

DESIGN AND MAINTENANCE CONSIDERATIONS FOR DRY KILN MOTORS

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Abstract

Dry kiln motors can best be described as "Definite Purpose" motors due to the high ambient temperature in which they are operated and the gasses present during the drying process. As a result, motors produced for this application must incorporate special design features to provide long life and reliability.

Design Considerations

NEMA (National Electrical Manufacturers Association) defines the standard operating conditions for electric motors. This would include operation at altitudes of 1,000 meters above sea level (3,300 feet) with ambient temperatures less than or equal to 40 degrees centigrade. In the kiln environment, ambient temperatures routinely meet 90 degrees centigrade. As a result, the motor designer is required to evaluate the insulation system being used along with the bearing types and type of lubrication used.

Typically, dry kiln motors are manufactured with a class "H" insulation which has a rating of 180 degrees centigrade (total temperature). With an ambient of 90 degree centigrade, a motor must not exceed a winding temperature rise of 90 degrees to fall within the insulation system capabilities. At this temperature, the insulation system would have an average design life of approximately three years.

There is a rule of thumb that for every ten degrees cooler that the motor is running, the insulation system design life will double. Therefore, it is desirable to design the motor to operate at a temperature below the 90-degree rise limit.

During the drying process, there are many vapors and gasses released. These gasses may attack the motor's insulation system. As a precaution, additional dip and bake cycles may be used or the application of a scotchcast system coating the coil head may be applied.

Another consideration is applying motors with adjustable frequency drives for energy savings and speed control. When looking at the wave form of an inverter fed system vs. a sine wave system you will notice two items. First, there are additional harmonics on the drive waveform. These harmonics cause additional losses in the motor and since all losses generate heat, the motor winding (and bearings) will run hotter when powered by a drive than when on sine wave. The amount of additional heating varies by the technology employed in the drive but could range from 5 to 30% additional heating.

The second item to review when applying drive technology is the high spike voltages with a short rise time, which is the result of the switching frequencies of the transistors. This causes a significant stress to the motor's winding. To address this

concern, motor manufacturers can wind the motor with an inverter grade insulation system to handle these high stress voltages. There is a section in NEMA (Section 31) for "inverter duty motors" and in it the surge withstand requirement of an insulation system is 1,600 volts peak with a 0.1 microsecond rise time. It is recommended that this capability be a standard requirement for motors operated with adjustable frequency drives.

In many applications, there will be a single drive powering multiple motors. For this situation, it is necessary to add the individual cable lengths to determine the effective cable length for consideration of filters or line reactors. This may be necessary to reduce the transmission line ringing effect and keep the spike voltage and rise time within the insulation system's capabilities (review this with your motor / drive supplier).

The motor bearings also need special consideration. As with the motor winding insulation system, there is a rule of thumb concerning the bearing lubrication. For every additional 15-degree centigrade rise, the lubrication life is cut in half. As a result, motor manufacturers will use an open bearing with a high temperature grease such as Dow Corning DC44 grease. These greases are designed for operation in high temperature environments and will provide extended lubrication life as compared to standard, general-purpose greases.

As a word of caution, do not mix greases without verifying compatibility with either the motor manufacturer or the grease manufacturer. Due to the reactions of the various materials used in the grease, you can end up with a mixture, which has properties significantly less than that of the individual grease. There are many examples of catastrophic bearing failures when incompatible greases are used.

Maintenance Considerations

Many times we begin to think about maintenance after the product is installed. However, there are practices and procedures to consider before and during product installation. To begin, you want to insure that the motor is properly sized for the application and incorporates design and construction features (class of insulation and lubrication) to handle the environmental issues present in the kiln. For direct-coupled applications, precision alignment and mounting is required for increased bearing life.

Typically, the fan is mounted directly to the motor shaft. If possible, it is desirable to run a vibration test to determine the initial conditions. Over time, there may be a buildup of creosote and other materials causing the fan to become out of balance. This will quickly reduce the bearing life if corrective measures are not taken.

After the motors are in operation, an ongoing program consists of a motor lubrication program where the recommended quantity and type of grease is added at the recommended time interval. During this time the ventilation is reviewed to insure that there are no restrictions to the airflow during operation. It is a good practice to periodically check the insulation resistance with a megger test. Toshiba recommends close monitoring when a value of 10 megohms is reached. Per the IEEE 43 standard, a motor should be taken out of service and reconditioned when a value of 1.5 megohms is reached.

Another area typically overlooked is the power system. This includes the balance of the voltage and a determination if there is high or low voltage at the motor terminals. As the motor is designed for a 230, 460 or 575-volt system, an unbalance or undervoltage

condition will result in additional motor heating and a reduction in insulation and lubrication life.

Conclusion

As the dry kiln environment has both high ambient temperatures and various gasses present, it is necessary to order electric motors with special construction features. These features include a full class "H" high temperature insulation system and open bearings with high temperature grease. For motors powered by variable frequency drives, the insulation system must also be designed to withstand the additional heating and surge voltages present. With these features, proper installation and a maintenance schedule which includes verification of the insulation resistance and proper regreasing (quantity, interval and type of lubricant), today's electric motors will provide long life and high reliability in the dry kiln application.