Rotary Kiln Maintenance Procedures

State of the Art Rotary Kiln Maintenance Technology

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Products and Services

The technical procedures described in this document, developed in large part by North American Kiln, make use of the latest advances in rotary kiln maintenance technology. Our products and services are state of the art. Our major kiln maintenance and repair activities are broken down as follows:

1. Hot Kiln Alignment - NAK provides the most accurate and comprehensive kiln alignment in the industry. Our procedure consists of optimizing shell ovality, without exceeding acceptable bearing pressures or hertz pressures. We locate the kiln axis coordinates using computerized laser procedures. In addition to aligning the kiln axis, we measure the thrust load on all support rollers and make bearing adjustments to minimize thrust loads. North American Kiln is the only company that includes all necessary support roller adjustments as part of the kiln alignment scope of work. We utilize high capacity torque wrenches, with which we can make bearing adjustments with speed and accuracy. Because of the efficiency of our experienced crews the cost of our alignments is the lowest in the industry. Our alignment procedures do not require kiln downtime.

2. Tire and Roller Resurfacing - We have state of the art grinding equipment to resurface tires and support rollers to OEM tolerances. We have been active in developments in grinding technology as applied to tire and roller resurfacing. We gave several seminars and published articles related to tire and roller grinding. As part of our grinding service we measure the shell ovalities and make roller adjustments to correct kiln misalignment caused by the changes in the tire and roller radiuses. No other company provides kiln alignment adjustments and shell ovality measurements as part of the grinding scope of work. As is the case with our alignments, the grinding procedures do not require kiln downtime. All measurements and repairs are done with the kiln in full operation.

3. Kiln Preventive Maintenance Service – Every four months we provide two technicians and all equipment necessary to inspect a kiln, measure the shell ovality on all piers, adjust all support rollers to minimize thrust loads, and make prioritized repair recommendations. Our reports include trending of variables critical to kiln operations, like shell ovality and tire clearance. This cost-effective preventive maintenance concept significantly improves kiln run time and productivity. All measurements and adjustments are done with the kiln in operation.

4. Major Kiln Repairs - We provide parts and labor for shell section replacements, gear reversals or installations, kiln seals, tire support pad replacement and all other kiln mechanical repair work. All work is done to OEM standards or better.

5. Replacement Parts - North American Kiln is active in the after market for kiln replacement parts. We supply new tires, support rollers, and thrust rollers, gears, gear spray systems, shell sections and bearings for all makes of kilns. Our parts are fabricated to OEM specifications or better. Using our fabrication capabilities kiln owners can save about 30% of the cost of parts obtained from kiln manufacturers.

6. Lubricants - We offer a full line of kiln lubricants. Our support roller bearing oil, BearingLube™, has no equal on the market today. We guarantee it to decrease the temperature of hot bearings, regardless of the cause of high temperatures.

Introduction

The reliable maintenance of rotary kilns requires an understanding of the prerequisites for the mechanical stability of the various interacting components. Timely and proper maintenance procedures consistent with that understanding will assure long and trouble free operation.

This manual offers an explanation of the variables that effect kiln operations and detailed procedures to assure minimum downtime. The manual also deals at length with narrow mechanical specialties, knowledge of which is necessary for a functional and practical understanding of rotary kiln operations.

Regardless of rotary kiln size or configuration the basic principles outlined in this manual govern the reliable operation of every rotary kiln, calciner, dryer, incinerator, digester and cooler application. For questions or problems with your specific application please contact North American Kiln for assistance.

There are four moving components at each pier. The tire rolls on two support rollers, and the shell moves circumferentially relative to the tire ID. Any relative misalignment of these interactive components results in mechanical instability.

Consider the rolling motion of the tire on a support roller. If the tire axis is parallel to the roller axis, both components roll in the same direction. If the tire axis is not parallel to the roller axis, the tire will roll in a direction slightly different than the roller. The two components are rolling in different directions, and have a common interface. The result is instability via a horizontal motion component, causing the roller to move axially in one direction, and the kiln in the opposite direction.

The roller will move axially until the thrust mechanism inside one of the bearings stops the lateral motion. If the degree of roller misalignment is high, the pressure on this thrust mechanism (either a bearing end cap or a thrust collar) becomes high and increased bearing temperature results. The reaction to the axial motion of the support roller is kiln movement in the opposite direction. This axial movement of the kiln is resisted by a thrust roller, which may become overloaded and either fail or overheat.

The difference in the direction of the tire motion and the direction of the support roller motion results in friction and erosion at the point of contact between the tire and the roller. Consequently, the wear of both components is accelerated, and frequent resurfacing becomes necessary.

The difficulties encountered because of the rolling motion of the shell inside the tire ID, commonly referred to as tire creep, are more difficult to envision. If the plane of the tire is perpendicular to the rotating axis of the kiln, the motion of the shell and the motion of the tire are in the same direction and the system is stable. If the plane of the tire is tilted relative to the kiln axis, the tire will roll in a slightly different direction than the shell. The relative horizontal motion of the shell vs. the tire is contained by the tire retainers. Pressure on the retainers results in retainer failure or wear of the retainer and the side of the tire.

The source of tire retainer pressure is the horizontal component of the interaction between the tire ID and the support pads. Tire retainer wear is therefore always accompanied by wear of the tire ID and the support pads. The wear of the pads will result in a loose tire, leading to high shell ovality and refractory failure. These adverse consequences of poor alignment between the shell and the tire will be covered later.

The interaction of the kiln drive components is another area of potential mechanical instability. The principal potential instability in this regard is torsional vibration of the kiln at the gear tooth contact frequency. The causes of such vibration always center on the abrupt transfer of load from one pinion tooth to the following tooth. The shock associated with such abrupt load transfer can sustain vibration of unacceptable magnitude if a resonance condition exists. The smooth transfer of load from one tooth to the next is assured if a) the tooth profiles are not worn, b) the axial and radial runouts of the main gear are within OEM specifications and c) the root clearance of the gear set is low.

Loose drive components can facilitate resonance vibration, and such conditions must therefore be corrected. The attachment of the gear to kiln has to be secure; that is, spring plate pins and gear bolts have to be tight. If a grid coupling is used between the pinion and the gear box, the spacing between coupling halves must be narrow, so resonance tortional vibration of one coupling half relative to the other cannot occur at the low frequency of gear tooth contact. Movement of the pinion in response to tooth pressure fluctuations, (because of a loose pinion base, for example), makes resonance conditions likely. These and other problems pertaining to drive vibrations are covered in greater detail later in the text.

One of the most important requirements of proper kiln maintenance is the stable alignment of the support rollers. Roller positions must be consistent with minimum ovalities, low support roller thrust loads, and a straight kiln axis. The preferred procedure to assure those conditions is a hot kiln alignment, where all alignment measurements are taken when the kiln is under normal operating conditions.

A kiln should be aligned when it is in operation for four very important reasons:

1. A straight cold kiln has a measurable misalignment at operating temperatures. This is because the shell axis elevation increases by one half of the thermal expansion of the shell diameter. This expansion is the function of the shell temperature and, as such, it varies measurably over the length of the kiln.

2. Shell ovality and the effects of heavy coating on ovality are impossible to assess on a cold kiln.

3. Support roller thrust load adjustments are only possible on a running kiln.

4. Measurements of pier load fluctuations in the course of kiln rotation are only possible on a running kiln.

Hot Kiln Alignment System

NAK Instruction No. 124
Revised March 28, 1990
By: Steve Farkas

The *typical* intended outcome of kiln alignment procedures is a straight kiln axis. Such an approach is simplistic and falls far short of assuring the mechanical stability of a kiln. The alignment must also optimize ovality, and address roller slopes and roller thrust loads. Without a comprehensive kiln alignment mechanical failures will frustrate cost effective operation.

A kiln is properly aligned if and only if it meets the following requirements:

1. The tire elevations are set to a) optimize shell ovalities, and b) keep bearing and hertz pressures at acceptable levels. Please note that this does not necessarily mean a straight kiln axis. Vertical misalignment in pursuit of optimum ovalities is preferable to a straight kiln axis with high ovalities.
2. The kiln axis is straight in the horizontal plane.
3. The support rollers thrust loads are very low, and all support rollers are in the downhill position.
4. There is light load on the downhill thrust roller. (This is assured if the support roller thrust loads are low and all rollers are in the downhill position).
5. The tires are perpendicular to the kiln axis. This condition is necessary to assure low tire retainer pressures. The condition is met if the roller slopes are the same as the shell axis slope at each pier. Please note that the shell axis slope at a particular tire is not necessarily the same as the kiln overall slope. This is because vertical shell deflection due to gravity may not be the same uphill and downhill of a tire.
6. The tire and support roller radiuses do not vary by more than .010". A tapered tire or roller tilts the plane of the tire relative to the kiln axis, causing high tire stop block loads and excessive support pad wear.
7. The shell must be assessed for doglegs that cause pier load variations as the kiln rotates. At the point of maximum pier load, ovality may be unacceptably high even if the average ovality at a pier is acceptable.

Shell Ovality

Ovality is the measurement of shell deformation in the course of a kiln rotation. Ovality readings are taken at each pier with an ovality meter. The device consists of a 40" beam with magnetic legs at both ends. The beam is attached to the shell near the tires. There is a spring-loaded pin in the center of the beam. This pin touches the shell and moves as the shell bends between the two sets of rigid magnetic legs. The movement of the pin is amplified and is recorded on a circular chart. The difference between the maximum and minimum pin positions in the course of a kiln rotation is a measure of the shell ovality. If the ovality at any pier exceeds empirically determined limits, corrective action is required.

Ovality measurements make it possible to change the pier load distribution in a manner that decreases shell flexing at high ovality piers. If the ovality at one pier is higher than at the adjacent piers, the support rollers can be moved to shift load to the low ovality piers. This is typically desirable near the burning zone, where the pier loading is high due to heavy coating. Tire elevations have to be set to assure minimum and uniform shell flexing at each pier.

Ovality measurements also show if one support roller on a pier is carrying a greater load than the other, in effect showing if the kiln has a lateral misalignment. The chart deflection corresponding to a roller carrying the higher load is greater than the deflection corresponding to the other roller. This is an important independent verification of any kiln axis misalignment found by way of survey procedures.

Please note that to achieve optimum ovalities, it is often necessary to place some tire centers above or below the kiln axis, so the end result of the alignment is a kiln axis that is not straight. For this reason alignment procedures based on ovalities are far superior to techniques that merely assure a straight kiln axis. To avoid excessive bearing pressures or hertz pressures as pier load distribution is changed in the pursuit of optimum ovalities, elevation changes have to be limited such that the pier loads are within 10 percent of the design loads.

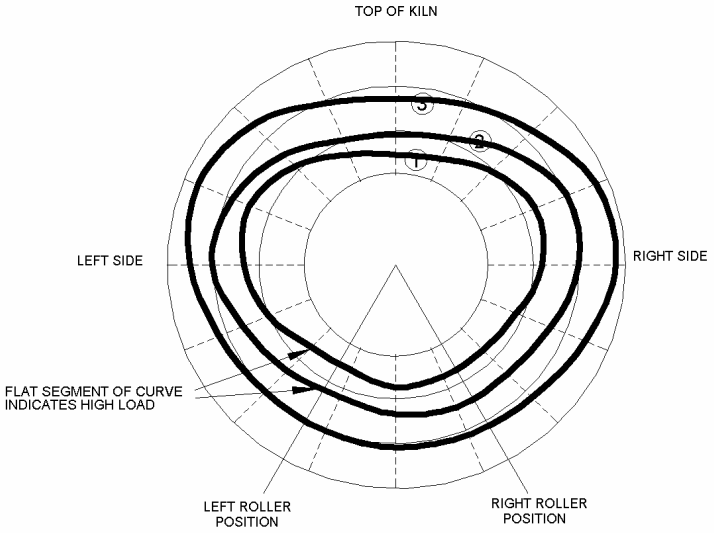
One or more of five variables may cause high shell ovality.

1. The tire elevation may be too high, causing a high shear load on the shell. The required correction is lowering the tire by moving the support rollers away from the kiln axis.
2. The tire support pads may be worn. A loose tire cannot provide the structural support necessary to maintain a circular shell cross section. The required action is to replace or shim the tire support pads.
3. Heavy coating or high chain density may result in a higher than intended pier load. The shear load on the shell may thus be high, causing high ovality.
4. The tire may not be massive enough to provide the support necessary to maintain a circular shell cross section. There are a number of solutions to this difficulty, but the subject matter is not within the scope of kiln alignment procedures.
5. A shell dogleg condition will cause variable pier loading. Dogleg conditions require repair only when they are of sufficient magnitude to affect ovality.

To correct ovality problems it is necessary to locate the tire centers coordinates. Ovality measurements give us a qualitative determination of misalignment, but they do not provide the magnitude of the required adjustments. It is possible to exceed hertz pressure and bearing pressure limitations if vertical kiln axis adjustments are made on the bases of ovality measurements alone. Tire elevation discrepancies in the pursuit of low ovalities must be limited to 3/8”. Locating the tire centers requires the determination of the following:

1. The tire center elevation.
2. The horizontal coordinates of the tire centers.

Example of Ovality Chart



PIER NO: 3 (UPHILL OF TIRE)
TIRE CREEP: 1-1/4"

	DEFLECTION	PERCENT OVALITY
POSITION 1	10.0 MM	0.54%
POSITION 2	13.0 MM	0.71%
POSITION 3	11.0 MM	0.60%

NOTE:
1. GRAPHS ARE NOT CONCENTRIC, INDICATING A LOAD VARIATION ON THE PIER AS THE KILN ROTATES. THE ROLLER SHAFT DEFLECTIONS NEED TO BE MEASURED.
2. FLAT LINES ON GRAPHS AT THE LEFT SUPPORT ROLLER POSITION OF GRAPHS 1 AND 2 INDICATE HIGH LOAD. BOTH ROLLERS NEED TO MOVE TO THE LEFT.
3. THE OVALITY IS EXCESSIVE BECAUSE OF HIGH TIRE CLEARANCE. THE SUPPORT PADS HAVE TO BE REPLACED.

Kiln Survey Procedures

Tire centers are most accurately located using state of the art laser theodolites. Target prisms are placed at the three, six, and nine o'clock positions of each tire. From several different setup points on each side of the kiln, the x, y, and z coordinates of the targets can be determined with the use of computer software. The coordinates of the three and nine o'clock target positions yield the tire center horizontal coordinates and the hot tire diameters. The tire radius added to the elevation of the target at the six o'clock position yields the tire center elevation.

The kiln axis can then be defined as a straight line between the center of the tire on the drive pier and the center of any other tire. The kiln misalignment at each tire is the perpendicular intersect between the defined kiln axis and the tire center.

After the tire centers are located, adjustments are made to correct any misalignment. The adjustments must be consistent with ovality considerations. As stated before, the proper goal of alignment is to minimize shell ovality over the length of the kiln, even if this is achieved at the expense of limited elevation discrepancies. The shell flexing per linear foot of shell resulting from a 3/8" pier elevation discrepancy is much lower in magnitude than the high localized flexing caused by excessive ovality.

This procedure to locate the shell axis is by far the simplest in the industry, requiring only three measurements at each pier. Procedures that require roller positions, roller diameters, base elevations and offset centerlines are very cumbersome and are seriously prone to error.

Tire Clearance

When a kiln is heated the shell expands more than the tire. Consequently, tire clearance is necessary to prevent shell deformation. The principle function of the tire is to provide the structural support necessary to maintain a circular shell axis. When the tire clearance is too high, the tire is too loose to provide this support and high ovality results. Shimming or replacement of the support pads is necessary to lower the high ovality.

It is a common kiln alignment error to raise a tire in order to compensate for excessive tire clearance. The flawed justification is as follows: a) if there is a tire clearance, the shell centerline is below the tire centerline; b) therefore if the tire centers are in a straight line, the kiln shell axis is undoubtedly misaligned; and c) to straighten the shell axis, a tire with a high clearance must be raised. The fallacy of this line of reasoning is apparent if we consider ovalities: If the tire clearance is high, the tire cannot provide the structural support necessary to maintain a circular shell cross section, so the ovality is high. Raising the tire increases the pier load, and thereby increases the ovality that is already higher than it should be. It is therefore far preferable not to correct shell axis misalignment caused by pier to pier differences in tire clearance.

Roller Bearing Adjustments

The next step in the alignment procedure is the adjustment of the roller bearings in order to minimize the support roller thrust loads. If a roller is not parallel to a tire axis, there are two vector components to the motion between the tire and the roller: one is circumferential, and the other is axial. The axial motion component moves the kiln uphill or downhill and moves the roller in the opposite direction, presenting two potential problems:

1. The axial stability of the kiln is diminished and a thrust roller may therefore become overloaded.
2. The thrust mechanism in a bearing may overheat because of high pressure.

The thrust load on each bearing must be measured and lowered until it is negligible. To the extent that there is a slight thrust load on a roller, it must be in the direction that pushes the kiln uphill, and thus opposes the effect of gravity on the kiln. When all roller bearings are adjusted in this manner, the kiln will run with very light load on the downhill thrust roller. If a kiln is against the uphill thrust roller, the aggregate thrust load on the support rollers is sufficient to overcome the force of gravity pulling the kiln downhill, which may be as high as 90 tons. That load, unevenly distributed among the support rollers can easily cause overload conditions on a bearing thrust mechanism.

When all rollers downhill, very close to their respective zero thrust load positions, the bearings will operate at minimum temperature and the thrust roller loads will be low. Under such conditions the axial stability of the kiln is optimum and the kiln can withstand thrust load changes that occur under upset conditions or adverse weather changes.

The sequence of roller adjustments is critical in maintaining mechanical stability during the alignment process. Each adjustment must simultaneously meet the following requirements:

1. The kiln must not be moved in the direction that will overload an already loaded thrust roller.
2. The adjustment must decrease the existing thrust load on a support roller.

The most critical and difficult phase of an alignment is the actual movement of the bearings. The procedure is not without serious potential problems, because in the course of numerous adjustments the mechanical stability of the kiln is at risk. The magnitude and the direction of the roller thrust loads change. Hot bearings can result. The thrust roller loads change because the kiln is physically pushed uphill or downhill as the roller bearings are moved. Moreover, if a roller moves uphill or downhill, the roller shaft slides axially on the brass liners. Mated bearing surfaces that are worn to accommodate surface irregularities lose contact and high temperatures are likely.

The adjustment of support rollers is also difficult because turning the bearing adjustment bolts requires up to 40,000 foot pounds of torque. The traditional means of turning these bolts is by way of slugging wrenches and twenty-pound sledgehammers. This procedure is very labor intensive under extremely difficult working conditions. The necessary adjustments on a five-pier kiln can take a crew of four men up to ten days.

Because of the difficulties and risks associated with bearing adjustments, there is reluctance among kiln repair contractors to make such adjustments. North American Kiln is the only company that includes roller adjustments as part of the kiln alignment scope of work. Other companies determine to what extent a kiln axis is misaligned and make adjustment recommendations, but the actual adjustments are left to plant personnel. All of the risks associated with the labor-intensive adjustments have to be assumed by the plants.

North American Kiln Service utilizes hydraulic wrenches of various torque capacities to make bearing adjustments with speed and accuracy. We not only determine the degree of kiln axis misalignment but we also adjust the support rollers as needed to achieve a kiln axis consistent with optimum ovalities, minimum support roller thrust loads and acceptable bearing and hertz pressures.

Roller Shaft Deflections

If a kiln has a bent axis, a condition commonly referred to as a dogleg, the load on an effected pier will vary as the kiln rotates. If the magnitude of the pier load variation exceeds the roller shaft fatigue limit, shaft failure will result. The effect of the pier load variation on the support rollers can be determined by measuring the bending of the roller shafts as the kiln rotates. If the bending of a shaft exceeds 0.015” corrective procedures are necessary to prevent future roller shaft failure.

Support Roller Slopes

No kiln alignment is complete without considering the effects of roller slopes on stop block pressure and tire support pad wear. There is a vertical deflection of the shell axis due to gravity at each span between kiln piers. This deflection is often greater on one side of a tire than the other. The shell axis at the tire will tilt in the direction of the higher deflection. Thus the slope of the shell axis at a tire section is often different from the overall kiln slope.

If the support rollers are set to the kiln overall slope (rather than the tilted tire section axis slope), the plane of the tire will not be perpendicular to the tilted shell axis. Given this condition, the tire creep has an axial motion component. The motion component of creep is resisted by the tire retainers.

There are two adverse consequences to the axial motion component between the tire ID and the support pads. The obvious effect is high stop block loads, but the more serious effect is the wear of the support pads. The wear of the pads results in excessive gap between the tire and the pads. The tire looses its girdling capacity and cannot provide the support necessary to maintain a circular shell cross section. The shell ovality increases and problems associated with ovality become inevitable. A complete kiln alignment must include an analysis of support roller slopes changes necessary to minimize stop block and support pad wear.

Incorrect roller slopes can be caused by improper base installation, pier settling, roller base damage and tapered tire and roller surfaces. Please note that because the axial motion component between a tire and its support pads is always greater than zero, lubrication of the tire ID is essential to retard support pad wear and thereby maintain low ovality. **NAK TireBar™** is a lubricant developed for this purpose. The lubricant consists of wax bars impregnated with high concentrations of soft metal powders and graphite. The metal and graphite laminate onto the tire ID to provide dry lubrication after the wax carrier dissipates.

Effects of Tapered Tires on Alignment

If tire or roller wear is uneven, a taper condition often develops. This causes the plane of a tire to tilt relative to the kiln axis, resulting in a horizontal motion component between the tire and the support pads.

The improper resurfacing of tires and support rollers adversely effects the alignment of a kiln by a) changing the alignment of the kiln axis, b increasing the support roller thrust loads, and c) causing stop block and support pad wear. These changes can significantly increase maintenance costs and breakdown frequencies. Plant management should therefore be familiar with the subtleties of resurfacing procedures and should demand adherence to meaningful specifications.

HOT KILN ALIGNMENT

NAK PROVIDES THE MOST ACCURATE AND COMPREHENSIVE KILN ALIGNMENT IN THE INDUSTRY.

OUR SCOPE OF WORK:

1. Locate the tire centers using computerized laser procedures.
2. Measure the shell ovality.
3. Measure the support roller thrust load on all rollers.
4. Adjust all bearings to a) optimize shell ovality and b) eliminate support roller thrust loads.
5. Check stop block pressures and recommend support roller slope changes to eliminate stop block wear.
6. Inspect the kiln and make prioritized repair recommendations.

ALL BEARING ADJUSTMENTS INCLUDED

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Tire and Roller Resurfacing

NAK Instruction No. 132
Revised March 13, 1990

Three conditions require tire and roller resurfacing:

1. When a tire or roller OD is tapered, the plane of the tire is not perpendicular to the kiln axis. This condition complicates the motion between the tire ID and the kiln. In addition to the circumferential rolling motion, there is an axial motion component that causes high pressure on the stop blocks and rapid wear of the support pads. High stop block loading requires frequent repairs, but as stated before, the accompanying wear of the tire support pads has the more serious consequence of increasing the tire clearance. High tire clearance reduces the tire's capacity to maintain a circular shell cross section, and the ovality increases.
2. Some piers have very high tire stop block loads, despite uniform tire and roller radii. The high loads are due to improper support roller slopes. (Please note: As explained earlier, the desired roller slope is often different than the kiln overall slope). Changing roller slopes is a difficult and precise procedure, particularly if the bearings do not have self-aligning ball and socket liner supports. Without such support, one bearing on a roller cannot be shimmed relative to the other, because the bearing liners would not then lie in a straight line. Both bearings have to be tilted such that the bearing liner load distribution is uniform after the slope change is complete. If downtime for a slope change is not practical, the problem of stop blocks pressure and support pad wear can be addressed by grinding the tire and the rollers with a 0.015" taper. This will result in a significant change in the angle between the tire plane and the kin axis.
3. If a tire or roller has a convex or concave load-carrying surface, the hertz pressure in areas of high load contact may be unacceptable. Resurfacing is required, given such conditions.

The setup of a grinding machine is a technically difficult procedure. All tires have an axial runout, so the line defined by the points of contact between the grinding stone and a tire does not stay parallel to the grinding

machine. In other words, the surface being ground moves toward and away from the machine near the tire edges as the kiln rotates. The machine design must assure uniform stone pressure despite this difficulty. To further complicate the setup procedure, the grinding machine has to be set parallel to the kiln axis, without the benefit of simple reference points that define the position of the kiln axis. The shell axis has to be located via precision measurements between the tire and the grinding machine, taken near the tire edges 90 degrees from the maximum and minimum extremes of the tire axial runout. The machine adjustment calculations must compensate for differences in the tire diameter where the measurements are taken. Unless this technically difficult procedure is successful, it is likely that the tire will be ground with a taper, or more than the minimum amount of steel will be removed to achieve a uniform radius.

Resurfacing decreases the radius of tires and rollers by as much as 1/4". A radius decrease changes the alignment of the kiln axis, at times resulting in shell ovality changes. After a resurfacing procedure, the ovalities should be measured and appropriate adjustments should be made.

The resurfacing of tires and rollers always changes the angle between the roller axis and the tire axis. This results in a change in the thrust load between the tire and its rollers. This may result in increased pressure on the tire stop blocks, increased bearing temperature (because the bearing thrust mechanism pressure increases), and increased thrust roller load. It is important to assess these changes and make appropriate bearing adjustments.

In view of these difficulties, plants should insist on high quality control standards over resurfacing operations. This is best accomplished by actual plant oversight of the final radius measurements and roller adjustments. The tire or roller radius should not vary by more than 0.010". The direction of a taper, if any should be dictated by stop block load considerations. Tires with a high axial runout should have up to a 0.020" crown; otherwise all components should be straight to within 0.010".

TIRE & ROLLER RESURFACING

North American Kiln technicians grind kiln tires and rollers to OEM tolerances. Our turnkey service includes:

- *Resurfacing of tire and rollers*
- *Shell Ovality Measurement*
- *Support Roller Bearing Adjustments*
- *Assessment of Grinding's Effect on Kiln Alignment*
- *Kiln Shell Inspected for Dogleg Conditions*
- *Tire Clearance Measurements*
- *No Shutdowns Required*

All work is guaranteed for a *no fine print* firm price. NO HIDDEN CHARGES.

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Hot Support Roller Bearings

NAK Instruction No. 105
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The undesirable consequence of high support roller bearing temperature is the loss of lubricant viscosity. Low viscosity leads to metal to metal contact and mechanical failure. If the lubricant can provide sufficient viscosity at an elevated temperature, the bearing can safely function indefinitely at that temperature. Therefore the strategy in dealing with hot bearings is twofold: eliminating the mechanism causing a temperature increase and elevating the lubricant viscosity.

Typically the cause of hot bearings is a combination of the following mechanisms:

1. Support roller overload caused by kiln misalignment.
2. High support roller thrust load caused by roller misalignment.
3. Inadequate bearing clearance. Proper lubrication of bearings requires a bearing clearance of 0.002" per inch of roller shaft diameter.
4. Damaged support roller base.
5. Low lubricant viscosity. The higher a lubricant viscosity, the less likely that a bearing will get hot. Therefore, the heaviest lubricant consistent with pour point limitations should be used.
6. Radiated heat. It is important to shield bearings and bearing bases from the kiln shell. Most kilns lack self-centering bearing sockets. In the absence of such sockets, (which can move to accommodate a poor bearing liner load distribution), any tilting of the base due to thermal expansion will cause a bearing temperature elevation.

The following is an elaboration on these mechanisms.

Support Roller Radial Load

A support roller overload is caused by kiln misalignment. If a roller is too close to a base center line, the load on that roller will be higher than normal. A kiln alignment is the only reliable means of finding and correcting this condition. Since a properly aligned cold kiln has a measurable misalignment when the kiln is hot, the alignment should be performed on a hot kiln operating under steady state conditions. NORTH AMERICAN KILN has state of the art expertise to provide the most complete and accurate hot kiln alignment in the industry.

Support Roller Axial Load

A thrust load on a support roller is caused by an axial component of motion between the tire and the roller. In other words, as the two components roll, the roller moves in a slightly different direction than the tire. This condition exists if the roller axis is not parallel to the tire axis. The resulting pressure on the bearing thrust mechanism can generate an unacceptable amount of heat. The proper remedy is the alignment of the roller relative to the tire axis by a series of bearing adjustments.

Bearing Clearance

Proper lubrication of bearings requires that the brass liner diameter be larger than the shaft diameter by 0.002" per inch of shaft diameter. In the absence of this difference in diameters, the oil film on the shaft will be thin and heat will be generated as the shaft slides on the brass.

The bearing clearance should be measured whenever a new liner or roller is installed. The measurement is taken with a feeler gauge inserted between the corners of the liner and the shaft. The sum the two readings at the end of the shaft or the sum at the roller side of the shaft is the clearance.

If the bearing clearance is found to be inadequate, the brass liners from both the uphill and downhill bearings have to be placed in a boring mill and the ID of both liners has to be increased. Bearing elevations will change if the brass liners are machined to increase clearance. While this elevation change will not effect the kiln axis alignment measurably, if one bearing elevation is changed relative to the other bearing on the same roller, unacceptable liner load distribution and high bearing temperatures may result.

If the bearing clearance is too high, the surface area of contact between the shaft and liner will not be adequate. A high viscosity synthetic lubricant should be utilized if a properly sized liner is not available.

Care must be taken when installing a bearing or a roller. A small piece of debris between the liner and the liner support will decrease the bearing clearance and will also decrease the heat transfer rate between the liner and the liner support.

Damaged Support Roller Base

If a roller base is damaged, the bearing housing slopes may change and the brass liner load distributions may become uneven. At areas of high bearing pressure, excessive heat may be generated.

Most bearings housings support the brass liners parallel to the base pedestal. If the uphill and downhill base pedestals are not in the same plane, the two bearings on the base will likewise not be in the same plane. Areas of high pressure between the roller shaft and the brass liners will result.

High thrust load on rollers will often twist a base and cause the above condition. A roller thrust load is resisted by a thrust mechanism inside the bearing (either pressure on the bearing end cap, or pressure on a thrust collar on the shaft.) A bearing is held on the base by bolts or an extension of the housing hanging over the inside edge of the base. High thrust load on the bearing will twist the base plate either via the bearing hold-down bolts or the housing extension hanging below the base. Once a base plate is twisted, uniform liner load distribution in the two bearings on that base is not possible. The bearing housings have to be step-shimmed to assure uniform liner load.

The above problem can be diagnosed by spanning the uphill and downhill base pedestals with a straight edge. A gap between the straight edge and any portion of the base is an indication of a twisted base. Measurements of such gaps provide the information necessary for shimming the appropriate bearings.

Lubricant Viscosity

A typical bearing oil has a viscosity of around 650 cst at 100 degrees F. If the bearing temperature increases, the viscosity decreases rapidly to around 70 cst at 210 degrees F. Ninety percent of the oil viscosity is lost with a 100 degree temperature increase. If a mechanical or process problem results in a bearing temperature increase, the typical lubricant has a very limited viscosity range. A small temperature increase results in a large viscosity decrease, which in turn increases the rate of heat generated. Most bearing lubricants therefore assure marginal stability at best, because the tolerance for a temperature increase is very limited.

Specially formulated synthetic oils provide both a low pour point and a flat viscosity curve. NORTH AMERICAN KILN is a distributor **NAK BearingLube™,** the best synthetic bearing lubricant on the market. With **NAK BearingLube™** a bearing can safely function at up to 400 degrees indefinitely. As a practical matter, that high temperature is never reached because the bearing cooling system effectiveness increases as the temperature goes up. With **NAK BearingLube™**a kiln with a hot bearing can function indefinitely at normal speed until the cause of a temperature increase is determined and corrected during a planned shutdown.

One unrelated note on the subject of bearing or drive lubricants, excessive lubricant spillage is more than simply an environmental or safety concern. If lubricant is allowed to collect on a pier, it will eventually seep into the concrete where over time it will destroy the grout. This results in a costly repair that can be avoided with good housekeeping.

Radiated Heat

Shielding the bearing from the kiln shell significantly decreases the operating temperature of a bearing. This is most effectively accomplished by placing a sheet of corrugated aluminum between the shell and the bearing. A standard 2' x 4' sheet can be attached to an angle iron frame and welded to the base. The installation of such a reflector can decrease the temperature of the bearing housing by as much as 60 degrees.

Hot Bearing Emergency Procedures

NAK Instruction No. 112
Revised Feb. 18, 1988

In the event a hot bearing is detected, proper maintenance procedures can prevent the loss of the bearing, and the loss of production.

Hot bearings will squeal at the start of metal to metal contact. Drive amps will rise dramatically when this happens. Application of very high viscosity oil to the shaft will stop the squealing and decrease the drive amps by providing an oil film between the shaft and the brass liner.

Applying graphite, grease or oil to the surface of a support roller will immediately decrease the thrust load on the roller. This will eliminate pressure on the thrust mechanism in the bearing. Load on the bearing thrust plate or thrust collar is the cause of most bearing temperature difficulties.

The oil should be changed next. The replacement oil should provide a minimum of 400 SUS viscosity at 200 degrees F.

The bearing inspection ports should be removed to provide cooling air circulation.

If the temperature of the top plate of a roller base is over 200 degrees, thermal distortion of the base can tilt the bearing housings and thus change the load distributions on the brass liners. Areas of high pressure on the brass liners can generate heat and cause hot bearings. Cooling the base with water often results in a dramatic decrease of the bearing temperatures.

Putting water in the trough under the support roller will significantly enhance heat transfer away from a hot shaft. Pouring oil on the water in the trough will coat the roller surface and thus reduce the roller thrust load.

Water sprayed on the bearing housings will cool the oil sump in the bearing.

Roller bearing adjustments should be made if it is determined that a high thrust load is contributing to the high bearing temperature. Until such adjustments are made, the roller surface has to be lubricated.

Hot Kiln Support Roller Bearings?

BearingLube™ is guaranteed to lower high kiln bearing temperatures, regardless of the mechanical cause of high temperatures.

Made of a special blend of synthetic lubricants with a high viscosity index, exceptional thermal stability and low pour point, **BearingLube™** allows kiln operation indefinitely, until the cause of a hot bearing is corrected during a planned shutdown. Totally eliminates bearing temperature related shutdowns.

Try **BearingLube™**. If you are not completely satisfied, we will not invoice you. There is no other kiln support roller lubricant on the market today backed with this guarantee.

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Tire Stop Block and Support Pad Maintenance

NAK Instruction No. 101
Revised Jan 13, 1990

High tire stop block pressure is a common maintenance problem. The pressure is the function of three variables:

1. Tire creep. The horizontal motion component of the tire creep is the cause of high tire retainer pressure. Tire retainer pressure is directly proportional to creep. A tire with one inch creep will have twice the stop block pressure of a tire with one half inch creep. If the creep is low, there cannot be high pressure on the tire retainers.
2. Support roller slopes. The support roller slopes determine the angle between the plane of a tire and the shell axis slope at the tire. If this angle is ninety degrees, the horizontal motion component of the tire creep is zero.
3. Stop block pressure is directly proportional to the coefficient of friction between the tire ID and the support pads. The stop block pressure comes from the interaction between the tire ID and the support pads. If the surface between the two interacting components is lubricated, slippage between the two will make high stop block pressure impossible.

The direct cause of stop block pressure is the horizontal motion component of tire creep. If the plane of the tire is not perpendicular to the shell axis, there are two components to the rolling motion of the shell within the tire: one axial (parallel to the kiln axis), and one circumferential. The tire retainers limit the axial motion of the tire. The greater the tilt of the plane of the tire relative to the shell axis, the greater the load on the stop blocks.

The much less obvious but more damaging consequence of the axial motion component between the tire and the shell is the wear of the tire support pads. High stop block pressure is always accompanied by wear of the tire support pads. Support pad wear leads to high tire clearance, high shell ovality, and ultimately, refractory failure.

The angle between the plane of the tire and the kiln axis is determined by the support roller slopes and is affected by taper conditions on the tire or the rollers. The proper response to high tire retainer pressure therefore is to

a) change the support roller slopes, b) and/or resurface the tire and rollers and c) lubricate the tire ID..

Determining the desired support roller slope is a problem. It is tempting to set the rollers to the kiln axis slope, a common practice with all kiln manufacturers for a long time, but this practice is often incorrect. The shell axis slope directly under a tire varies from pier to pier. There is a vertical shell deflection caused by gravity at each span between tires. The magnitude of this shell deflection is often different uphill and downhill of a tire and the shell axis under the tire tilts in the direction of the higher deflection. Unless support roller slopes are set to the tilted tire section axis slopes (rather than to the kiln overall slope), the plane of a tire will not be perpendicular to the rotating axis under the tire. All rollers on a kiln have to be set to slopes based on shell deflection considerations. Otherwise, the wear of the support pads and stop blocks will be greater than necessary.

The magnitude of the shell deflection between piers is difficult to calculate, requiring approximations of numerous variables. Under the best of circumstances, the desired slope of the support rollers can only be approximated. Furthermore, as refractory wears or is replaced, the shell temperatures, pier loads and shell deflections will change, as will the tire section axis slopes relative to the roller slopes. So the angle between the plane of a tire and the shell axis slope under the tire is often different than the required ninety degrees. It is therefore important that the ID of all tires on a kiln be lubricated. The lubrication results in the lowering of the coefficient of friction between the tire ID and the pads. Since tire retainer pressure is the result of the interaction between the tire ID and the support pads, the pressure is directly proportional to this coefficient of friction.

An important note: It is tempting to reduce tire retainer pressure by adjusting the support rollers to push the tire away from the retainers. This will never work. There are two independent forces affecting mechanical stability at each pier. One set comes from the interaction between the tire and the support rollers, and the other from the interaction between the tire ID and the support pads. Stop

block pressure is the result of the latter, and is independent of the direction of thrust loads on the support rollers. It is possible to push a tire uphill so hard that the bearings overheat from high thrust loads, yet have very high pressure on the downhill tire retainers. This seems very counterintuitive, but vector analysis confirms the conclusion.

Kiln Drive Vibration

NAK Instruction No. 122
Revised March 29, 1990

Kiln drive vibration is sustained by the abrupt transfer of load from the engaged pinion tooth to the following tooth. The transfer of load is abrupt either because the tooth profiles are worn or the gear has a high radial runout. Given a high radial runout, at the point of maximum root clearance, the load overlap of the tooth profiles is lost and the driving tooth disengages before the following tooth makes contact. Smooth transfer of load is therefore impossible.

Helical gears are particularly susceptible to vibration unless the alignment of the gears is near perfect. The helical overlap assures that two teeth are carrying the load at the time of load transfer, thus allowing the load to gradually transfer from tooth to tooth with zero drive load variation. If there is a moderate axial runout, however, the helical overlap is lost over a portion of the gear circumference, and only the involute overlap is left to assure smooth load transfer. Since the tooth height of helical gears is small, the involute overlap is very low, and even a moderate radial runout will cause vibration

Such vibration may be conveniently dampened by several mechanisms. If the drive control system response time to a motor speed change can be set to a time interval that is different from the time interval between two successive tooth contacts, the vibration may cease because motor load cycling will not be in phase with the tooth contact frequency.

The vibration can also be dampened by changes in the low speed coupling. Flexible grids often connect the coupling halves, so torsional vibration of one coupling half relative to the other offers a mechanism to start and sustain resonance vibration. Changing the spring constant of the coupling can change the frequency of vibration of the coupling halves. If the separation of the coupling halves is set low, the coupling vibration frequency will increase and will sustain vibration at the relatively low frequency of the pinion tooth contact.

It is essential that the gear be mounted on the shell in a rigid manner. Loose spring plate pins or gear bolts allow vibration of the gear. The vibration is transferred to the

other components of the drive, causing significant damage.

The pinion base and the gear reducer base must be properly anchored to eliminate possible base movement. Such movement, even if it is only as little as 0.010”, promotes high tooth pressure fluctuations that enhance vibration and accelerates the wear of the tooth profiles.

Reversing the main gear and properly aligning the entire drive eliminates drive related vibration difficulties. This procedure is necessary if less expensive remedies are ineffective.

The Myth of Shell Profile Analysis

NAK Instruction No 136
Revised January, 2003

Several companies in the kiln repair industry charge a significant fee for Shell Profile Analysis reports, and use the reports to recommend the replacement of what is often perfectly good kiln shell. This shell replacement justification is without technical merit. Shell profile analysis provides no insight into the mechanical stability of kilns because the theory behind it is fundamentally flawed. The procedure yields shell runout data, without the ability to quantify the degree to which the runouts are dampened by often significant changes in shell stress distributions as a kiln rotates.

Consider a perfect kiln perfectly installed. A shell profile analysis would indicate zero radial runout over the length of the kiln, and correctly declare the kiln to be free of doglegs. If you cut such a kiln close to a tire and open that cut at the top, the tire will eventually come off the support rollers. Now close the cut until the tire touches the support rollers, but does not put any weight on them. The kiln would be mechanically unstable because of a substantial pier load distribution discrepancy, but a shell profile analysis would still indicate zero radial runout over the length of the kiln. The load distribution problem would be masked (as far as shell profile analysis is concerned) by significant shell stress fluctuations in the course of kiln rotation, but the problem would definitely be there. (Note: zero tire clearance is assumed for the purpose of this thought experiment).

Next, consider a kiln having seriously deformed shell with high pier load variations. A shell profile analysis would produce a distinctive profile for the shell. If the pier load variations are then corrected with correction cuts ***close to tires***, the effects of the doglegs would be eliminated, but the shell profile would not change. (This is because if a correction cut is close to an effected tire, the pier load change is achieved without radial movement of the shell at the cut). The shell would have identical radial runout profiles before and after the corrections cuts are made, but the shell stress distributions would be radically different.

Shell replacement is never necessary if the only intent of the replacement is to remedy doglegs. A dogleg is not caused by defective shell; it is caused by the misalignment (relative to the kiln rotating axis) of possibly perfectly good shell. NAK has demonstrated at numerous plants that cutting the shell and realigning it eliminates dogleg conditions without the need to replace the shell.

Using correction cuts instead of shell replacement for the purpose of correcting doglegs offers significant cost benefits:

1. The cost of shell is eliminated.
2. Brick removal is limited to less than four feet per correction cut.
3. There is no need for a crane.
4. Because only one or two cuts are required for correction purposes, and each cut spans only 300 degrees of shell, welding time is cut by 75%.

The proper way to guarantee kiln shell stability is to measure and correct pier load variations in the course of kiln rotation. If such load variations are eliminated with correction cuts, the kiln will be stable. Arguably, there may be a shell radial runout between piers, but this condition would not affect kiln stability. And if no one measures such a runout, nobody will know the runout is there, because the kiln will run without adverse symptoms that attract attention.

Incidentally, every time a shell section is replaced, the pier load variation has to be measured at the adjacent piers, and adjustments have to be made until the pier loads are constant as the kiln rotates. Centering joints is the commonly accepted means of aligning new shell sections prior to welding. This procedure is seriously flawed because it often causes a dogleg condition. As often happens, when joints are adjusted to eliminate doglegs (or tire axial runouts for that matter), one of the consequences is shell radial runout at the joints. In other words, the joints need to be pulled off center to eliminate doglegs, contrary to

misconceived notions that the joints should be centered. Radial runout at joints will not affect shell stability, whereas pier load variations will.

Solutions to Problems in Kiln Mechanical Performance

Following is a series of cause and effect relationships between undesirable mechanical symptoms of kiln operations and a combination of mechanisms that explain the symptoms.

Most kiln mechanical problems are caused by the following mechanisms.

Incorrect support roller slopes
Excessive tire clearance
Improper roller bearing adjustments
Poor drive component alignment
Improper shell section installation
Inadequate roller bearing clearances
Poor kiln alignment
Worn tire and roller surfaces
Damaged kiln shell

A combination of the above mechanisms results in kiln drive related difficulties and the deterioration of the mechanical stability of various kiln components as outlined below:

PROBLEM:	HIGH BEARING TEMPERATURE
CAUSE:	HIGH ROLLER THRUST LOAD
SOLUTION:	ADJUST ROLLER BEARINGS
CAUSE:	LOW OIL VISCOSITY
SOLUTION:	CHANGE TO HEAVY OIL
CAUSE:	TIGHT BEARING LINERS
SOLUTION:	INCREASE BEARING CLEARANCE
CAUSE:	ROLLER TO BEARING LINER MISALIGNMENT
SOLUTION:	SHIM BEARING BASES

PROBLEM:	OVERLOADED TIRE STOP BLOCKS
CAUSE:	INCORRECT ROLLER SLOPES
SOLUTION:	CHANGE ROLLER SLOPES BY SHIMMING BEARINGS

CAUSE:	TIRE AND/OR ROLLER TAPERS
SOLUTION:	RESURFACING/GRINDING

PROBLEM:	HIGH TIRE CLEARANCE OR CREEP (CAUSE OF HIGH OVALITY AND BRICK LOSS)
CAUSE:	SUPPORT PAD WEAR CAUSED BY INCORRECT ROLLER SLOPE
SOLUTION:	CHANGE ROLLER SLOPE CHANGE OR SHIM SUPPORT PADS LUBRICATE TIRE ID
CAUSE:	SUPPORT PAD WEAR CAUSED BY TAPERED TIRES/ROLLERS
SOLUTION:	RESURFACE TIRE/ROLLERS CHANGE OR SHIM SUPPORT PADS LUBRICATE TIRE ID

PROBLEM:	FREQUENT BRICK LOSS
CAUSE:	HIGH SHELL OVALITY
SOLUTION:	REPLACE OR SHIM SUPPORT PADS
CAUSE:	BOTTLE NECKED SHELL SECTION
SOLUTION:	SHIM SUPPORT PADS
CAUSE:	IMPROPERLY SIZED TIRE
SOLUTION:	INSTALL INSULATED SHELL STIFFENER RINGS
CAUSE:	TIRE ELEVATION TOO HIGH
SOLUTION:	ALIGN KILN
CAUSE:	DAMAGED KILN SHELL
SOLUTION:	REPLACE SHELL SECTION SHELL CORRECTION CUT

PROBLEM: OVERLOADED THRUST ROLLER

CAUSE: HIGH ROLLER THRUST LOADS
SOLUTION: ADJUST SUPPORT ROLLERS FOR MINIMUM THRUST LOADS, WITH ALL ROLLERS IN THE DOWNHILL POSITION

PROBLEM: UNPREDICTABLE MOVEMENT OF KILN BETWEEN THRUST ROLLERS

CAUSE: ROLLER THRUST LOADS ARE TOO HIGH, SOME ROLLERS PUSHING KILN UP AND SOME DOWN
SOLUTION: ADJUST ROLLER BEARINGS

PROBLEM: DRIVE VIBRATION

CAUSE: CONSISTENTLY HIGH BACKLASH
SOLUTION: REDUCE PINION BACKLASH:
PINION

ADJUSTMENT OR GEAR REVERSAL (NOTE: BACKLASH IS MINIMUM WHEN KILN IS COLD)

CAUSE: VARIABLY HIGH BACKLASH
SOLUTION: REALIGN MAIN GEAR FOR MINIMUM RADIAL RUNOUT

CAUSE: LOSS OF TOOTH PROFILE
SOLUTION: DAMPEN CONTROL RESPONSE TO SPEED CHANGE OR REVERSE GEAR

CAUSE: LOOSE GEAR (SPRING MOUNTED)
SOLUTION: INSTALL OVERSIZED GEAR PINS

CAUSE: MOTOR CONTROL RESPONSE TIME IS IN PHASE WITH TOOTH CONTACT FREQUENCY
SOLUTION: DAMPEN CONTROL RESPONSE

CAUSE:	EXCESSIVE COUPLING GAP
SOLUTION:	SET GAP TO MINIMUM ALLOWED

PROBLEM: HIGH KILN DRIVE TORQUE

CAUSE:	TIGHT ROLLER BEARING LINERS
SOLUTION:	INCREASE BEARING CLEARANCE
CAUSE:	INCORRECT ROLLER SLOPES
SOLUTION:	SHIM ROLLER BEARINGS
CAUSE:	HIGH ROLLER THRUST LOADS
SOLUTION:	ADJUST ROLLER BEARINGS
CAUSE:	BENT KILN AXIS (DOGLEG)
SOLUTION:	CUT AND REALIGN SHELL
CAUSE:	BADLY WORN TIRE/ROLLER SURFACES
SOLUTION:	RESURFACING/GRINDING
CAUSE:	EXCESS INLET/OUTLET SEAL CONTACT
SOLUTION:	ADJUST SUPPORT ROLLERS CUT, RECENTER AND REATTACH SEAL
CAUSE:	EXCESS FEED PIPE
SOLUTION:	ADJUST FEED PIPE REMOVE EXCESS BUILDUP
CAUSE:	EXCESS GEAR GUARD CONTACT
SOLUTION:	CUT, RECENTER AND REATTACH GUARD FLANGE

Kiln Preventive Maintenance

Daily Inspections

1. Conduct a walk-by inspection of the kiln.
    a) Are there any shell discolorations or hot spots?
    b) Check and record the temperature profile of kiln shell and tires.

2. Inspect each pier.
    a) Does any tire lift off the roller during any portion of the kiln rotation?
    b) Is there any unusual bearing movement?
    c) Is there adequate lubricant in the support roller bearings?
    d) Is there evidence of recent damage or unusual wear to the support pads, stop blocks, or tire/roller surfaces?
    e) Are there any unusual sounds or vibration?
    f) Does the surface of the bearing housing feel unusually warm?
    g) Is the bearing lubricant level adequate?
    h) Is there enough cooling water available for the bearing housings? Any leaks?
    i) Clean pier of dust and buildup that may contaminate roller surface or seize the graphite block.

3. Check condition of nose ring area.
    a) Are any castings loose damaged or missing?
    b) Are the nose brick worn, damaged or missing?

4. Check the condition of the drive system.
    a) Is there adequate gear lubrication?
    b) Any unusual sounds from the drive system?
    c) Is there any noticeable vibration?
    d) Is the reducer lubricant level adequate?

5. Check oil levels of roller and thrust bearings. Make sure fill pipe/level indicator is not plugged.

6. During start up measure tire creep. During shut down apply graphite solution to rollers.

Weekly Inspections

1. Start up the emergency drive engine and run it for at least 30 minutes.
   a) Check the water level and cables of the emergency engine battery.
   b) Check the fuel level of the emergency engine.
   c) Check the lubrication system of the gearbox and drive system.

2. Check graphite block lubrication
   a) Are holders clean and free of product or dirt contamination?
   b) Is the graphite block free and loose in its holder?
   c) Is the graphite providing an adequate supply of lubrication?

3. Check creep or gap of tires on all piers.
   a) Has level of creep increased since the last inspection?
   b) Has the tire developed a wobble?
   c) Lubricate between the filler bars and tire ID after creep measurements.

4. Check the condition of the tire on each pier.
   a) Is there any spalling, ridging or unusual wear on the tire face (visible tapers, convex or concave wear)?
   b) Since the last inspection, has the tire position changed relative to the stop blocks?
   c) Are there any broken welds or cracks on any parts of the support pad components, stop blocks or adjacent kiln shell?
   d) Is the tire centered over the carrying rollers?

5. Check the condition of the carrying rollers on each pier.
   a) Are the rollers thrusting uphill or downhill? Hard or light?
   b) Is there spalling, ridging or unusual wear on the roller face (visible tapers, convex or concave wear)?

c) Are the bearing seals working properly?
d) Is the roller shaft receiving adequate lubrication?
e) Do tires and rollers have full-face contact?
f) Is there any movement between the pier and support frame?
g) Are there any loose anchor bolts on the support frame?
h) Is there progressive cracking of the concrete or grout on the pier?

6. Check the condition of the thrust rollers.
   a) Is the kiln against the uphill or downhill thrust roller?
   b) Is there spalling , ridging or unusual wear on the roller surface?

7. Check the condition of the drive system.
   a) Does the gear housing show any signs of contact with the gear?
   b) Has the pattern of gear/pinion contact changed?
   c) If applicable, are there any loose or missing flange bolts?
   d) If applicable, is there any visible cracking or looseness of spring-plate components?
   e) Is there adequate gear lubrication?
   f) Are there any unusual sounds coming from the drive system?
   g) Is there any noticeable vibration, where from?
   h) Are the motor, reducer and pinion bearing base bolts tight?

8. Clean the pier tops of dirt, oil product spillage.

9. Check condition of discharge and feed end seals.
   a) Is there any leakage of excess air or product?
   b) What is the condition of the seal support?
   c) Is there any visible kiln runout?

Monthly Inspection

1. Check for pitch line separation of gear and pinion.
2. Check for pitch line run-out of gear and pinion.
3. Check condition of welds on gear flange or spring plates.
4. Lubricate the drive coupling.
5. Perform vibration analysis on kiln drive.
6. Take samples for oil analysis (drive and suspect thrust or support rollers).
7. Check feed and discharge hoods for metal damage or corrosion.

Three Month Inspection

1. Measure shell ovality.
2. Determine and perform support roller adjustments to optimize kiln and roller thrust.
3. Weekly and monthly kiln inspections.

Annual Inspection

1. Change gear lubricant and clean sump and gear area if needed.

2. Change oil in thrust roller bearings.

3. Inspect kiln shell for cracks under rings.

4. Check alignment of gear and pinion.

5. Inspect drive coupling grid members.

6. Check the kiln alignment, (as needed).

7. Inspect refractory for cracking, crushing or unusual wear, especially around tires.

8. Clean and inspect gear.
   a) Check gear teeth for abnormal wear.
   b) Change gear lubrication.
   c) Check drive train couplings for wear and replace if needed.
   d) Check and repair welds on gear flange or spring plates and gear if needed.
   e) Check for loose nuts or bolts on gear mounting flange or loose spring plate pins.
   f) Inspect, clean, repack and change lubrication on pinion bearings.
   g) Check brush rigging and electrical components of drive motor.
   h) Take samples of reducer, main gear, thrust rollers and problem support roller bearings oil and send to a laboratory to detect oil contamination.

9. Clean and inspect roller bearings.
   a) Remove covers and drain lubricant.
   b) Check for bearing wear, shaft condition, and bearing liner thickness.
   c) Flush with new bearing lubricant.

10. Clean and protect the bearing adjustment screws.

Kiln Preventive Maintenance Service

North American Kiln provides thorough quarterly kiln preventive maintenance inspections that include the following:

- ***Shell Ovality Measurement***
- ***Kiln Drive Inspection***
- ***Support Roller Bearing Adjustments***
- ***Assessment of Kiln Alignment***
- ***Kiln Shell Inspection for Dogleg Conditions***
- ***Tire Clearance Measurements***
- ***Complete Pier Inspection***
- ***No Shutdowns Required***

DETAILED ANALYSIS OF MECHANICAL PROBLEMS

PRIORITIZED REPAIR RECOMMENDATIONS

IDEAL FOR DOWNTIME PLANNING, BUDGETING, AND TRAINING

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