Retrofitting drives

When replacing a mechanical adjustable speed drive with an electronic variable speed drive, the best solution may be to meet the starting and running torque requirements of the actual load.

Figure 1

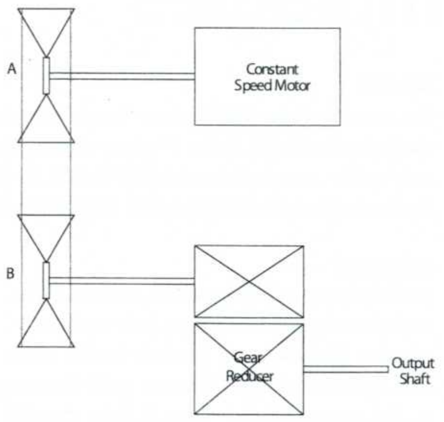


Figure 2

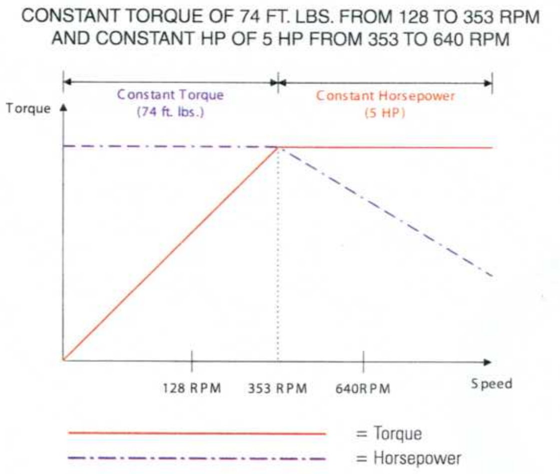
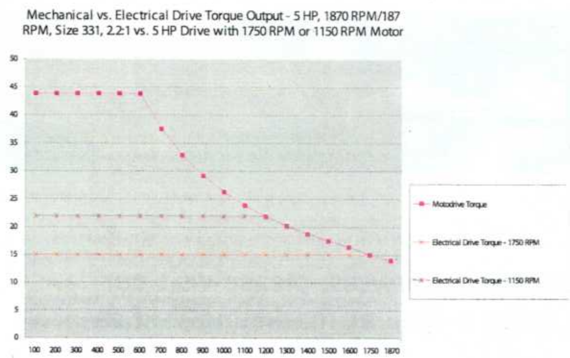


Figure 3



Retrofitting an application using a mechanical adjustable speed drive to an AC or DC variable speed drive can be done successfully if all the details are understood beforehand. First, let's take a look at what a mechanical drive really looks like conceptually.

A constant speed motor is connected to a variable-diameter sheave (item A in Figure 1) that transmits power through a belt to another variable-diameter sheave (item B). An internal gearbox can then be used to further reduce speed as necessary.

The variable sheave/belt assembly will act as a reduction gear up to motor base speed, and then will increase speed beyond that. Sheave B speed will be the same as motor base speed when the diameter of the sheaves are equal, so motor base speed is roughly the midpoint of the speed range of sheave B.

The drive is said to have constant torque from low speed operation up to the midpoint speed and constant horsepower (hp) from the midpoint speed up to full speed. (Ideally, an increase, but this is not the case due to belt slippage and friction).

Constant hp is the case from midpoint speed through full speed since the sheaves are acting to increase speed, therefore torque is falling off as speed is increased (Figure 2).

> **The variable sheave/belt assembly will act as a reduction gear up to motor base speed, and then will increase speed beyond that.**

The real replacement solution, however, may not be to duplicate the mechanical drive capability, but meet the starting and running torque requirements of the actual load. An internal gearbox may or may not be employed, depending on the output speed desired. If used, it simply has an impact on output speed and torque as any other reduction gear would, so the speed is reduced by the ratio and torque is increased by the ratio.

Let's look at an example using a 5-hp Reeves Motodrive, with a maximum output speed of 640 rpm, a minimum output speed of 128 rpm, an internal gear ratio 5.1:1, and a motor base speed of 1,800 rpm.

We can determine the output speed when the sheaves are at equal speed by dividing the motor rpm by the gear ratio: motor rpm/gear ratio = 1,800/5.1 = 353 rpm.

At this output speed, 353 rpm (roughly the mid-point of the Motodrive speed range), the drive delivers full running torque. This is the running torque we must be able to achieve with our replacement drive.

From the torque/speed/hp formula: Torque = 5250 (hp)/rpm = 5250 (5)/353 = 74 ft-lb.

If we replace the Motodrive with an AC or DC variable speed drive without a gear reducer, this is the full load torque that the motor must be sized for. This could result in the selection of an AC motor of 20 hp with a base speed of 1,200 rpm.

Running torque at reduced speeds is a consideration that should not be overlooked when converting to an electrical solution. Per the example above, the temptation might be to size the drive and modify the internal gear to deliver 5 hp at an output speed of 640 rpm. However, differences in the constant-horsepower and constant torque characteristics between electrical and mechanical drives (as shown in Figure 3) can make this a bad choice.

Once the running torque issue is resolved, the electrical solution provides the following benefits.

- Faster response to speed changes
- Tight regulation with digital drive technology
- The ability to coordinate speed with multiple drive sections
- Operating changes are achieved through simple configuration parameter changes.

What about starting torque? The Motodrive has the same potential starting torque as that of the AC motor which is driving it; 225%. But general-purpose drives only have 150%. To deliver as much starting torque with an AC or DC variable speed drive without a gearbox as the Motodrive could deliver would require: 2.25 (74 ft lb)/1.5 = 111 ft lb.

This is the full load torque requirement for the motor needed to meet the starting torque of the Motodrive. If an AC XE 1,200 rpm motor were used, the horsepower would need to be rated at 25.

It may not always be necessary to oversize for starting torque. For example, the AC motor can develop 225% start-up torque across the line, assuming we are accelerating the load as fast as possible. Since an AC drive can extend the acceleration rate, we can decrease the starting torque demand on the drive based on the following equation: Torque of Acceleration = Change in Speed x Connected Inertia (Wk2) divided by (308) x Acceleration Time.

Therefore, we only need to oversize for starting torque if the application has a quick starting time restraint or if there is a high breakaway torque requirement for the load.

You can see from this example that a variable speed drive without a gear will need to be of a much larger horsepower than a mechanical drive. If we were to use a gear with the variable speed drive, the hp would certainly come down. The mechanical replacement solution to this example is a drive/motor to deliver: Constant torque of 74 ft lb from 128 to 353 rpm *and* constant hp of 5 hp from 353 to 640 rpm. **MRO**

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