NEKDA FALL MEETING OCTOBER 2014

Kiln motor recommendation, maintenance and repair savings

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Question?
Are you sure the person in charge of the maintenance of your kiln motors knows what to do, when, and how to do it?
In fact ...

Examples of Motor Failures
Overgreased Bearings

Fact: Most kiln motor problems are caused by mechanical failures.

Case: Overgreased bearings

Reason: Drain plug closed or not functioning properly.

Results: Overheating which increases resistance of rotating parts, compression of lubricant and eventually affects bearing durability.

Dried Bearings

Case: Dried bearings

Reason:
• Lack of regreasing
• Grease incompatibility
• Grease contamination
• Zirt not functioning
• Bearing currents (VFD)

Results:
• Bearing overheating
• Deterioration of bearing housing (rotor + end bells)
• Amperage increase
• Loss of properties: hardened grease, oil separates from soap, change of color, etc.
**Rust and Corrosion Inside Motor**

Case: Rust and corrosion inside the motor

Reason:
- Water condensation (extreme T° variation)
- Drain not open (vertical motor)
- Weakness of seal
- Long period of non-use

Results:
- Ground fault
- Bearing failure
- Overload problem

**Rotor Scrubbing Stator**

Case: Rotor scrubbing stator

Reason:
- Lack of grease
- Vibration problem
- Bearing current (VFD)

Results:
- Ground fault
- Bearings failure
- Overheating
Some examples of winding failures

Heat Effects on Motor

MOTOR INSULATION LIFE AS AFFECTED BY TEMPERATURE

Figure 9 helps estimate the impact that voltage frequency variations have on the winding insulation life once the temperature change is determined.

As shown in Figure 9, for every 10°C increase in winding temperature, the expected thermal life of the winding is reduced by half. There may also be a notable decrease in bearing lubricant life as the operating temperature of the motor increases.

6. Ambient Temperature

NEMA Std. MG 1-2009, Rev. 1-2010. 1243 cells for standard motors to be designed to operate in a maximum of 49°C ambient. Table I indicates the effects that exceeding this limit can have on the insulation life, assuming the motor is operating at rated load when designed to operate at Class B temperatures with Class F insulation materials.

<table>
<thead>
<tr>
<th>Ambient °C</th>
<th>Insulation life - hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>250,000</td>
</tr>
<tr>
<td>40</td>
<td>125,000</td>
</tr>
<tr>
<td>50</td>
<td>62,000</td>
</tr>
<tr>
<td>60</td>
<td>30,000</td>
</tr>
</tbody>
</table>
Typical Failures in Three-Phase Stator Windings

1. Winding single-phased (wye-connected)
   A single-phased winding failure is the result of an open in one phase of the power supply to the motor. The open is usually caused by a blown fuse, an open contactor, a broken power line or bad connections.

2. Winding single-phased (delta-connected)
   A single-phased winding failure is the result of an open in one phase of the power supply to the motor. The open is usually caused by a blown fuse, an open contactor, a broken power line or bad connections.

3. Winding shorted phase-to-phase
   This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.

4. Winding shorted turn-to-turn
   This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.

5. Winding with shorted coil
   This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.

6. Winding grounded at edge of slot
   This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.

7. Winding grounded in the slot
   This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.
Typical Failures in Three-Phase Stator Windings

**Shorted connection**
This type of insulation failure is typically caused by contaminants, abrasion, vibration or voltage surge.

**Phase damage due to unbalanced voltage**
Thermal degradation of insulation in one phase of the stator winding can result from unequal voltage between phases. Unequal voltages usually are caused by unbalanced loads or the power source, a poor connection at the motor terminal, or a high resistance contact (weak spring). Notice: A one-percent voltage unbalance may result in a ten percent current unbalance.

**Winding damaged due to overload**
Thermal deterioration of the insulation in all phases of the stator winding typically is caused by load demands exceeding the rating of the motor. Notice: Under-voltage and over-voltage (exceeding NEMA standards) will result in the same type of insulation deterioration.

**Damage caused by locked rotor**
Several thermal deterioration of the insulation in all phases of the motor normally is caused by very high currents in the stator winding due to a locked rotor condition. It may also occur as a result of excessive starts or reversals.

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**Question?**

Are you sure that your motor repair shop that takes care of your kiln motor is doing the right thing?

Do you know and understand the cause of your motor failure?
What you should expect from your motor repair shop

Make sure that you receive a detailed report about the conditions of your motor and the explanations of its failures. If you don’t know and don’t understand why your motor is defective, how can you improve its efficiency?

When it's time to pay for the repair …don’t hesitate to ask for:

- Class H insulation materials
- Class H varnish
- High temperature grease (compatible)
- High temperature leads wire (sleeving)
- Lap winding for a better heat distribution
- High temp silicone gasket (J Box)
- Inverter Duty copper magnet wire (VFD)

### Table: Temperature Withstand Capabilities

<table>
<thead>
<tr>
<th>Insulation class</th>
<th>Maximum allowed temperature (IEC 60085-1, T96)</th>
<th>Maximum allowed temperature (NEMA MG-1-2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>105°C 221°F</td>
<td>105°C 221°F</td>
</tr>
<tr>
<td>B</td>
<td>130°C 266°F</td>
<td>130°C 266°F</td>
</tr>
<tr>
<td>F</td>
<td>155°C 311°F</td>
<td>155°C 311°F</td>
</tr>
<tr>
<td>H</td>
<td>180°C 356°F</td>
<td>180°C 356°F</td>
</tr>
<tr>
<td>C</td>
<td>&gt;180°C 356°F</td>
<td></td>
</tr>
</tbody>
</table>

Image of concentric winding that does not use all the slot space available in the stator

Image of lap winding that shows a complete use of the slot space filled with copper wires to maximize heat dissipation.
Lubrication

Grease classifications:

<table>
<thead>
<tr>
<th>BUSH GROUP</th>
<th>TEMPERATURE RANGE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-40 to 200</td>
<td>Low temperature, general use</td>
</tr>
<tr>
<td>2</td>
<td>0 to 200</td>
<td>Medium temperature, light duty</td>
</tr>
<tr>
<td>3</td>
<td>200 to 350</td>
<td>High temperature, heavy duty</td>
</tr>
<tr>
<td>4</td>
<td>350 to 450</td>
<td>Very high temperature, extreme conditions</td>
</tr>
</tbody>
</table>

Lubrication:

- Properly clean grease fittings before and after each greasing of bearings.
- While motor is running, apply necessary quantity of grease.
- Let motor run sufficiently for grease to spread in bearings until grease excess starts coming out of grease fittings.
- However, if no grease comes out of grease fittings, make sure that grease fittings are functioning properly.
- To avoid overheating, do not apply more grease than necessary in bearings. This would increase resistance of rotating parts, compression of lubricant and consequently cause an eventual loss of efficiency.
Recommended maintenance schedule

Proceed with the following inspections every 6 months:

- Winding resistance and insulation resistance to ground – with a multimeter and a megger.
- Winding resistance in ohms between phases (T1 vs T2, T1 vs T3, T2 vs T3) must be the same.
- Insulation resistance in megohms at 500vdc or 1000vdc
- Ground for feeding cable.
- Condition of bearings.
- On the shaft, axial and radial mechanical movement must not be apparent.
- Make sure fan is properly fixed to shaft.
- Junction box must be very clean without water or dirt inside.

Recommended maintenance schedule

Proceed with the following inspections every 12 months:

- Make sure that fan does not vibrate, nor is damaged and that it is dirt-free.
- Its rotation must be regular.
- Make sure that motor is well fixed to its anchors.
- Make sure that the connecting cable to the motor wires is fixed and free of any corrosion or damage in the feeding cable protective sleeve and motor junction wires.
- Make sure that the junction box and covers are well fixed and waterproof.
Variable frequency drive

Advantages to use a variable frequency drive:
- Helps control the soft-starting of the motors (less vibration)
- Helps control the speed of the fan during the drying schedule
- Protect motors against electrical problem such as
  - Power loss – Phase loss
  - Improvement of the Power Factor (KVA / KVAR)

Disadvantages to use a variable frequency drive:
- Create harmonics on the power lines (heat factor in windings)
- Create bearings currents (heat factor in bearings)
- Create disturbance on electronics components

Variable Frequency Drive

Energy Saving Rules
Principales of variable torque application

*Figure 20. Variable Torque Load*
Variable Frequency Drive

Improvement of the Power Factor (KVA – KVAR)

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\begin{align*}
\text{kW} & : \text{Active Power} \\
\text{kVA} & : \text{Total Power} \\
\text{KVAR} & : \text{Reactive Power} \\
\text{PF} & = \frac{\text{kW}}{\text{kVA}}
\end{align*}
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Questions period

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