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NEKDA FALL MEETING OCTOBER 2014

Kiln motor recommendation,
maintenance and repair savings

Presented by: Eric Bourque

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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?

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In fact …

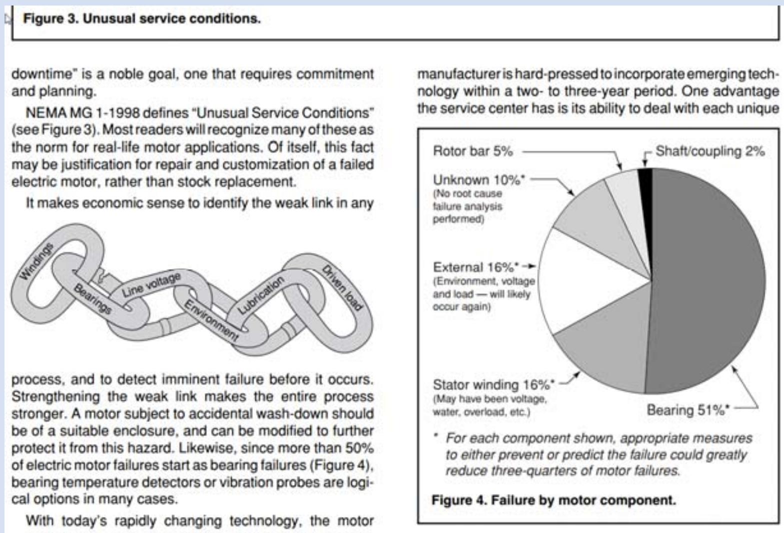

Figure 3. Unusual service conditions.

downtime" is a noble goal, one that requires commitment and planning.

NEMA MG 1-1998 defines "Unusual Service Conditions" (see Figure 3). Most readers will recognize many of these as the norm for real-life motor applications. Of itself, this fact may be justification for repair and customization of a failed electric motor, rather than stock replacement.

It makes economic sense to identify the weak link in any

process, and to detect imminent failure before it occurs. Strengthening the weak link makes the entire process stronger. A motor subject to accidental wash-down should be of a suitable enclosure, and can be modified to further protect it from this hazard. Likewise, since more than 50% of electric motor failures start as bearing failures (Figure 4), bearing temperature detectors or vibration probes are logical options in many cases.

With today's rapidly changing technology, the motor manufacturer is hard-pressed to incorporate emerging technology within a two- to three-year period. One advantage the service center has is its ability to deal with each unique

** For each component shown, appropriate measures to either prevent or predict the failure could greatly reduce three-quarters of motor failures.*

Figure 4. Failure by motor component.

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Examples of Motor Failures

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Overgreased Bearings

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

Case:
Overgreased bearings

Reason:
Drain plug closed or not functionning properly.

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

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Dried Bearings

Case: Dried bearings

Reason:
- Lack of regreasing
- Grease incompatibility
- Grease contamination
- Zirt not functionning
- 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.

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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




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Rotor Scrubbing Stator

Case: Rotor scrubbing stator

Reason:

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

Results:

- Ground fault
- Bearings failure
- Overheating



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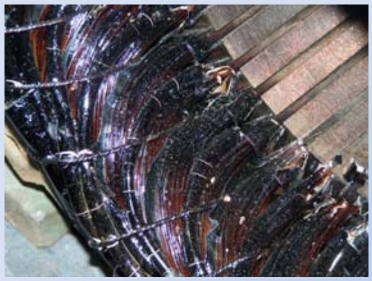
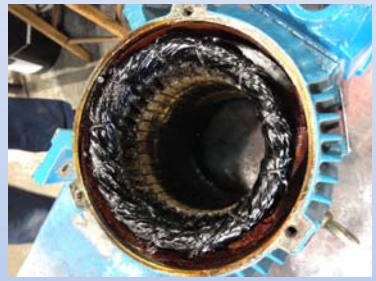
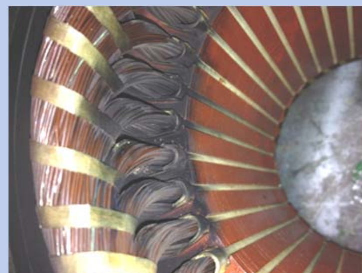
Some examples of winding failures







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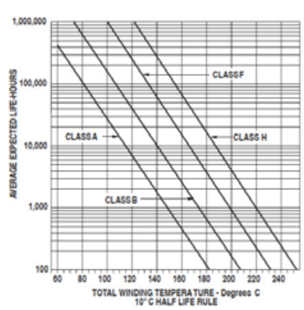
Heat Effects on Motor

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.

Figure 9



Temperature vs. life curves for insulation systems (per IEEE 117 & 101)

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 Stds. MG 1-2009, Rev. 1-2010, 12.43 calls for standard motors to be designed to operate in a maximum of 40°C ambient. Table 1 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 1: AMBIENT TEMPERATURE VS. INSULATION LIFE

Ambient °C	Insulation life - hours
30	250,000
40	125,000
50	60,000
60	30,000

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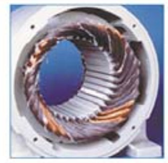
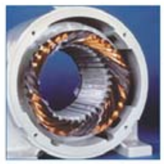
Typical Failures in Three-Phase Stator Windings

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.





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.

Winding shorted phase-to-phase

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

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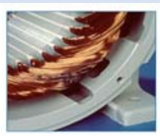
Typical Failures in Three-Phase Stator Windings



Winding shorted turn-to-turn

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

Winding with shorted coil

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

Winding grounded at edge of slot

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

Winding grounded in the slot

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

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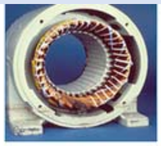
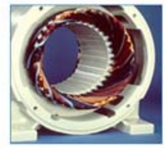
Typical Failures in Three-Phase Stator Windings



Shorted connection

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

Phase damage due to unbalanced voltage



Thermal deterioration of insulation in one phase of the stator winding can result from unequal voltage between phases. Unequal voltages usually are caused by unbalanced loads on the power source, a poor connection at the motor terminal, or a high resistance contact (weak spring). **Note:** A one-percent voltage unbalance may result in a six- to 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. **Note:** Under-voltage and over-voltage (exceeding NEMA standards) will result in the same type of insulation deterioration.

Damage caused by locked rotor

Severe 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?

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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 3. TEMPERATURE WITHSTAND CAPABILITIES

Insulation class	Maximum allowed temperature (IEC 60034-1; 1998)		Maximum allowed temperature (NEMA MG1-12.43)	
A	105° C	221° F	105° C	221° F
E	120° C	248° F		
B	130° C	266° F	130° C	266° F
F	155° C	311° F	155° C	311° F
H	180° C	356° F	180° C	356° F
C	>180° C	356° F		

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What you should expect from your motor repair shop

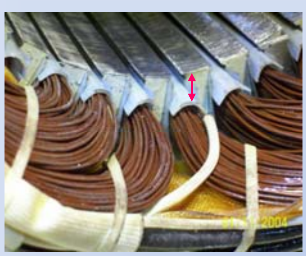

Image of concentric winding that does not use all the slot space available in the stator

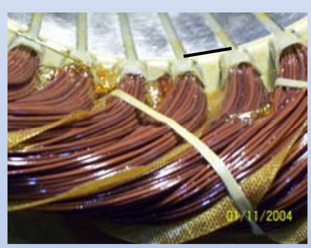

Image of lap winding that shows a complete use of the slot space filled with copper wires to maximize heat dissipation.

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Lubrication

GREASE CLASSIFICATIONS

NLGI* GROUP	TEMPERATURE RANGE						APPLICATION
	°F			°C			
1	-40	to	250	-40	to	121	General purposes
2	0	to	300	-18	to	149	High temperature
3	32	to	200	0	to	93	Medium temperature
4	-67	to	225	-55	to	107	Low temperature
5		to	450		to	232	Extreme high temperature

* NLGI stands for the National Lubricating Grease Institute.

GREASE COMPATIBILITY CHART

	Aluminum Complex	Barium Complex	Calcium Stearate	Calcium 12-Hydroxy	Calcium Complex	Calcium Sulfonate Complex	Clay (Non-Soap)	Lithium Stearate	Lithium 12-Hydroxy	Lithium Complex	Polyurea (Conventional)	Polyurea Shear (Stable)
Aluminum Complex	-	I	I	C	I	B	I	I	I	C	I	C
Barium Complex	I	-	I	C	I	C	I	I	I	I	I	B
Calcium Stearate	I	I	-	C	I	C	C	C	B	C	I	C
Calcium 12-Hydroxy	C	C	C	-	B	B	C	C	C	C	I	C
Calcium Complex	I	I	I	B	-	I	I	I	I	C	C	C
Calcium Sulfonate Complex	B	C	C	B	I	-	I	B	B	C	I	C
Clay (Non-Soap)	I	I	C	C	I	I	-	I	I	I	I	B
Lithium Stearate	I	I	C	C	I	B	I	-	C	C	I	C
Lithium 12-Hydroxy	I	I	B	C	I	B	I	C	-	C	I	C
Lithium Complex	C	I	C	C	C	C	I	C	C	-	I	C
Polyurea (Conventional)	I	I	I	I	C	I	I	I	I	I	-	C
Polyurea (Shear Stable)	C	B	C	C	C	C	B	C	C	C	C	-

Relative Compatibility Rating

B = Borderline C = Compatible I = Incompatible

NOTE: This chart is a general guide to compatibility. Specific properties of greases can dictate compatibility. Testing should be done to determine if greases are compatible.

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Lubrication

Use following table for quantity of grease* to apply :

Bearings	Grease	Bearings	Grease
6200 to 6207	0.177 oz (5 grams)	6304 and 6305	0.177 oz (5 grams)
6208 to 6210	0.353 oz (10 grams)	6306 to 6308	0.353 oz (10 grams)
6211 to 6215	0.530 oz (15 grams)	6309 and 6310	0.530 oz (15 grams)
6216	0.706 oz (20 grams)	6311 and 6312	0.706 oz (20 grams)

Grease bearings after each 720 hours of use as per the following procedure: (Never exceed 2200 hours of use)

•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;

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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.

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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.

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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

Improvment 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

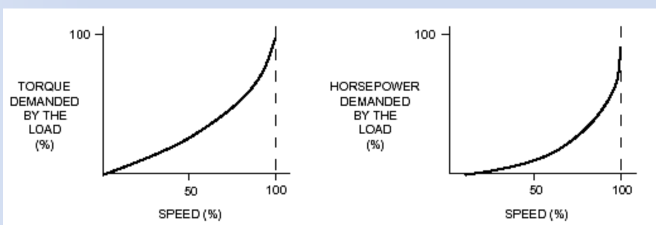
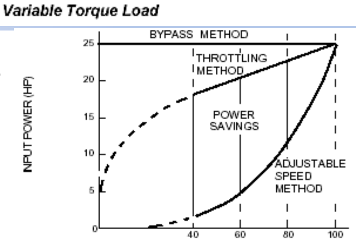


Figure 20. Variable Torque Load

SPEED	VOLUME OR FLOW	INPUT HP
100%	100%	100%
90%	90%	73%
80%	80%	51%
70%	70%	34%
60%	60%	22%
50%	50%	13%
40%	40%	6%
30%	30%	3%



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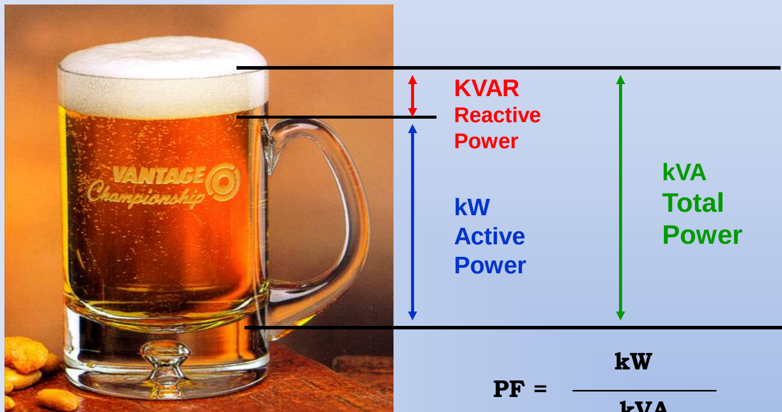
Variable Frequency Drive

Improvement of the Power Factor (KVA – KVAR)



$$PF = \frac{kW}{kVA}$$

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Questions period

Eric Bourque
EBI Electric inc.
2250, 90th street
St-Georges, QC, Canada G5Y 7J7
Tel: (418) 228-5505 Ext: 228
Toll free: (800) 228-5505 Ext: 228
Fax: (418) 228-5630
Email: ebourque@ebielectric.com