SCREW CONVEYOR EXAMPLE

There are many different factors to consider when designing a screw conveyor. The purpose of this example is to provide a step-by-step process that a KWS engineer would follow when designing a screw conveyor. It is important for the person designing the screw conveyor to understand how each factor affects the final screw conveyor design.

The following information will be used for the example –

- Bulk Material: Corn Meal
- Capacity: 25,600 lbs/hr
- Screw Conveyor Length: 16-feet, 0-inches from centerline of inlet to centerline of discharge
- Screw Conveyor Degree of Incline: 0° Horizontal

The screw conveyor for the example is control fed at the inlet by another screw conveyor.

SCREW CONVEYOR EXAMPLE - STEP 1: ESTABLISH CHARACTERISTICS OF BULK MATERIAL

The first step is to look up corn meal in the Bulk Material Table and write down the following information –

Bulk Material: Corn Meal

Maximum Particle Size: minus 1/8-inch and smaller

Bulk Density: 32 to 40 lbs/ft^3

Trough Loading: 30A (30-percent)

HP Factor: 0.5

Component Series: A1-A2

Abrasiveness: I

Corrosiveness: I

Flowability: III

Note – For the example, the additional characteristics provided in the "Note" column of the bulk material will not be considered in order to simplify the solution. Please refer to the Bulk Material Factors section for more detailed information.

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 2: DETERMINE CONVEYOR SIZE AND SPEED BASED ON CAPACITY

Information Given for Example:

- Bulk Material: Corn Meal
- Capacity: 25,600 lbs per hour
- Length: 16'-0" from centerline of inlet to centerline of discharge
- Conveyor Type: Horizontal

Information Provided from Bulk Material Table:

Bulk Material	Maximum Particle Size (in.)	Bulk Density (lbs/ft³)	% Loading	HP Factor	Component Series	Abrasiveness	Corrosiveness	Flowability
Corn Meal	-1/8	32-40	30A	0.5	A1-A2	I	I	III

Now that the characteristics of the bulk material to be conveyed have been determined, the next step is to calculate the capacity in cubic feet per hour. Always use the lowest bulk density when calculating capacity in order to get the highest potential volumetric capacity.

The recommended trough loading percentage according to the Bulk Material Table is 30A, or 30-percent.

Fill in the blanks and calculate the Capacity:

$$\text{Capacity (ft}^3\text{/hr)} = \frac{\text{Capacity (lbs/hr)}}{\text{Bulk Density (lbs/ft}^3\text{)}} = \frac{25{,}600 \text{ lbs/hr}}{32 \text{ lbs/ft}^3} = 800 \text{ ft}^3\text{/hr}$$

Using standard full pitch, fill in the blank to calculate the Selection Capacity:

$$SC = CFH \times CF = 800 \text{ ft}^3\text{/hr} \times 1 = 800 \text{ ft}^3\text{/hr}$$

Nomenclature:

SC = Selection Capacity (ft³/hr)
CFH = Required Capacity in Cubic Feet Per Hour (ft³/hr)
CF = Capacity Factor

The Selection Capacity will be used to select the proper screw conveyor diameter and speed from the Capacity Table. Using the Recommended Trough % Loading and calculated Selection Capacity, select the proper conveyor diameter. The Selection Capacity must be less than the maximum capacity given in the Capacity Table. Fill in the blanks below based on your previous calculations:

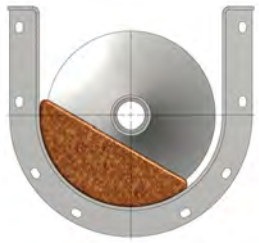
Conveyor Diameter: 12" Capacity at Max RPM: 1,161 Capacity at 1 RPM: 12.9

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 2: DETERMINE CONVEYOR SIZE AND SPEED BASED ON CAPACITY (CONTINUED)

The Actual Conveyor Speed is calculated by dividing the Selection Capacity by the Capacity at 1-RPM. Fill in the blanks below:

$$\text{Actual Conveyor Speed (S)} = \frac{\text{SC (ft}^3\text{/hr)}}{\text{Capacity at 1 RPM}} = \frac{800 \text{ ft}^3\text{/hr}}{12.9 \text{ ft}^3\text{/hr at 1 RPM}} = \underline{62} \text{ RPM}$$

Capacity Table				
Trough Loading	Screw Dia. (in.)	Max. RPM *	Capacity in ft³/hr	
			At Max. RPM	At 1 RPM
 30% A	4	139	57	0.4
	6	120	179	1.5
	9	100	545	5.5
	12	90	1,161	12.9
	14	85	1,768	20.8
	16	80	2,496	31.2
	18	75	3,375	45.0
	20	70	4,375	62.5
	24	65	7,085	109.0
	30	60	12,798	213.3
	36	50	18,440	368.8

SCREW CONVEYOR EXAMPLE - STEP 3: CALCULATE HORSEPOWER REQUIREMENTS

Information Given for Example:

- Bulk Material: Corn Meal
- Capacity (CP): 25,600 lbs/hr
- Length (L): 16'-0" from centerline of inlet to centerline of discharge
- Conveyor Type: Horizontal

Information Provided from Bulk Material Table:

Bulk Material	Maximum Particle Size (in.)	Bulk Density (lbs/ft³)	% Loading	HP Factor	Component Series	Abrasiveness	Corrosiveness	Flowability
Corn Meal	-1/8	32-40	30A	0.5	A1-A2	I	I	III

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 3: CALCULATE HORSEPOWER REQUIREMENTS (CONTINUED)

Calculating Horsepower

Friction Horsepower

A 12-inch diameter screw conveyor was selected in Step 2 of the example. The Diameter Factor (DF) selected from the Diameter Factor Chart (HP Section) is 55 for a 12-inch diameter screw conveyor.

Diameter Factor Chart (DF)							
Dia.	Factor	Dia.	Factor	Dia.	Factor	Dia.	Factor
4	12	12	55	18	135	30	377
6	18	14	78	20	165	36	549
9	31	16	106	24	235		

Since the bulk material to be conveyed is corn meal, a wood hanger bearing is selected for the application. The Hanger Bearing Factor (HBF) selected from the Hanger Bearing Factor Chart (HP Section) is 1.7 for a wood hanger bearing.

Hanger Bearing Factor Chart (HBF)		
Bearing Type	Bearing Factor	Bearing* Class
Ball, Roller, or none	1.0	2
Bronze, or Wood	1.7	2
Plastic, Nylon, UHMW, or Teflon	2.0	3
Hard Iron, or Stellite	4.4	4

The screw conveyor speed calculated in Step 2 is 62-rpm.

Fill in the blanks and calculate the Friction Horsepower (FHP):

$$FHP = \frac{DF \times HBF \times L \times S}{1{,}000{,}000} = \frac{55 \times 1.7 \times 16 \times 62}{1{,}000{,}000} = 0.09HP$$

Nomenclature:

DF = Conveyor Diameter Factor HBF = Hanger Bearing Factor

L = Conveyor Length (ft) S = Conveyor Speed

Material Horsepower

The capacity (CP) given in the example is 25,600 lbs. per hour. Please note: Do not use Selection Capacity (SC) to calculate horsepower. The screw conveyor length is 16-feet.

The Material Factor (MF) or HP Factor for corn meal is 0.5 from the Bulk Material Table.

$$MHP^* = \frac{CP \times MF \times L}{1{,}000{,}000} = \frac{25{,}600 \times 0.5 \times 16}{1{,}000{,}000} = 0.21HP$$

Nomenclature:

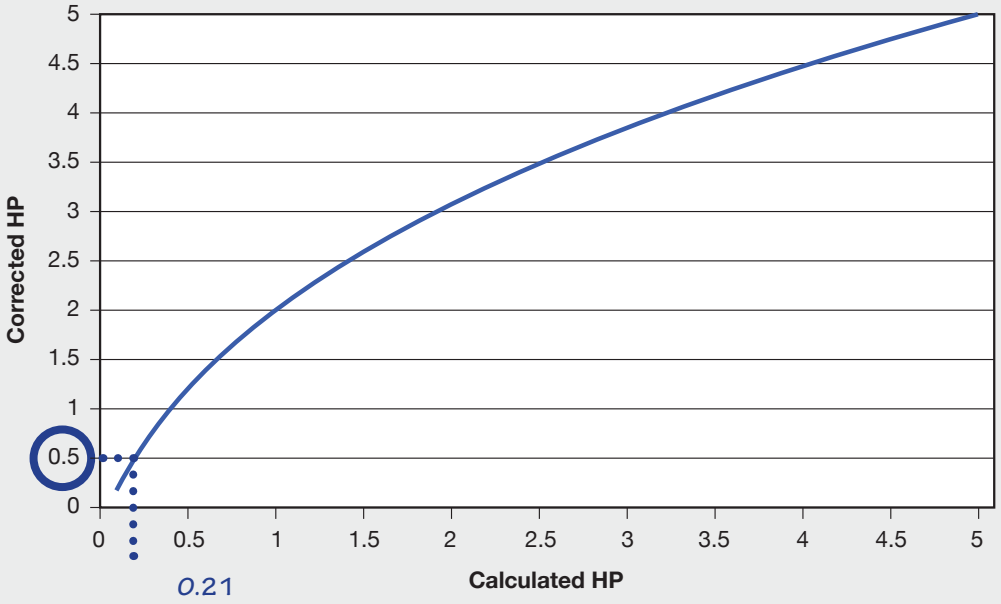
MF = Material Factor CP = Capacity (lbs/hr)

The calculated Material Horsepower (MHP) is 0.21-HP and must be corrected since it is less than 5-HP. Using the Corrected Material HP Chart below, locate 0.21-HP on the horizontal axis of the chart, draw a line vertically until it intersects the curved line, then move horizontally to determine the Corrected Material Horsepower of 0.5-HP.

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 3: CALCULATE HORSEPOWER REQUIREMENTS (CONTINUED)

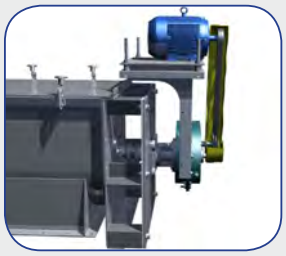
Corrected Material HP Chart



Fill in the blanks and calculate Total Shaft Horsepower (TSHP) by summing the Friction Horsepower (FHP) and the Corrected Material Horsepower (MHP) as follows:

$$TSHP = \frac{FHP + MHP^*}{e} = \frac{0.09 + 0.50}{0.88} = 0.67\ HP$$

Drive efficiency (e) for a typical screw conveyor drive unit with shaft-mounted reducer and V-belt drive is 88-percent, or 0.88.



Total Shaft Horsepower (TSHP) is typically rounded up to the next commonly available motor size. The most commonly available motor size for the example would be 1-HP. The drive unit selected for the example is 1-HP at 60-rpm. The speed of the drive unit is typically rounded to the closest 5-rpm increment.

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 4: CALCULATE TORQUE REQUIREMENTS

Information Given for Example:

- Bulk Material: Corn Meal
- Capacity: 25,600 lbs/hr
- Length: 16'-0" from centerline of inlet to centerline of discharge
- Conveyor Type: Horizontal

Information Provided from Bulk Material Table:

Bulk Material	Maximum Particle Size (in.)	Bulk Density (lbs/ft³)	% Loading	HP Factor	Component Series	Abrasiveness	Corrosiveness	Flowability
Corn Meal	-1/8	32-40	30A	0.5	A1-A2	I	I	III

Calculating Full Motor Torque

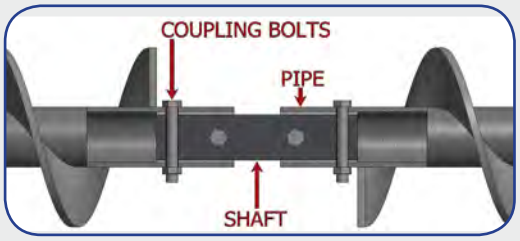
A 1-HP at 60-rpm drive unit was selected for the example screw conveyor. Full Motor Torque is calculated with the following equation below:

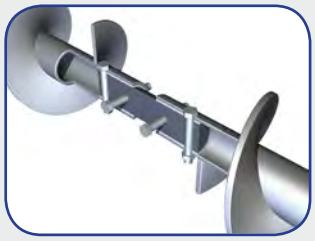
$$\text{Full Motor Torque} = \frac{HP \times 63{,}025}{S} = \frac{1 \times 63{,}025}{60} = 1{,}050 \text{ inch-lbs.}$$

HP = Nameplate Horsepower of the motor on the screw conveyor
S = Screw Conveyor Speed.

The torque rating of the drive shaft, coupling shafts, coupling bolts and conveyor screw must be greater than Full Motor Torque for proper design.

A 12-inch diameter screw conveyor was selected for the example. The minimum standard shaft size for a 12-inch diameter screw conveyor is 2-inch diameter. The corresponding pipe size is 2-1/2-inch schedule 40 pipe with 5/8-inch diameter coupling bolts. The materials of construction of the screw conveyor is carbon steel.





Standard Screw Construction (by Shaft Size)								
Shaft Diameter (In.)	1	1-1/2	2	2-7/16	3	3-7/16	3-15/16	4-7/16
Nominal Pipe Size	1-1/4	2	2-1/2	3	3-1/2	4	5	6
Coupling Bolt Dia. (In.)	3/8	1/2	5/8	5/8	3/4	7/8	1-1/8	1-1/4

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 4: CALCULATE TORQUE REQUIREMENTS (CONTINUED)

Maximum torque ratings for each screw conveyor component are shown in the Torque Tables below. Maximum torque ratings are based on a safe stress value for the specific material of construction. The screw conveyor components will have an infinite life under normal operating conditions.

Shaft Dia.	Carbon Steel Torque Values							
	Shaft		Coupling Bolts (2-Bolt)		Pipe – Schedule 40			
	C-1045		Grade 5		A-53			
	Shaft in Torsion		Bolts in Shear		Pipe in Shear		Pipe in Bearing	
	Safe Stress	Torque Rating	Safe Stress	Torque Rating	Safe Stress	Torque Rating	Safe Stress	Torque Rating
	PSI	In-Lbs	PSI	In-Lbs	PSI	In-Lbs	PSI	In-Lbs
1	8,750	1,000	15,500	3,400	6,700	3,100	6,700	2,200
1-1/2	8,750	3,800	15,500	9,100	6,700	7,600	6,700	5,600
2	8,750	9,500	15,500	19,000	6,700	14,200	6,700	8,900
2-7/16	8,750	18,700	15,500	23,000	6,700	23,000	6,700	13,200
3	8,750	35,400	15,500	41,000	6,700	31,900	6,700	17.500
3-7/16	8,750	53,000	15,500	64,000	6,700	42,700	6,700	24,700
3-15/16	8,750	76,400	15,500	121,300	6,700	72,600	6,700	58,200
4-7/16	8,750	110,200	15,500	168,800	6,700	112,900	6,700	101,300

The torque rating of the screw conveyor components from the Torque Tables:

Drive and Coupling Shafts = 9,500 inch-lbs.
Coupling Bolts = 19,000 inch-lbs.
Pipe in Shear = 14,200 inch-lbs.
Pipe in Bearing = 8,900 inch-lbs.

The torque rating of each screw conveyor component is much higher than the Full Motor Torque generated by the drive unit. The screw conveyor in the example is designed properly and will function many years with minimal maintenance or downtime.

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 5: COMPONENT SERIES SELECTION

Information Given for Example:

- Bulk Material: Corn Meal
- Capacity: 25,600 lbs/hr
- Length: 16'-0" from centerline of inlet to centerline of discharge
- Conveyor Type: Horizontal

Information Provided from Bulk Material Table:

Bulk Material	Maximum Particle Size (in.)	Bulk Density (lbs/ft³)	% Loading	HP Factor	Component Series	Abrasiveness	Corrosiveness	Flowability
Corn Meal	-1/8	32-40	30A	0.5	A1-A2	I	I	III

The recommended Component Series for corn meal is A as listed in the Bulk Material Table. Corn meal is a light, non-abrasive and free-flowing bulk material.

The 12-inch diameter by 16-feet long screw conveyor for the example is constructed from carbon steel with the following construction as selected from the Component Series Table:

Screw Dia.	Shaft Dia.	Cover Thickness	Series A		
			Screw Number		Trough Thickness (Min.)
			Helicoid	Sectional	
4	1"	14 Ga.	4H206	N/A	14 Ga.
6	1-1/2"	14 Ga.	6H304*	6S309	14 Ga.
9	1-1/2 " 2"	14 Ga.	9H306* 9H406*	9S309 9S409	14 Ga.
12	2" 2-7/16" 3"	14 Ga.	12H408* 12H508* 12H614*	12S409 12S509 12S612	12 Ga.
14	2-7/16" 3"	14 Ga.	14H508* 14H614*	14S509 14S609	12 Ga.
16	3"	14 Ga.	16H610*	16S612	12 Ga.
18	3" 3-7/16"	12 Ga.	N/A	18S612 18S712	10 Ga.
20	3" 3-7/16"	12 Ga.	N/A	20S612 20S712	3/16"
24	3-7/16"	12 Ga.	N/A	24S712	3/16"
30	3-15/16"	10 Ga.	N/A	30S816	3/8"
36	4-7/16"	3/16"	N/A	36S916	3/8"

Screw: 12H408 helicoid screws with 1/8-inch nominal flight thickness and 2-inch shaft diameter
Trough: TUA1212 angle flange trough with 12-gauge trough thickness
Cover: COV1214UFL flanged cover with 14-gauge cover thickness

SCREW CONVEYOR EXAMPLE

SCREW CONVEYOR EXAMPLE - STEP 5: COMPONENT SERIES SELECTION (CONTINUED)

The recommended Bearing Material Series is 1-2 as listed in the Bulk Material Table.

The 12-inch diameter by 16-feet long screw conveyor for the example can utilize several different hanger bearing materials as selected from the Component Series Table:

Series	Bearing Material
1	Nylatron, Plastech, UHMW, Wood, Ball
2	Plastech, Gatke, Ball
3	Bronze, Hard Iron
4	Hard Iron, Hardsurface, Stellite, Ceramic

Based on a Bearing Material Series of 1-2, the hanger bearings can be Nylatron, Plastech, UHMW, Wood, Gatke or ball bearing. We are selecting wood for the example because wood hanger bearings are very cost-effective and durable.