SASKATCHEWAN ENERGY MANAGEMENT TASK FORCES

TECHNOLOGY INFORMATION SHEET

HIGH AND PREMIUM EFFICIENCY MOTORS

Background

There are a variety of motor types available to suit electrical drive power needs. AC induction motors and DC motors are the most common but other designs such as synchronous, switched reluctance and permanent magnet motors are used in specific applications. This fact sheet specifically addresses the energy efficient improvements available for AC induction motors.

Standard Motors

Standard motors compromise efficiency, durability, starting torque, and cost. While lower quality materials and dated designs may reduce their cost, they also prevent the motors from operating as effectively as they should. Standard motors generally compete on price, not efficiency, and they are designed just efficient enough so that they do not overheat.

High & Premium Efficiency Motors

The term "high" efficiency is often used to describe any motor with an efficiency greater than a standard motor. It has no definitive meaning because the standard and high efficiency products vary between manufacturers. The term "premium" efficiency is now used to define a motor which meets the highest efficiency levels on the market. Premium efficiency motors offer improved efficiencies of 2 to 8% over standard motors. They improve upon standard motors by a number of means:

1) Increased copper (up to 60%) in the winding reduces resistance losses and operating temperatures due to the larger amount of thermal mass.

2) Improved design reduces windage and other losses.

3) Improved quality steels in an increased number of thinner laminations reduces core losses from the stator and the rotor.

4) A narrowed air gap between the rotor and the stator improves the intensity of the magnetic flux so that the same torque is available at reduced power input.

5) Complex rotor bar designs improve starting torque yet maintain efficient full speed operation.

Energy efficient motors often have less slip than their standard counterparts. Because they can rotate closer to synchronous speed, they can actually negate some the energy gains from their efficient design and operation. This is due to the additional energy required to spin the rotor faster.

Motor Efficiency Standards

AC motor efficiency testing standards have been developed in the US, Canada, Europe, and Japan and it is important to compare motors on the basis of similar testing procedures. The NEMA test procedure MG1-12.53 used in the US is quite similar to the Canadian CSA procedure C(390)-M1985 so that tested efficiencies are comparable between the two methods.

At the present time, the US standard NEMA 12-6B is defines the efficiency required to achieve a premium efficiency label. This standard is not enforced and motor manufacturers can produce motors below, to, or above these efficiency levels. Table 1 illustrates the efficiency levels expected by the NEMA 12-6B code for various motor sizes. Also in Table 1 are the comparable NEMA 12-6C

standards. The NEMA 12-6C ratings will be enforced as the minimum efficiency standards for any motor manufactured in the US as of September 1997.

Table 1: NEMA 12-6B and NEMA 12-6C Minimum Motor Efficiency Standards

Motor Size (HP)	NEMA 12-6B Enclosed Motors		NEMA 12-6C Enclosed Motors	
	3600 rpm	1800 rpm	3600 rpm	1800 rpm
1	-	77.0	74.0	81.5
10	85.5	85.5	88.5	88.5
50	88.5	91.0	91.7	92.4
100	91.7	92.4	93.0	94.1
200	93.0	93.6	94.5	94.5

Motors that meet or surpass these standards are already available. Many US states are pre-empting this legislation by requiring any motor sold in their jurisdiction to meet the NEMA 12-6C standards. Similarly, all motors sold in BC, Ontario, and Nova Scotia will be required to meet the NEMA 12-6C standard by January 1996.

It is important to note that unless the standards are legislated in each jurisdiction, it will be possible to purchase motors that do not meet the NEMA 12-6C efficiency standards since it does not apply to manufacturers outside the US (and likely Canada).

Actual motors are allowed losses up to ± 20% of their nameplate rating. This allows for variations in the materials used for their production. Therefore, any motor purchased may not meet the exact specifications on its nameplate.

Some premium efficiency motor designs have been found to have lower starting torque than standard models. There are variations across all efficiency dasses and premium efficiency motors are available to meet any starting torque requirements.

Motor Specification and Sizing

Any new motor purchase or replacement should specify the performance expectations of the motor. If the following items are included in the specification, the desired performance can be achieved from the motor, be it a standard design, or a premium model:

- horsepower and service factor
- supply voltage
- maximum starting current
- temperature rise and insulation class
- power factor range
- minimum stall time
- efficiency range
- load inertia, and number of starts
- motor duty and the operating environment
- particular protection needs and any other site-specific requirements

The efficient operation of any motor requires that it be properly specified so that it is correctly chosen for its desired duty. Motor power factors and efficiencies are generally stated for a specific load range. Operating outside this range results in poor motor performance or worse, motor malfunction. The incorrect choice of any motor, standard or premium, will result in poor motor performance and poor system performance.

Premium Performance at a Premium Price? Not Necessarily !

On average, premium efficiency motors are 15 to 30% more expensive than standard motors. There is such a spread in prices, though, that premium efficiency motors can often be purchased for the same or lower price than their standard equivalent.

Motors use approximately four times their purchase cost in electricity per year. Therefore, for any high duty motor, the added capital cost is readily recovered from the energy savings in less than 2 years.

Lower operating temperatures generally mean lower maintenance costs and longer life-expectancies.