Mechanical Data Application Engineering

Heat Dissipation

To accelerate any part of a machine from rest to a given velocity or decelerate from a given velocity to rest, energy must be given to or taken from the part. This energy, neglecting friction and windage losses, is equal to the energy possessed by the part when moving at the given velocity.

Kinetic energy in parts that rotate about an axis such as gears, pulleys, and rotors is:

$$E = 1.7 \times WR^2 \times \left(\frac{N}{100}\right)^2$$

Where:

N = RPM

E = Energy, ft.lb.

WR^2 = Inertia, lb.ft.^{2}

On repetitive cycles, the energy per minute may be determined by multiplying the energy calculation by the cycle frequency F:

a. $E/\text{min.} = 1.7 \times WR^2 \times \left(\frac{N}{100}\right)^2 \times F$

Where:

E/min. = Energy, ft.lb./min.

This becomes important when determining whether a given size clutch or brake is capable of dissipating the heat (energy) required to cycle a given load. To determine this, the heat dissipating capability of the clutch-brake must be calculated using the formula:

b. $E/\text{min.}_{\text{avg.}} = \frac{t^1}{t^1 + t^2}\left(\frac{E/\text{min.}}{@RPM_1}\right) + \frac{t^2}{t^1 + t^2}\left(\frac{E/\text{min.}}{@RPM_2}\right)$

Where:

t^1 = time (seconds) @ RPM_1

t^2 = time (seconds) @ RPM_2

RPM_1 = starting speed

RPM_2 = maximum speed

E/min. = energy rate from heat dissipation curves

The heat (energy) to be dissipated (per formula a. above) is then compared with the heat (energy) dissipating capacity (per formula b. above) of the clutch-brake to determine whether unit sizing is correct.

Example: A load of 5.353 lb.ft.^{2} (includes couplings, bearings, etc.) is driven by a 15 HP, 700 RPM motor. Using an SF-1225 (bearing mounted, normal duty with armature in input side) and PB-1225 (normal duty, pin drive), determine whether this clutch-brake can be cycled 40 times per minute with an "on" time of one second without overheating.

1. Determine amount of heat which is dissipated at this cycle rate.

$$E = 1.7 \times WR^2 \times \left(\frac{N}{100}\right)^2 \times F$$

Total WR^2: 5.353 lb.ft.^{2} (load inertia)
2.751 lb.ft.^{2} (clutch inertia, ref. p. 239)
2.147 lb.ft.^{2} (brake inertia, ref. p. 239)
Total = 10.251 lb.ft.^{2}

$$E = 1.7 \times 10.251 \times \left(\frac{700}{100}\right)^2 \times 40$$

E = 34,156 ft.lbs./min.

2. Determine the heat dissipating capacity of this clutch-brake combination.

$$E/\text{min.}_{\text{avg.}} = \frac{t^1}{t^1 + t^2}\left(\frac{E/\text{min.}}{@RPM_1}\right) + \frac{t^2}{t^1 + t^2}\left(\frac{E/\text{min.}}{@RPM_2}\right)$$

Where:

t^1 = .5 second

t^2 = 1 second

RPM_1 = 0

RPM_2 = 700

E/min. @ RPM_1 = 20,000 ft.lbs./min.

E/min @ RPM_2 = 47,000 ft.lbs./min.

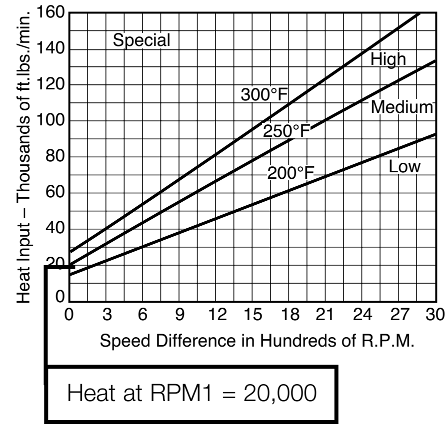
$$E/\text{min.}_{\text{avg.}} = \frac{.5}{1.5} \times 20{,}000 + \frac{1}{1.5} \times 47{,}000$$

$E/\text{min.}_{\text{avg.}}$ = 38,000 ft.lbs.

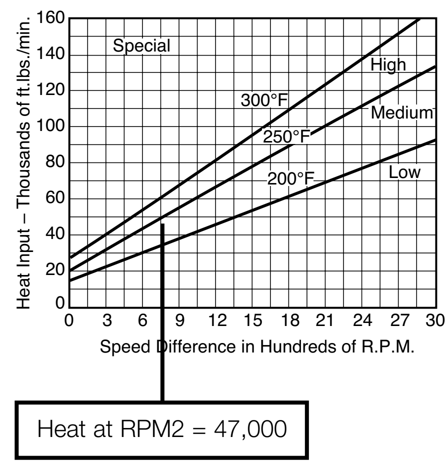
Since the capacity (38,000 ft. lbs./min.) is greater than the heat to be dissipated (34,156 ft. lbs./min.), this clutch-brake can be operated continuously at 40 cycles/ min. under the stated load without overheating.

Examples

Size 1225 **Maximum Speed 3,000 rpm**



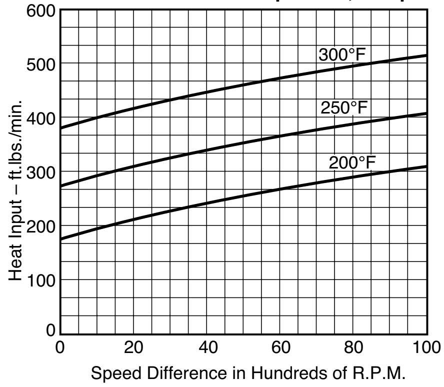
Size 1225 **Maximum Speed 3,000 rpm**



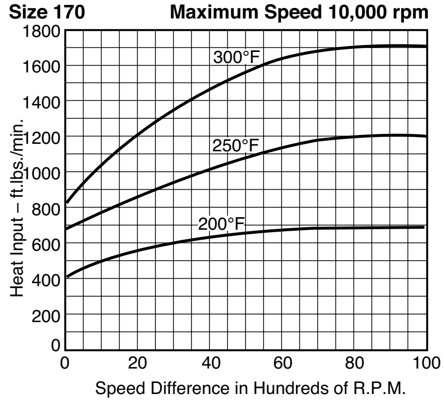
Note:
Select a clutch or brake with heat dissipation requirements below the 250° line. For heat greater than 250° but less than 300°, special coils are required.

Heat Dissipation

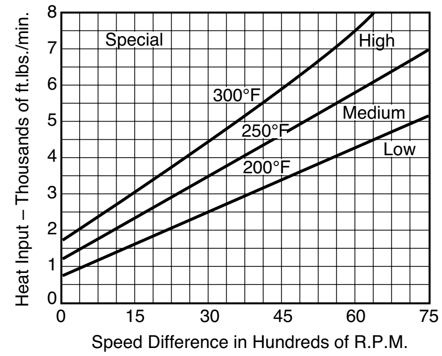
Size 120 **Maximum Speed 10,000 rpm**



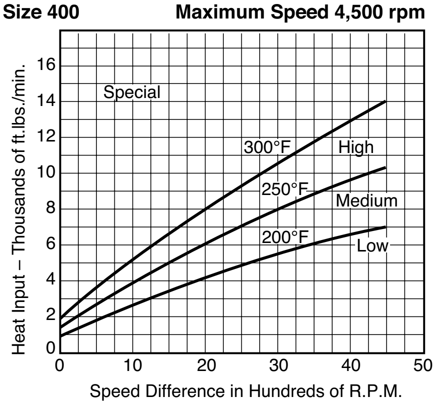
Size 170 **Maximum Speed 10,000 rpm**



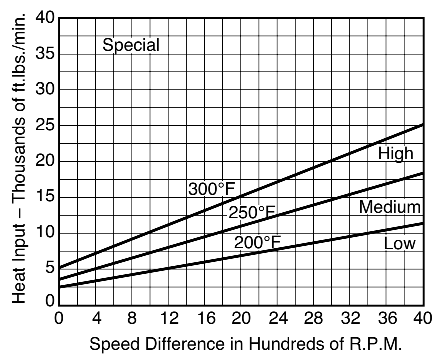
Size 250 **Maximum Speed 7,500 rpm**



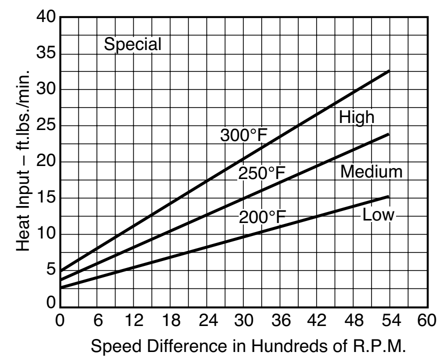
Size 400 **Maximum Speed 4,500 rpm**



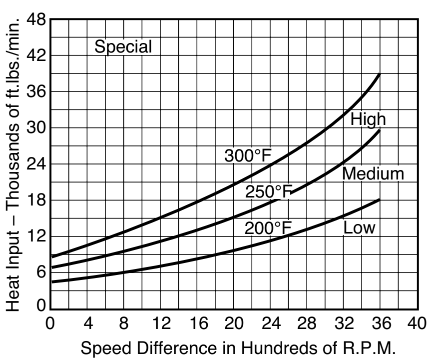
Size 500-SF **Maximum Speed 4,000 rpm**



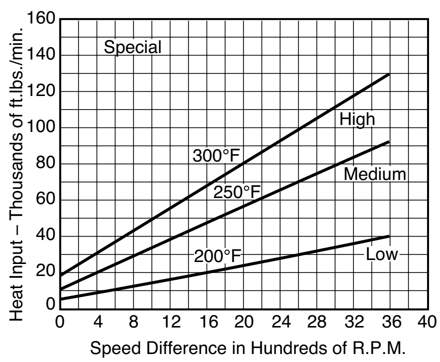
Size 500 PC & PB **Maximum Speed 5,400 rpm**



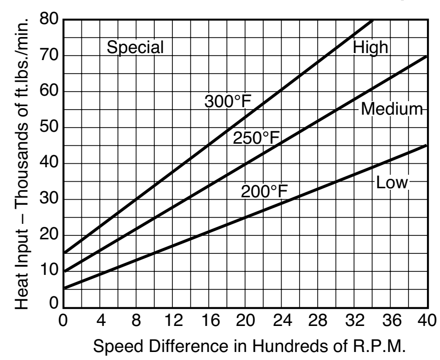
Size 650 **Maximum Speed 3,600 rpm**



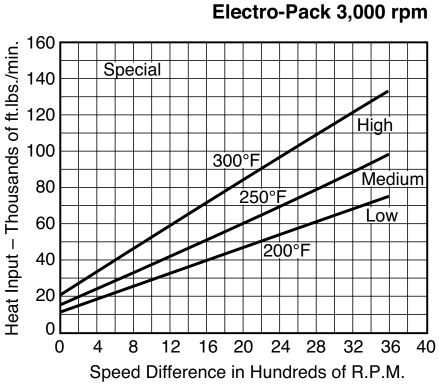
Size 825-Brg. Mtd. **Maximum Speed 3,600 rpm**



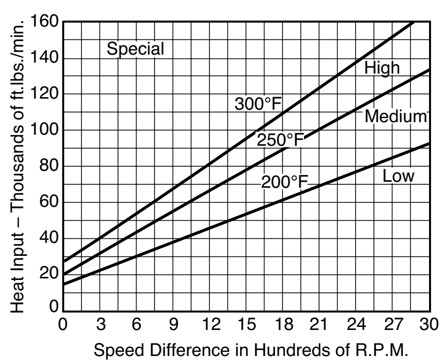
Size 825 **Maximum Speed 4,000 rpm Electro-Pack 3,600 rpm**



Size 1000 **Maximum Speed 3,600 rpm Electro-Pack 3,000 rpm**



Size 1225 **Maximum Speed 3,000 rpm**



Size 1525 **Maximum Speed 2,000 rpm Electro-Pack 1,800 rpm**