Using A Cost-Efficient Regenerative Dynamometer

By Bill Colton
Baldor Electric Co.
Commerce, California
Technical Services
Committee Member

Today's cost of energy has become a major consideration in most businesses. This is certainly true of EASA service centers as it is with most industry. We are all trying to find ways to make our facilities more efficient to either become more competitive, or gain greater profits – perhaps both.

One of the tools that may make an EASA facility more attractive to potential customers is the ability to put a motor under load or even tested to a specified load.

This is often done with a dynamometer. A dynamometer is defined as a device for measuring mechanical power, especially one that measures the output or driving torque of a rotating machine.

Many Different Devices To Create Load

This can be done with many different devices to create the load including apparatus such as friction or air brakes, pumps, water brakes or electric motors.

In this article I will discuss the use of a line regenerative AC vector drive to provide the load to the motor being tested. **Figure 1** depicts a drive and load motor dynamometer test setup, with the regenerative drive (cover removed for illustration purposes) in the background. **Figure 2** shows a larger motor and load regenerative dynamometer setup.

Figure 2. Regenerative drive and large load motor dynamometer test setup.

One of the tools that may make an EASA facility more attractive to potential customers is the ability to put a motor under load or even tested to a specified load.

In the AC vector drive dynamometer application, the motor being tested is driving the vector (load) motor. **Figure 3** (on Page 9) graphically illustrates the difference between a conventional absorption dynamometer (upper drawing) and regenerative dynamometer load test (lower drawing). The vector motor will resist rotation of the motor being tested (hence applying the load).

When creating this load to the tested motor, the vector drive is acting as a generator. Power from the vector motor travels back to the bus of the vector drive.

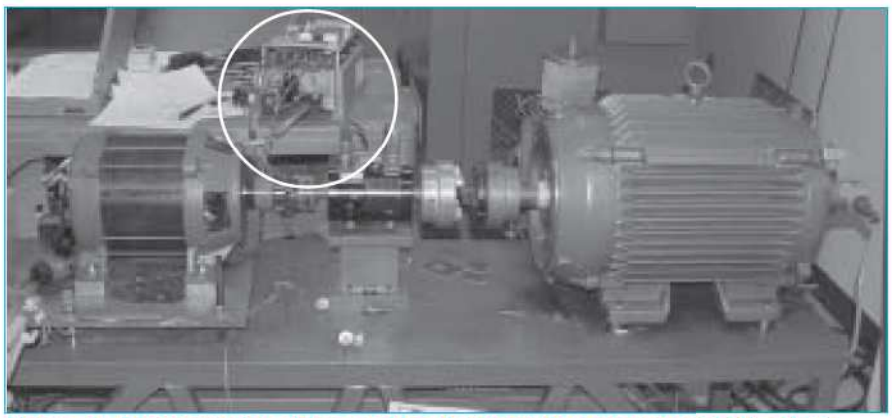

Figure 1. Regenerative drive and load motor dynamometer test setup. The AC vector drive is circled.

Typical Vector Drive

A typical vector drive will wait for the DC bus to reach a certain level and then regulate the DC bus by converting some of the power to heat. This is accomplished by completing a circuit by closing a transistor allowing the DC power to flow into a resistor bank turning it into heat. This technique is not very efficient because it converts most of the load energy into heat.

A more energy-efficient method is to use a line regenerative AC vector drive as the load to the motor being tested. In this case, the vector motor converts the mechanical energy into electrical energy and that power starts to increase the DC bus voltage in the vector drive. The energy is converted back into AC power and transferred back into the service center's power grid to be used by other electrical loads.

Continued On Page 2

Using A Cost-Efficient Regenerative Dynamometer

Continued From Page 2

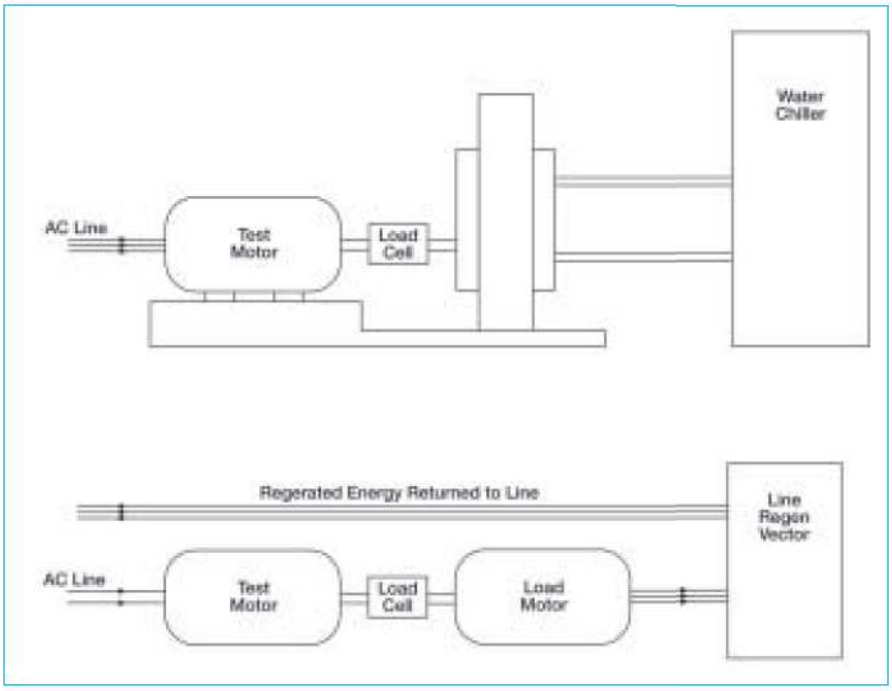

Figure 3. Illustration of the difference between a conventional absorbtion dynamometer (upper drawing) and regenerative dynamometer.

To have an accurate load indication, you will need to use a torque transducer (**Figure 4**). Often, these have a shaft to connect to the load so as to measure the torque. The output can be an analog or a digital signal. You can use the feedback in an automatic closed loop system by demanding (set point) the amount of torque you want applied to the test motor and use the transducers output for the feedback loop. Or, you may use the transducers feedback to read out in a display, and adjust the torque demand (by analog or digital signal) into the drive. You can use the speed on the vector drives display for the speed and the readout from the torque transducer to obtain the applied torque.

If you are trying to just place a load on the motor and apply an approximate torque to the motor, you can verify the torque curve of the vector drive and demand a torque to be produced by the drive without employing a torque transducer. Although this is quite a bit less sophisticated, it may serve the purposes of your service center.

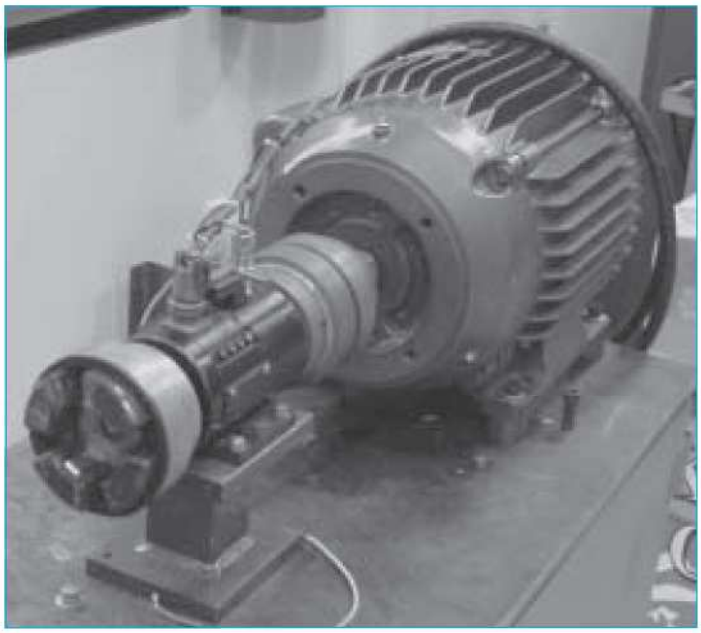

Figure 4. The torque transducer is mounted and connected between the drive motor (shown) and driven load (not shown).

Testing Brushless Motors

You may also need to test brushless motors by placing a load on them. **Figure 5** (on Page 10) illustrates a drive motor and servo motor as the load. This can be a bit trickier since you will most likely not have the customer's drive to run the motor. There are drives that will "auto tune" a brushless motor when some basic parameters are loaded into them. You will have to ascertain if it is resolver or encoder feedback and employ the drive that accepts that kind of feedback. Program the motor and feedback data and auto tune the drive. Then couple the brushless motor to the load and start the brushless drive. Then when at the speed you want to test, increase the load on the tested motor by increasing the torque in the AC vector drive.

If you are getting involved with the testing of brushless motors it is a good idea to have a dynamometer so you can apply a load and see the amount of current it takes to create a specified load. This will help you identify that the motor has the proper KI (torque constant). You also can use the AC vector drive to run the brushless motor

Continued On Page 3

Using A Cost-Efficient Regenerative Dynamometer

Continued From Page 2

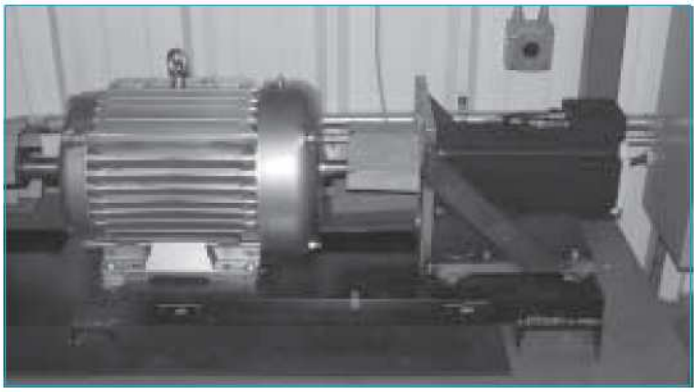

Figure 5. A squirrel cage induction drive motor using a servo motor as the load.

at a given speed and measure the back EMF (voltage between motor leads) to determine if the motor has been demagnetized.

Load Energy Goes Back On Line

The big advantages to using an AC line regenative vector drive are that you get good control of output torque and speed measurement (reading the encoder). And, you only use the energy losses of the motors, mechanics and drive; all of the load energy goes back on the line. **Figure 6** illustrates a dynamometer setup that provides a three-motor arrangement to be able to run either an induction motor (one side) or a brushless motor (the other side), with only one torque transducer.

Although this could also be done with a four quadrant DC drive, you would have brush wear problems if you continued to run a test lightly loaded. The AC drive doesn't face this problem.

Summary

In conclusion, if you want to use a load to verify some motor data and be able to offer this service to your customer, you should consider a line regenerative AC vector drive. It offers one of the most efficient means of loading the test motor. You understand the AC vector motor and can work on it yourself if required. It provides a fairly accurate torque measurement and torque control as well as speed measurement. It also can provide holdback torque as well as overdriving torque to see how well a motor can handle an overhauling load. It is a good instrument for providing a load in a rotating dynamometer application.

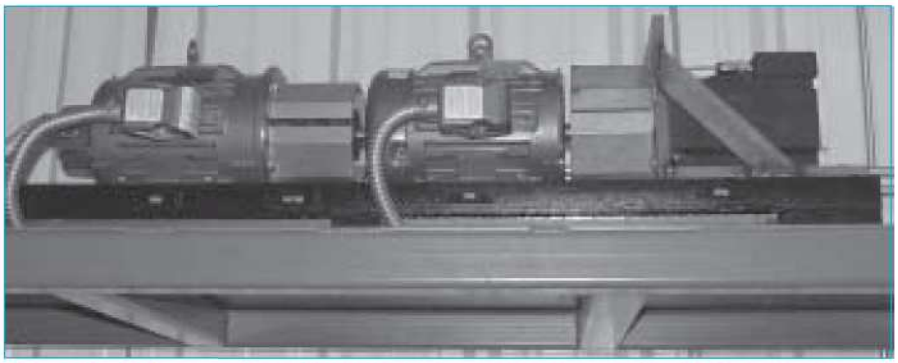

Figure 6. A three-motor dynamometer arrangement allowing either an induction motor (one side) or a brushless motor (the other side) load test, with only one torque transducer.