2ND ANNUAL REFRIGERATION CONFERENCE 2018

High Efficiency Motors to Save Energy

HIGH EFFICIENCY MOTORS TO SAVE ENERGY

Motors efficiency and performance

- The electric motor is the most efficient energy converter in common use today. The energy it consumes in the form of thermal losses is in the order of five times lower than the losses in the machines it drives.
- Nevertheless, some motor types and end applications offer the opportunity to reduce motor losses by 20% to 40%.
- The energy efficiency of a typical (50) HP motor found in HVAC&R applications is 90%. A 20% to 40% reduction in losses means an efficiency improvement to 93% or more.
- Industry studies indicate that larger electric motors (over 125) HP are already highly efficient due to purchasing influences from end users. On the other hand, motors under (125) HP have traditionally been purchased more on the basis of first cost, size, and weight than on energy efficiency. Thus, for motors in typical HVAC&R applications, an opportunity exists for higher efficiency and resulting energy conservation.
- Motor labeling: Indicating the efficiency on the motor nameplate informs buyers so the most efficient motor can be selected for a given application.

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Motors efficiency and performance:

The National Electrical Manufacturer's Association (NEMA) adopted standard MG 1-12.54.1 that calls for the nominal efficiency of poly phase motors (1 to 125) HP to be identified on the motor nameplate. The NEMA standard is based on testing a statistically valid sample, so the NEMA efficiency table below includes both a nominal and a minimum full load efficiency value expected from a large population of motors of a given design. The nominal efficiency value represents the average efficiency of a large population of motors of the same design. The minimum efficiency is the lowest efficiency allowed for a motor of specific design within a designated efficiency band.

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Motor losses and loss reduction techniques:

The only way to improve motor efficiency is to reduce motor losses. Since motor losses result in heat rejected into the atmosphere, reducing losses not only save energy directly but also can reduce cooling loads on a facility's air-conditioning system.

Motor energy losses can be segregated into five major areas. Motor losses may be grouped into fixed losses and variable losses. Fixed losses occur whenever the motor is energized and remain constant for a given voltage and speed. Variable losses increase with motor load.

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The five loss categories are:

Fixed losses

1- Core loss

2- Windage/friction loss

Variable losses

1- Stator losses

2- Rotor losses

3 Stray load losses

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- **Core losses:**

Core losses result from energy required to magnetize the core material (hysteresis) and include losses due to eddy currents that flow in the core. Core losses may be decreased by using improved permeability electro- magnetic (silicon) steel, and by lengthening the core to reduce magnetic flux density. Eddy current losses are reduced by using thinner steel laminations. Core losses are fixed and typically represent 15% to 20% of total motor losses.

- **Windage and friction losses:**

Those are due to air resistance and bearing friction. Improved airflow design, fan design, and bearing selection reduce theses losses. In an energy efficient motor, reducing losses reduces cooling requirements, so the motor manufacturer can use a smaller fan. Windage and friction losses are fixed losses and typically represent 5% to 10% of total motor losses.

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- **Stator losses:**

Appear as heating due to current flow through the stator winding. These losses are some times called I^2R losses referring to current flow (I) and resistance ® of the current carrying conductor. I^2R losses can be decreased by modifying the stator slot design or by decreasing the insulation thickness to increase the volume of wire in the stator. Stator losses are variable losses and typically represent 40% to 45% of total motor losses.

- **Rotor losses:**

Appear as I^2R heating in the rotor winding. Rotor losses can be reduced by increasing the size of the conductor bars & end rings to reduce resistance or by reducing electrical current. Rotor losses are variable & typically represent 20% to 25% of motor losses.

- **Stray load losses:**

Are the result of leakage flux induced by the load current. They are variable losses & typically represent 10% to 15% of total motor losses.

Thank you