Selection Information

Friction Product Selection

The selection charts shown in each section of this catalog are based on torque only. They are intended to be used when only motor HP is known and the cycle rate is less than 15 CPM.

These charts do not consider the heat capability of a unit.

To select a unit using this method is simple. Match the drive HP and speed on the chart to determine the correct model.

When the cycle rate is greater than 15 CPM or a more cost effective method of product selection is desired, a detailed analysis of the system should be used. The following steps and formulas can be used.

Step 1 Determine Function and Style

Function:

- Start: Clutches or Clutch-Coupling
- Stop: Brakes
- Start-Stop: Clutch-Brakes or Clutch-Brake-Couplings

Style:

Packaged Products or Custom Design

Step 2 Determine Cycle Rate

Less than 15 CPM by available drive torque – use the "Selection Charts"

Greater than 15 CPM or by calculated torque and heat dissipation:

A. Calculate system WK^2

Reflect WK^2 to the clutch or brake

B. Calculate Dynamic Torque requirement

Select model by torque capacity. Choose from the Quick Reference Chart or Performance Curves. Capacity must exceed calculated requirements.

C. Calculate Heat Generated Requirement

Select model by heat capacity. Choose from the Quick Reference Chart or Performance Curves. Capacity must exceed calculated requirements. Verify that Dynamic Torque capacity is still correct. If necessary, increase size of Clutch and/or Brake until both torque and heat requirements are satisfied.

Torque

$$\text{Torque (in-lbs)} = \frac{63{,}000 \times HP}{RPM}$$

HP

$$HP = \frac{\text{Torque (in-lbs)} \times RPM}{63000}$$

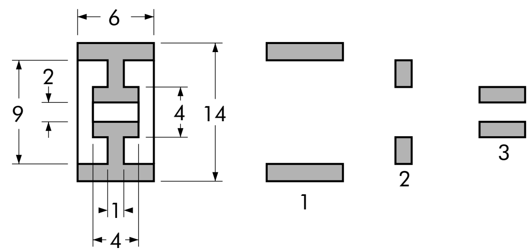
Rotating Inertia

The WK^2 values of objects rotating on the same shaft can be added together. For this reason, the calculation of the WK^2 of a relatively complicated part can be simplified by sectioning it into simple components and totaling up the individual WK^2's. The formula for calculating hollow cylinders is listed; formula's of other shaped objects are listed in this Engineering Section.

$$WK^2\ (\text{lb-in}^2) = .09806 \times p \times L \times (D^4 - d^4)$$

Where:
- p = density of rotating object (lb/cu-in)
- L = Cylinder length (in)
- D = Outside diameter (in)
- d = Inside diameter (in)

Example



A steel flywheel is sectioned into three different hollow cylinders; the rim, webbing and hub. Calculate the WK^2 of parts 1, 2, and 3; then add for the total WK^2 as shown.

Note: The density of steel is .282; other common materials are also listed in this section.

$WK^2(1)$	=	$.09806 \times .282 \times 6 \times (14^4 - 9^4)$	=	5285 Lb-In^2
$WK^2(2)$	=	$.09806 \times .282 \times 1 \times (9^4 - 4^4)$	=	174 Lb-In^2
$WK^2(3)$	=	$.09806 \times .282 \times 4 \times (4^4 - 2^4)$	=	27 Lb-In^2
		Flywheel WK^2	=	5486 Lb-In^2

The inertia of a flywheel or sheave is concentrated in the rim. In many cases the hub and webbing can be ignored without significantly affecting the final outcome. Sprockets and gears pose a problem, the outside diameter is not continuous. For these items use the pitch diameter of the plate (face width) as the outside diameter and add this to your hub figures for the total.

Reflected Inertia

The effect of the WK^2 of an object depends on its speed. The object may be rotating or moving in a straight line. If the object is moving at a different speed than the Clutch or Brake the WK^2 must be reflected or ratio'd back to the Clutch or Brake. For rotating parts the formula is:

$$WK^2 \text{ (Shaft A)} = WK^2 \text{ (Shaft B)} \times \left(\frac{\text{RPM B}}{\text{RPM A}}\right)^2$$

Where:
- Shaft A = shaft where Clutch or Brake is located
- WK^2 Shaft B = Inertia of all objects on this shaft
- RPM A = Speed of shaft A
- RPM B = Speed of shaft B

Example

The previously calculated steel flywheel is rotating at 250 RPM and the Clutch-Brake at 1800 RPM.

$WK^2 = 5486 \times (250 \div 1800)^2 = 106$ Lb-In^2

For straight line moving objects usually conveyors the formula is:

$$WK^2 \text{ (lb-in)} = W \times \left(\frac{1.91 \times V}{N}\right)^2$$

Where:
- W = Weight of straight line moving objects (lbs)
- V = Speed of straight line moving objects (FPM)
- N = Speed of shaft where Clutch or Brake is located (RPM)

Example

A conveyor is moving at 375 FPM with a 1250 Lb load on it; the Clutch-Brake is mounted to an 1800 RPM motor.

$WK^2 = 1250 \times ((1.91 \times 375) \div 1800)^2 =$ 198 Lb-In^2

The torque required to either accelerate or decelerate the system WK^2 during a specified time period is dynamic torque. Do not allow the start or stop time to exceed 5 seconds when the unit is operated at full torque; damage to the friction surfaces may occur.

The formula to calculate dynamic torque is:

$$\text{Dynamic Torque (lb-in)} = \left(\frac{WK^2 \times N}{3700 \times \tau}\right)$$

Where:
- WK^2 = System inertia reflected to Clutch or Brake (lb-in^2)
- N = Speed of shaft where Clutch or Brake is located (RPM)
- t = Time to accelerate or decelerate load (sec)

Example

The above conveyor with 198 Lb-In^2 system WK^2 requires an acceleration and deceleration time of .5 second or less to achieve the desired 25 CPM rate. At 25 CPM it takes 2.4 seconds to complete one cycle. During this time the conveyor must do four things: accel, run, decel, and hold. .5 seconds is a preliminary estimate allowing 1.4 seconds for run and hold this may have to be adjusted to maintain process time.

Torque = $(198 \times 1800) \div (3700 \times .5) = 193$ In-Lbs

Therefore, when selecting a Clutch-Brake for this application it must transmit more than 193 In-Lbs of torque at 1800 RPM.

Time to Speed

If a load is rapidly started and or stopped damage may occur to the machine or items handled by the machine. An accel or decel control may be required to reduce system shock. A "Time to Speed" calculation can give you an idea of how fast the system will be started or stopped. This Formula is also used in high cycle rate applications to verify if there is enough process time during the machine's operating cycle. The time to accelerate or decelerate a load is similar to the torque formula; it is:

$$t \text{ (seconds)} = \left(\frac{WK^2 \times N}{3700 \times T}\right)$$

Where:
- WK^2 = System inertia reflected to Clutch or Brake (lb-in)
- N = Speed of shaft where Clutch or Brake is located (RPM)
- T = Clutch or Brake dynamic torque at running speed (in-lbs)

Mechanical Energy Generated

A rotating body has energy because it is in motion. If the rotational speed of the body is decreased, the energy content of the body is decreased, and since energy can neither be destroyed nor created, this loss of energy of one body must cause an increase in the energy of another body or bodies. This transfer is usually done in the form of heat.

In friction products the energy released by the rotating body as it is accelerated or decelerated is dissipated by the Clutch or Brake. The amount of energy or heat that is transferred per engagement must be considered for applications cycling faster than 15 CPM.

The formula to calculate heat generation is:

$$E \text{ (ft-lb/min)} = .0118 \times WK^2 \times \left(\frac{N}{100}\right)^2 \times F$$

Where:
- WK^2 = System inertia reflected to Clutch or Brake (lb-in^2)
- N = Speed of shaft where Clutch or Brake is located (RPM)
- F = Number of starts and/or stops (CPM)

Example

The previous conveyor example is started and stopped 25 times per minute.

E = .0118 x 198 x (1800 ÷ 100)″ x 25 = 18,934 Ft-Lb/Min

Therefore when selecting a Clutch-Brake for this application it must have a heat dissipation capability greater than 18,934 Ft-Lbs/Min at 1800 RPM.