the required thrust power per cylinder, according to the nature of load (See Formula 3 and 1 in page 9).
2. Provisionally select a model being in the range of tolerable load, by referring to the Table on synchro-cylinder Tolerable Thrust. (See Table 1 in page 7)
3. By referring to the diagram on the expected life span, correct the provisionally selected model to the model which satisfies the expected service life. (See Fig. 18 in page 8)
4. In case of compressive load, make correction according to the Table on Tolerable Backing Load. (See Fig. 22 in page 10)
5. Select a model which satisfies all the conditions as above.

Speed

In the SGB Series Synchro-cylinders, the operating speed can be selected according to its application. The table at the right shows the tolerable load/speed values for each model, and the maximum tolerable speeds are shown in the column of specifications. Use your cylinder within the tolerable ranges.

Cylinder may be operated at a speed higher than the values in the table depending on the condition. In this case, please contact us for consultation.

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Table 1
Service Life

When operating the Synchro-cylinder at high speed and high frequency, examine the service life of the ball screw to be used. The service life is represented by the travelling distance of the ball screw.

- **Formula to obtain service life**
  \[
  L_t = t \left[ \frac{C_a}{F_a \cdot f_w} \right] \quad \ldots \ldots (1)
  \]
  
  \( L_t \): Life span by travelling distance (km)
  \( t \): Load of screw (mm)
  \( C_a \): Dynamic load capacity of screw (kg)
  \( F_a \): Load (kg)
  \( f_w \): Load factor

  *Values of "t" and "C_a" are determined by the frame number of the cylinder body.

- **Load**
  
  If the load fluctuates, for example, the load varies in the course of reciprocation (advance and retraction), use the following formula
  \[
  F_a = F_{\min} + \frac{2F_{\max}}{3} \quad \ldots \ldots (2)
  \]

- **Load factor**
  
  In normal operation without impact
  \( f_w = 1.0 \sim 1.2 \)
  
  In operation accompanying severe impact and vibration
  \( f_w = 1.5 \sim 2 \)

- **Load/Service life diagram**
  
  The diagram below the reciprocal lifting (ascend/descent) load and the life span by travelling distance. This diagram is plotted taking into consideration not only the strength of the ball screw but also that of the frame. Also, the diagram shows the load of reciprocation. Therefore, if the load varies between advance and retraction the service life is prolonged over the results obtained by the formula (1) and (2).

![Load/Service life diagram](chart)

  \( f_w \) in this diagram is assumed to be \( f_w = 1 \)

Life span by travelling distance

Overload Countermeasure

This cylinder is not equipped with any overload protective mechanism. If the limit switch provided at the stroke end fails to work, or if one of the cylinders being in link motion has been locked, the maximum torque (about three times the rated torque) of the motor and the rotary inertia of the motor will work simultaneously and abruptly, which may give damage to the cylinder.

When operating plural cylinders in link motion, do adjustment so that all load is not concentrated on one cylinder.

It is effective to provide a torque limiter coupling or flexible coupling with the motor output shaft.

Torque setting values:
- Horizontal drive: About 150% of the necessary torque
- Up and down drive: About 200% of the necessary torque
Linked Operation

Effectiveness of the Synchro-cylinder consists in the link motion. Set up the layout with reference to the figures below.

**Straight Type**

Motor with brake

Torque or flex coupling

Coupling

Power transmission shaft

Fig. 19

**Balanced Type**

Motor with brake

Double shaft reduction gears (Miter gear box)

Coupling

Coupling

Motor with brake

*This type is effective particularly when linking a large number or cylinders.

Fig. 20

**Square Type**

Miter gear box

Coupling

Miter gear box

Torque or flex coupling

Motor with brake

*This type is convenient for lifting carts. 4 cylinders are to be linked.

Fig. 21

**Link motion factor**

When the number of linked cylinders is increased, overload is concentrated on one of the cylinders if the linked cylinders have been locked on the way. Particularly, load is applied to the input shaft near the motor. To prevent this, take the link motion factor into consideration when linking a large number of cylinders.

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Table 2

**Use factor**

Refer to the use factors below and select a value suitable to the nature of load.

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<td>Uniform motion</td>
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Table 3

**Load factor**

Refer to the load factor as below.

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<th>Load condition</th>
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Table 4

Obtain the rated thrust power per cylinder in the above values of factor.

(Formula, ball screw service life and cylinder buckling load)

Load on ball screw/cyl. = Load/cyl. × Link motion factor

(Formula, Synchro-cylinder tolerable thrust power)

Thrust power for one cyl. = Load on one cyl. × Link motion factor × Use factor × Load factor

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9
Load

Make allowance for the working load including the peak load.
- Make the allowance more than 20% of the max. peak load in case of fluctuated load.
- The right diagram shows the relationship between the cylinder stroke length and the tolerable load per length cylinder. In case of suspension load, the buckling load may not be taken into consideration.
- If bending load is applied from outside direction, consider the safety factor proportional to the degree of the load. For further information, please contact us.

Selection of Driving Source

The driving source can be selected freely. For example, reduction motors, DC motor, cyclo motor, pole-change motor, etc. However, since the Synchro cylinder is an extremely high efficient cylinder, be sure to provide a electric brake. Otherwise, the motor will be rotated reversely by heavy load. Use a brake having 150% or more braking torque and short time lag to activate.
Braking time lag may vary depending on the control system.
(Reference)
Simultaneous cutting off method ...... About 0.2~0.8 sec.
Individual cutting off method ...... About 0.2 sec. or less.
If the motor having unnecessarily large capacity is used, overload will work as large inertia when the cylinder has been locked on the way. Be sure to use a motor with the optimum capacity.

- Determination of motor capacity

\[ P = \frac{F_a + V}{102 \cdot \eta} \]  \hspace{1cm} (5)

\[ P \] : Motor capacity [kw] \hspace{0.5cm} \[ F_a \] : Load [ton]
\[ \eta \] : Total efficiency (Total efficiency includes those of cylinder and coupling, power transmission bearing, reduction gears. Link motion factor may be excluded therefrom.) The factor is assumed to be 0.85 for single unit of cylinder.

Positioning and Stroke Allowance

- Be sure to provide a stroke allowance at both ends. The stroke indicated in the model name is the maximum mechanical stroke. In the actual use, provide an enough allowance including the overrun distance after braking.
The overrun distance varies depending on the time lag of braking, load condition, speed, etc. Review it case by case.
- In case of the high-speed operation at 100 mm/sec. or faster, it is recommended to provide the 2-stage limit switches for normal restriction of the stroke and for ultimate safety.
- As an optional accessory, an integrated external limit switch is available.
Specifications

- **Standard specifications**
  - **Installation place**: w/o/bellows — General plant indoor and less dusty place.
    w/bellows — Outdoor and dusty place.
  - **Speed**: Max speed 100 ~ 150 mm/sec.
  - **Ambient temperature**: -15°C ~ 50°C
  - **Lubrication**: Grease supply
  - **Paint color**: Munsel 2.5GB/2

- **Special specifications**
  - **Installation place**: For the installation in corrosive environment, we can manufacture the Synchro-cylinder coated with epoxy-based paint.
  - **Speed**: When an oil bath is used, it is possible to operate the cylinder at a speed higher than the standard speed.
  - **Ambient temperature**: When low-temperature grease and high-temperature grease are used, the working temperature range can be expanded from -40°C to 100°C.
  - **Lubrication**: For high-speed and high-frequency operation, use of oil bath is recommended. In that case, direction of installation etc. will be limited.
  - **Anti-rotation mechanism**: Not supplied for the standard type. Equip the device to prevent the rotation torque on the mate machine in proportion to the load.
  - **Self-lock**: To prevent drop accident, the type of screw shaft is changed from ball screw to trapezoidal screw. By doing so, the cylinder is locked automatically. For details, Please consult us.

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Table 5

Fig. 24
### Dimensions

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### Special large-sized cylinders

We can manufacture cylinders of up to 200 ton thrust power.
How to Select Model

Conditions: Lifting of 30 ton load slab carrying cart, 30 ton load of ascent and 10 ton load at descent. 2 cylinders are linked.

Speed: 100 mm/sec. Up/down motion frequency: every 10 min. Operated for 8 hrs./day; 300 days/yr. Target service life: 5 years. Stroke: 1000 mm.

Calculation:
1. Obtain the total travelling distance by frequency of operation.
\[
\frac{10}{60} \times 8 \times 300 \times 5 = 72,000 \text{ reciprocations. 1000 mm stroke} \rightarrow 0.001 \times 2 \times 72,000 = 144 \text{ km} \quad \text{[A]}
\]
2. Obtain the average load per cylinder. Since the 2 cylinders are subject to 30 ton load at ascent and 10 ton load at descent, each of them shares the half. Hence, the following value is obtained by the Formula [2] (\(w = 1\)).
\[
F_a = \frac{5 + 2 \times 15}{3} = 11.67 \text{ (ton)} \quad \text{[B]} \quad \text{under the condition} \quad w = 1
\]
3. Then, look up the load on ball screw of one cylinder. (Table 2 in page 9) Since 2 cylinders are linked, the link motion factor becomes 1.05
\[
11.67 \times 1.05 = 12.25 \text{ (ton)} \quad \text{[C]}
\]
4. Look up the thrust power required for one cylinder. (Table 2, 3 and 4 in page 9) Since 2 cylinders are linked, the link motion factor becomes 1.05. The use factor becomes 1.0 in uniform motion. The load condition factor becomes 1.5 for unidirectional load. Hence, the following value is obtained by the Formula [5].
\[
1.05 \times 1.0 \times 1.5 = 1.575 \text{ (ton)} \quad \text{[D]}
\]
5. Hereunder is the calculation of the motor capacity. The general efficiency \( \eta \) in the Formula [5] in page 10 is assumed to be 0.76. Since the load to be shared by 2 cylinder is 30 tons, the following value is obtained.
\[
P = \frac{30 \times 1.0}{102 \times 0.76} = 38.7 \text{ kW} \rightarrow 37 \text{ kW} \quad \text{[E]}
\]
Selection: Select the model “SGB30T” listed in the diagram “Life span by travelling distance”. This model satisfies all of the values \( \text{[A], [B] and [C]} \). Besides, the buckling strength is also adequate in the light of the diagram “Torque load”. The speed is lower than 150 mm/sec and the tolerable thrust power exceeds 23.63 tons \( \text{[D]}. \) Thus, the model “SGB30T” satisfies the conditions for practical use. Also, it is recommended to use a motor with brake having 37 kW output.

Options

- Trunnion bearing.

**Table 7**

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**Limit switch unit**
The external limit switch unit for limiting the stroke is available as option. When plural number of cylinders are linked, these cylinders can be controlled by only one.
Installation

The Synchro-cylinder is composed not only of the cylinder body alone but also by aggregation of other equipment such as a driving motor, couplings, power transmission shaft, pillow block, etc. For this reason, please install each equipment, paying particular attention to the centering and leveling.

Installation of cylinder body
Install the bracket of the trunnion mounting part so that it should be at right angle with the working direction. In case this installation be incomplete, the tip end of inner tube swings and bending load may actuate on the body.
Also, prior to entering into operation be sure to weld the stoppers securely to the base to prevent dislocation of the cylinder body. If no stoppers are provided even when the centering work has been carried out correctly, the cylinder body will be displaced to cause a deflection of the center, which may lead to breakage of the shaft and the bevel gear in the cylinder body.

Recommended installation

If the installation as shown below is inevitable, fix the trunnion bearing completely with stoppers so that it should not move nor deflect its center.

Maintenance

High quality grease has been sealed in the Synchro-cylinder. No maintenance is needed for one year as far as the greasing frequency is limited generally to once an hour. Grease it more frequently in accordance with the frequency of operation.

Greasing spots:
- Gears ............. Apply through grease port of the gear case.
- Ball screw .......... Apply through tube hole at the center of the outer tube.
- Thrust bearing ...... Using a grease gun supply grease through the external grease nipples.

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<td>COSMO OIL</td>
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Table 8
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