IMPROVING KILN MOTOR RELIABILITY

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Background

This presentation is meant to give insight to the saw mill industry where the use of 3-phase AC induction motors in kiln applications expose new and old issues in regards to maintaining machine or kiln uptime.

This presentation will cover areas where application and product design have gone through changes to improve reliability. These changes coupled with improving end user product knowledge through available technical services can dramatically improve the motors uptime and deliver savings.

Subject Material

- Changes in the Industry
- What does a motor need to survive?
- How to improve total cost of ownership

With all potential solutions there comes a need for documentation of the past history before true change or improvements can be made. Since the introduction of these types of motors to this environment, there has always been a need to incorporate specific design aspects to improve the kiln motor. All base kiln designs stem from standard type designs used in softer or less severe environments. In addition to this need for design improvement, which should come from the manufacturer there is also a need to focus facilities on what can be done from within their organization to make additional improvements in life cycle.

Changes in the Industry

Toshiba receives product feedback through many channels, some are through the traditional paths of service or warranty reports, which if submitted and documented properly are great tools. Many times however the feedback of specific site issues is not well documented and dictates a more direct involvement in order to separate fact from emotion. Over the past 2-3 years we have documented these site issues and found some very common threads.

Common Issues:

A. An over all loss of motor knowledge in some facilities and typically would rely upon one single person.
B. Changes in operating conditions saw an increase in ambient from the typical 90 to upwards of 135 ˚C.
C. Increased usage of ASD's (adjustable speed drives).

D. A lack of motor records, storage and clearly defined PM programs.

E. Industry itself has seen a steady decline or loss in motor knowledge over the past few years. Senior employees built their knowledge through years on the job, more active maintenance programs and from other senior employees. The decline of knowledge is common over many industries due to outsourcing of service, retirements or reduction of people. In addition an extremely soft economy in 2002 and 2003 caused many companies to not replace workers and place more load on those senior people. This loss is then more dramatic in impact if this employee leaves or is loss to the company.

F. Changes in operating conditions occurred as the result of a need for more flexible production to allow faster drying cycles. The biggest impact to the motor took place when ambient conditions changed from what used to be the industry norm (90 deg C) to ambient's as high as 135 deg. C. This change was not completely understood until the data gathered by the field research with end users and kiln manufacturers.

G. With the increased and now widely accepted application of ASD's came improvements in production and reduction in energy cost. However with these devices comes another level of needed end user knowledge in how to properly apply these devices to avoid serious impact to the motor's life. These issues are further discussed in slides 20 and 21 found in the last half of this presentation.

There are advantages to selecting manufacturers who design, build and market motor and ASD together. Those potential issues can be avoided or greatly reduced by choosing common manufacturers and receiving "System Responsibility" instead of finger pointing in the event of motor failures resulting from poor installations.

H. Lack of proper motor records results in loss of control concerning health of system and in particular the component such as the motor. True failure root cause analysis can be greatly improved with something as simple as an excel data base used to retain information by serial number or equipment tag numbers. This data base can improve making better decisions on whether to repair or replace, accurate motor information concerning horsepower, speed, frame and other pertinent information. There are out of the box software systems that can be purchased that not only address the previous documentation issues but can also assist in setting of good preventative maintenance programs. Motor storage as simple as it sounds, is many times the last thing thought of to improve life cycles. This simple understanding can avoid issues such as false brinelling of bearings due to exposure to high vibration or sudden impact and reduction of insulation health due to high moisture.

I. As a result of the data and feedback obtained Toshiba began a program to improve its Kiln Motor life cycle. This has culminated in an overhaul of Toshiba's proven track record in this industry. The results of the product changes are leading to an increase in motor uptime and reflecting in increased production or output. Further research will be performed to correlate field information such as lubrication and periods between calculations and component studies. This field research is targeted to complete the initial evaluations within the next few months.

What Does a Motor Need to Survive?

An ODP (Open Drip Motor) gets its cooling from the construction of the motor and how air circulates through the motor. ODP style motors are the typical or preferred for the kiln's fan deck due to the high ambient conditions. The key to operation is the free flow of air inlet coming in from the ends of the motor through the end bracket inlet and exhausting out the side openings of the frame. Concerns should be to not restrict incoming or exhaust air. Restrictions can also occur by mounting the fan too close to the end bracket thus blocking the inlet. Blockage will cause the motor to run over its intended temperature rise and will cause a roasting condition of the winding. A rough rule of thumb is that spacing should be equal to or greater than the rough area of the end bracket inlet in square inches or feet. Another method is to take a 4-6" piece of paper and hold it up to the inlet, it should tend to be sucked tight against the end bracket. Using the same piece of paper and holding it onto the exhaust outlet, it freely moves away from the frame opening and will not circulate back towards the opening.

When reviewing the construction of your motor pay attention to the materials used or the lack there of. Toshiba focused on 2 key areas of concern: moisture and heat.

When 90 deg C design traditional units were used in ambient's approaching the 100 deg C mark cracking of the scotch cast system would occur. When the costing cracked moisture in the winding would send ground fault detection to the ASD unit and the unit would shut down the motor. Moisture was the key since interviews with the more senior mill operators revealed that the operator would simply leave the motors in the high ambient and allow the motor to bake out the moisture, then the operator would restart the unit and continue the charge process.

Toshiba focused its improvement around components that withstand moisture; this was validated by the IEEE Immersion test standard. Standard components such as inverter grade wire failed when individually tested. Older technology such as single Daglas coated wire was found to be more resistant to moisture. In addition this wire has a higher degree of dielectric strength. Other components changed were the lead wire going from a glass braid Class H material to a silicon jacket Class H material. The last key is the connection and developing a sealing method that resisted the penetration of moisture. Final stage was the removal of the older scotch cast system to reduce potential winding rise issues. Remember that a Class H recognized system is 180 deg C, this includes the ambient of 135 deg C in some cases. So keeping a low winding rise is crucial to maintaining the ability to nameplate.

Additional changes concerning greases were initiated after field testing a newer technology Exxon/Mobil Mobilith SHC 460 product against the incumbent Dow Corning DC 44 product traditionally used. The results and potential savings in addition to the support provided for the newer product convinced Toshiba of the need to upgrade. Further field testing will continue to calibrate the calculated intervals to the real world conditions being performed in the field. This study should be complete within the next few months and will document 18 months of operation in new field sights. Key is using a higher viscosity rated grease to maintain the needed film thickness for the high ambient.

Increased Usage of ASD's (Adjustable Speed Drives)

1. Motor Lead Length
    a. PWM output pulses are not true square waves
        i. Voltage overshoots on the leading edge of the pulse.
            (1) These leading edges can cause motor insulation failure
        ii. Amount of overshoot depends on:
            (1) power components used
            (2) hardware and software snubber circuits
            (3) inductances in the inverter bridge
            (4) load
        iii. Overshoot on commercially available frequency drives vary between 0 to 50%
2. Motor Lead Length
    a. PWM output pulse train is similar to surge waves in the ocean
        i. The longer the median the higher the standing wave.
        ii. Output pulse train travels in the motor cable at 150m/µs (approximately 1/2 the speed of light)
3. Motor lead wire is a complex circuit
    a. wire resistance
    b. lead to lead capacitance
    c. lead to ground capacitance
    d. wire inductance
4. Motor lead length may increase (or multiply) any overshoot as will an increase in carrier frequency
5. Motor Lead Length
    a. Drive manufacturers publish guidelines for maximum lead lengths.
    b. Allowable lead lengths from one manufacturer to another can vary significantly.
    c. Adding output filters can help extend the allowable lead lengths but can add 15% to 20% to the cost of the drive.
6. Multiple Motors
    a. Each motor must have overload block
    b. Drive motor overload 'turned' off
    c. Aux. Contact from motor overload blocks series wired to drive enable input.
    d. Lead length is considered to be sum
    e. Drive 100% amps should be sum of motor FLAs PLUS 10%

Lack of Motor Records, Storage and Clearly Defined PM Programs

During the site visits and interviews conducted it was very apparent that most mills still had questions on what was a proper PM program and what it could achieve. The case example shown in this presentation clearly identified and concluded that a good PM program can save significant dollars and improves a mills bottom line. There are clearly two philosophies in the purchase and operation of equipment in industry today.

One of these philosophies is to buy components on quality and reliability over cost due to the understanding that if equipment is running then it is making money. The other philosophy is buy it at a low cost and run it till it dies. This philosophy follows the line of get good at fixing things rather than addressing root cause of failures or down time. Many companies today are beginning to take back the buy decisions and place them back into the facility rather than corporate procurement. The other philosophy focuses on the health of their assets due to the philosophy of reliability.

PM programs do not have to demand time but rather they focus more on planning. As shown in the case study key tools such as:

- Base line vibration and periodic measurements can help to predict and allow scheduled motor replacements as other PM activities are performed or as the kiln is unloaded for a different production load. There are simple meters that do not require technical or college degrees to operate, the simple method of consistent placement of the vibration probe and consistent documentation of the data is all that someone needs in order to evaluate health of the equipment.

- Simple spot checks on fans for dirt and build up help prevent vibration issues, which can result in bearing loads increased, heat build up and failure.

- Proper storage of motors, as simple as it may sound, can prevent issues such as brinneling or loss of lubricant, so do not underestimate the value of rotating stored motor shafts. This replenishes the film needed between the races and rolling elements.

Document storage is an easy way to help track and resolve motor performance and can assist in root cause analysis of failures. In addition, motors that have seen rewinds should be tracked due to core loss potential. This can lead to overheating of the motor in addition to poor efficiency performance.

The use of technical services is essential to facilities simply due to the reduction in manpower that many facilities have encountered as business conditions sometimes dictate.

These potential services are typically free and can educate personnel of the basic needs such as motors or lubrication. The case study shown could not have occurred if the facility had not called on their supplier to assist. A supplier should always welcome the opportunity to assist and take this as a way to gather customer feedback on their products.

The last key issue to a good PM program is to get involved with your EASA or motor rewind shop. Too many companies do not take the time to check and validate failures as a simple means of documentation. There are very simple text book examples of specific types of winding and bearings failures that can expose misapplication or lack of proper preventative maintenance. Simple steps such as cutting a failed bearing in half can sometime give immediate answers to why something failed like fluting of raceways due to shaft voltages induce from drive applications.

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