Is it Cost-Effective to Replace Old Eddy-Current Drives?

Suggested Actions

- Contact your drive supplier to obtain drive efficiency information as a function of motor operating speed or drive power output. Use this information to determine the energy savings due to the use of a PWM ASD versus an eddy-current drive.
- When ASD part-load performance values are not readily available, use the values given in the Motor Tip Sheet #11: *Adjustable Speed Drive Part-Load Efficiency.*
- Efficiencies for integral horsepower NEMA Design A and B motors at full and part-load can readily be obtained from the U.S. Department of Energy's Motor-Master+ 4.0 software tool.

Resources

U.S. Department of Energy—For additional information on motor and motor-driven system efficiency, and to download the MotorMaster+ software tool, visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices, or contact the EERE Information Center at (877) 337-3463.

National Electrical Manufacturers Association (NEMA)—Visit the NEMA Web site at www.nema.org for information on motor standards, application guides, and technical papers.

Overview

New pulse-width-modulated (PWM) adjustable speed drives (ASDs) may be cost-effective replacements for aging or maintenance-intensive eddy-current drives.

The eddy-current drive or clutch is a slip device consisting of two rotating elements that are coupled by a magnetic field with the slip and rotor speed based upon the magnetic field strength. An alternating current motor drives a constant-speed rotating drum that surrounds a cylinder (rotor), which is coupled to an output shaft. Torque is transmitted from the outer rotating drum to the rotor with an adjustable magnetic field. The maximum efficiency of a slip-based adjustable speed controller is approximately equal to the amount of slip, or difference between full-load speed and the operating speed. Table 1 indicates the efficiency of a magnetically coupled eddy-current drive when matched to a centrifugal load.

Table 1. Efficiency Versus Speed for an Eddy Current Coupled Centrifugal Load[1]

Drive Speed, % of Full-Load Speed	Load %	Eddy-Current Drive Efficiency, %
100	100	94.3 to 99.3
90	72.9	85.9 to 90.4
80	51.2	76.1 to 80.1
70	34.3	66.9 to 70.5
60	21.6	56.9 to 59.8
50	12.5	47.7 to 50.2
40	6.4	39.7 to 41.7
30	2.7	28.6 to 29.9

1. Source: Coyote Electronics, Inc. "Payback®" Magnetic-Coupled Variable Speed Drive Literature.

Energy Savings Example

An eddy-current drive on a 50 hp boiler forced-draft fan has reached the end of its useful operating life; the proposed replacement is a PWM ASD. The fan operates for 8,000 hours per year while delivering 90% of rated flow for 20% of the time, 80% flow for 50% of the time, and 70% of rated flow for the remaining operating hours. Energy savings are obtained due to the improved efficiency of the PWM drive over the eddy-current drive. In Table 2, the existing system or baseline annual energy consumption is determined as follows:

Table 2. Average Power Requirements for a Centrifugal Fan with Eddy Current Drive Speed Control

% of Rated Fan Speed/ Flow	Load Duty Cycle, %	Load, Shaft hp	Motor Efficiency,%	Eddy-Current Drive Efficiency, %	Weighted Input Power (kW)
90	20	36.45	91.6	90.0	6.59
80	50	25.6	90.9	80.0	13.13
70	30	17.2	86.6	70.0	6.33
				Total:	**26.05**

Note that the input power is equal to 0.746 times the shaft horsepower divided by the product of the motor and drive efficiency values. The weighted input power value is the input power times the load duty cycle percentage divided by 100. In Table 3 when the ASD is installed, the fan power requirements decrease.

Table 3. Average Power Requirements for a Centrifugal Fan with ASD Speed Control

% of Rated Fan Speed/ Flow	Load Duty Cycle, %	Load Shaft hp	Motor Efficiency,%	ASD Efficiency, %	Weighted Input Power (kW)
90	20	36.45	91.6	96	6.18
80	50	25.6	90.9	95	11.05
70	30	17.2	86.6	93	4.76
				Total:	**21.99**

As the eddy-current drive efficiency drops rapidly at loads below 70%, energy savings are very sensitive to the load profile and duty cycle. The annual energy savings for this application is:

(26.05 – 21.99) kW x 8,000 hours/year = 32,480 kWh/year

At an electrical rate of $0.05/kWh, the value of these savings is:

32,480 kWh x $0.05/kWh = $1,624/year

The above example illustrates that although early replacement of an older eddy-current drive with an electronic ASD may not meet the two-year simple payback typically required by industry, the cost effectiveness can be significantly improved if a utility efficiency incentive is available. Other factors that may favor replacement include predictive maintenance tests indicating an impending failure or when equipment fails and requires repair.

Load Considerations

An ASD may not be a suitable replacement for high-torque repetitive-slip applications such as a punch press or a crusher. Eddy-current drives can produce more torque at low speed than an induction motor and ASD. When switching to an ASD for a constant torque load, the motor and the drive may require oversizing by a factor of 150% to 200%. Eddy-current drives can be used with standard efficiency motors, do not produce harmonic distortion, are not subject to nuisance trips due to power disturbances, and operate independently of the motor power supply voltage. As eddy-current drives are not directly coupled to the load shaft, they do not transmit vibrations to the motor and provide inherent protection against load seizures. Installers must ensure that operational problems are not created through installation of an electronic ASD.

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