



Application #1 – EXTRUDER SYSTEM

A manufacturer of candy is retrofitting an extruding machine. The machine presently uses a hydraulic ram attached to a plunger to push a thick candy mixture through a dispensing tube into a mold. The manufacturer is concerned with contamination from leaking hydraulics and would like more consistency in the dispensing rate and volume.

SPECIFICATIONS:

- Force to push the candy is 5400 pounds (no load on retraction)
- Force is vertical and will put the jack lift shaft in compression
- Minimum speed is 2.25 inch per second
- Actuation cycle: 50 times/hour, 8 hours/day, 200 days/year
- Desired design life is two years
- Mechanism must be mounted overhead
- Maximum stroke is 15 inches
- Food processing plant requires cleanliness

ANALYSIS:

Configuration: Speed, duty cycle and orientation of the operation dictates the use of an inverted ball screw jack. The plunger mechanism will be attached to the travel nut of a rotating jack.

Column Strength: Using the application data, 5,400 pound load, 15 inch travel with an “L” dimension of 21 inches, assume mounting condition “A,” the column strength chart shows that the a five ton or larger jack will handle the compressive load.

Speed and Horsepower: The 0.473 inch lead lift shaft in a 5 ton ball screw jack will provide the proper speed:

$$2.25 \text{ inches per second} \times 60 \text{ seconds per minute} \times 12.66 \text{ "turns of worm for 1" raise} = 1709 \text{ input rpm.}$$

$$\text{Horsepower required (Torque to raise one pound (from chart) X Load (lbs) X Worm Speed (rpm)/63,025} = (.0183 \times 5,400 \text{ pounds} \times 1,750) / 63,025 = 2.74 \text{ Horsepower}$$

2.74 Horsepower is below the three horsepower limit for this jack. Use a brake motor rated for 3 hp at 1750 rpm for this application.

Life: The life, based on the Ball Screw Life Expectancy chart on page 295, is at least 8,121,000 inches of travel for a standard inverted rotating 5 ton jack with a 5,400 lbs load.

$$\text{Calculated life is } 15 \text{ loaded inches per cycle} \times 50 \text{ cycles per hour} \times 8 \text{ hours per day} \times 200 \text{ days per year} = 1,200,000 \text{ inches per year or } 6.7 \text{ years of life} (= 8.1/1.2).$$

SELECTION:

Reference Number: From page 296, put together a reference number for the following: 5 ton ball screw jack, inverted rotating configuration, 6:1 worm gear ratio, motor mount with 3 hp 3 phase motor on the input shaft, standard extension for the output shaft, flange base, travel nut orientation “A”, “L” dimension of 21” for a 15” travel. Lastly the jack will be modified to include food grade grease and epoxy paint.

5-BSJ-IR 6:1/30BT-1/SSE-2/FA/21/M

M= Modified (food grade grease and epoxy paint)

Application #2 – MACHINE TOOL FIXTURE LOADER

A manufacturer is building a system to position a machine tool table horizontally inside the machine.

SPECIFICATIONS:

- The table is well guided and weighs 4,000 pounds
- The fixture needs accurate and repeatable positioning
- The table moves only a few times per shift.
- Stroke length is 30 inches maximum
- Desired design life is two years
- Thrust can only be applied at two corners
- No specific speed requirements

ANALYSIS:

Configuration: Infrequent operation suggests a machine screw jack. Application arrangement, available clearance and good guidance allow the use of upright translating jacks. The jacks must have an adjustable anti-backlash feature to assure accurate bidirectional positioning. Two manually operated jacks will be used, connected with a common driveshaft.

Column Strength: Even though the unit is horizontal, column strength must still be considered. Using the application data (4000 pound load, 30 inch travel, assume mounting condition “C”) with the column strength chart shows that a 2 ton upright jack with 1” diameter screw will handle the potential compressive load of 2000 lb per jack.

Input Torque: This is a horizontal, manually operated system. The force required to move the load is the actual load times the coefficient of friction of the guide system. For example, if linear bearings were used, the force required to move the load would be equal to 4000 pounds times .002 or 8 pounds. The torque required to move 8 pounds with a 6:1 ratio jack is 0.0250 times 8 or .2 in-lbs. This could easily be supplied by an operator turning a handwheel.

SELECTION:

Reference Number: From page 289, put together a reference number for the following: 2 ton anti-backlash machine screw jack, upright translating configuration, 6:1 worm gear ratio, standard shaft extensions for the worm shaft input and output, Flange base, clevis end on the lift shaft with 30” travel. An interconnecting shaft will be installed between the jacks at assembly to drive the jacks from a common handwheel.

2AB-MSJ-U 6:1/SSE-1/SSE-2/FC/30/S

