SIX ESSENTIAL Concepts for Kiln Maintenance

Ron Christen and Bill Hankes P.E., A-C Equipment Services, USA, offer kiln maintenance advice and explain how to get the best performance from existing equipment.

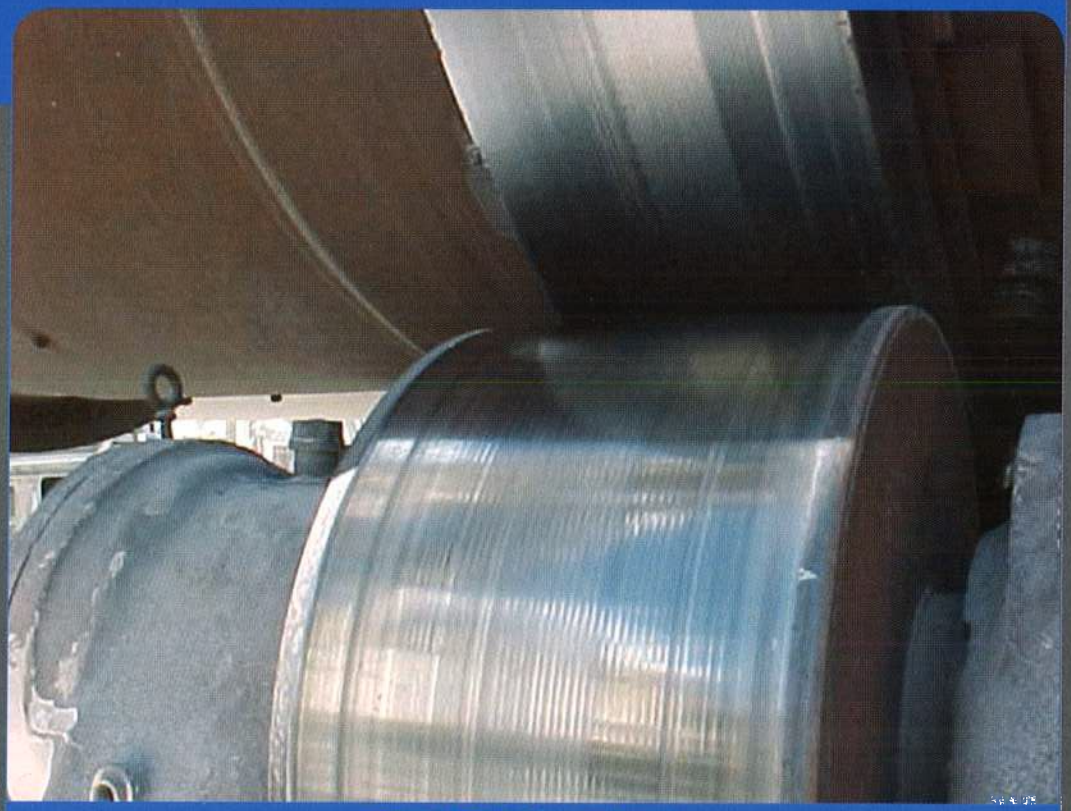

Figure 1. Roller and tyre wear.

Introduction

Drawing upon many years of collective kiln repair experience, A-C Equipment Services has developed six essential concepts of kiln maintenance. Inspecting kilns with these in mind helps to ensure the proper long term operation and service life of a kiln. Failure to utilise these concepts may not initially cause kiln performance issues; however, the longer these items are ignored, the more damage will occur.

Base slope

The kiln carrying roller supports are often overlooked and frequently neglected. This is unfortunate, since for trouble free, long term operation, proper support is critical. Many people tend to classify a kiln differently than other types of rotary equipment such as turbines, pumps or fans. Most people would never consider operating any of these with broken bases or crumbling foundations. The reason for this is speed. Most rotary equipment will fail very quickly with a poor foundation or "soft foot". A kiln fails much the same, but it takes weeks, months or even years before the damage done by a bad foundation impacts kiln operation.

A kiln is a dynamic, rotary piece of equipment. There are torsional, bending and dynamic forces that act upon the kiln shell and supports. Since kilns are designed for very long service life and rotate slowly, more time is needed for the tyres, frames and kiln shell to fail.

Reprinted from April 2007 WORLD CEMENT
www.worldcement.com

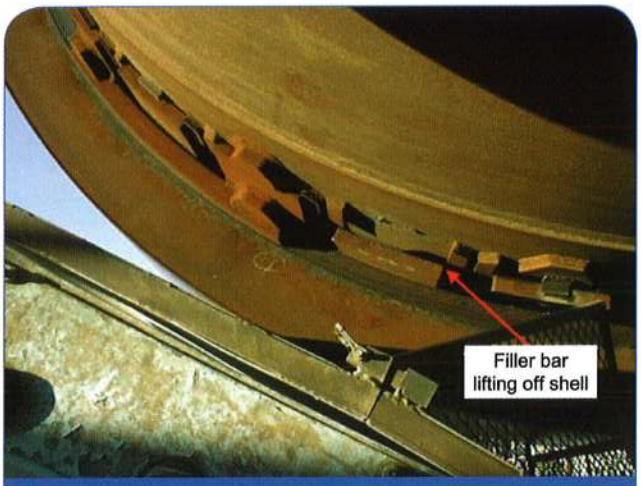

Figure 2. Inadequate tyre clearance.

Maintaining a proper carrying roller base slope is therefore critical to keeping the carrying rollers parallel to the kiln centreline and thus maintaining operating stresses and deflections in the original design range. The kiln will maintain a centreline slope even if the bases are off slope. This puts tremendous force on the support equipment, which is not designed to handle this kind of pressure. This leads to hot/failed bearings, broken frames, cracked carrying roll shafts, cracked tyres and failed kiln shell welds.

The slope and condition of all bases should be checked and corrected every time a carrying roller or bearing is changed. It is also very important to prevent oil from pooling on and penetrating into the grout and concrete supporting the frames. The root cause of many frame failures is directly related to grout failure caused by oil.

To check the base slope accurately, proper tools are needed. These include a straight edge, slope block and machinist's level.

Roller face flatness

After the base, the next most critical components are the carrying rollers and tyres. These components support the entire mass of the kiln and provide the means of rotation. The tyres provide the extremely critical function of keeping the kiln shell sufficiently round to hold refractory. Without properly designed and functioning carrying rollers and tyres, the kiln thrust will be difficult to control and the shell will not hold refractory.

Carrying rollers and tyres are designed with specific stress and ovality limits. These limits are typically conservative, allowing for the harsh operating environment of a cement kiln. However, with misalignment or poor contact, these stress levels can be easily exceeded. This will lead to premature carrying roller and/or tyre failure.

It is very important to maintain proper alignment between the carrying roller and tyre. Carrying rollers wear faster than tyres due to their increased rotating speed. This means any issues will typically be seen in the carrying roller face first.

Base slope is the first essential concept and operating off slope can wear a taper into the carrying rollers and tyres. Once these surfaces are tapered, controlling the kiln thrust or float becomes difficult. The replacement of parts is also affected, since operating a straight surface like a new carrying roller against a tapered tyre will cause point loading or severe thrusting.

A carrying roller with a true and uniform face parallel to the kiln centreline, allows the tyre to always "see" the same contact surface. This is very important for maintaining control of the kiln thrust and not overstressing the support equipment.

Frequently, the contact surface of carrying rollers wear into a tapered or concave condition (Figure 1). This causes the tyre to "see" a different contact surface depending upon the kiln axial location. These concave or tapered surfaces should be ground true. Grinding the roller has little impact on the operating stresses. Grinding the tyre reduces the tyre thickness, increasing stress and ovality.

Grinding the carrying roller surface before the tyre needs corrective action is the best solution to these issues. However, one should never grind rollers or tyres unless the base slope is correct. If it is not, it should be corrected first.

Tyre clearance

Optimising tyre clearance is another essential concept of kiln maintenance. The cold and hot creep or tyre migration for each tyre must be known, monitored and adjusted to avoid a number of serious issues. These include refractory failure, broken filler bars, (tyre pads) necking the kiln shell (Figure 2) and/or cracking the tyre. This requires the plant to log tyre creep under all start up, operating and ambient conditions. Each tyre location will have unique clearance variations due to operating conditions.

Some kilns were designed without filler bars under the tyres to save money. Extra caution is required on these installations when changing refractory and during startup.

Tyre clearance is adjusted by shimming under the filler bars. New installations typically have the shell machined with uniform thickness filler bars. As the filler bars and tyre bore wear, shims must be added under the filler bars to maintain the correct clearance.

A-C Equipment recommends that a minimum shim amount of 1/16 in. is used. Shims thinner than this wear quickly and can migrate out from under the filler bars. Tangentially supported tyres should be maintained as per the manufacturer's instructions.

Gear root clearance

The operating environment for all equipment within a cement plant is harsh, to say the least. This is particularly true for the precision machined girth gear and pinion driving the kiln. This gearing is very expensive and replacements require long delivery time. There are many things that can go wrong with girth gearing, including lubrication problems, contamination, misalignment and interference. Of these issues, the one with the greatest potential for almost instant catastrophic failure is interference. Girth gearing failures caused by interference

typically take the form of top land roll-over, tooth profile distress, pinion shaft breakage and/or gear rim breakage. A gear rim or pinion shaft failure could mean an extended downtime if no spares exist.

All gearing requires clearance between the teeth to mesh properly. This clearance is typically measured as backlash or tip-to-root distance (Figure 3). These two items are physically related so if the backlash is increased, root clearance also has to increase. Extra clearance is always part of the installation procedure for a girth gear set on a kiln to ensure interference does not occur. Backlash is used for new gearing only. Once the gearing is worn, set-up is based on tip-to-root clearances, contact and pitch line separation.

Root clearance is a nominal value since tooth root diameters are not a specifically controlled manufacturing dimension. Different gear manufacturing processes yield different root diameters for the same tooth size. Manufacturing variances also impact the actual final root diameter of gearing.

It is recommended that root clearance measurements are taken at four locations at least once a year. A current and correct root clearance value will provide information to assure that any kiln movements made during an alignment position the kiln for maximum gear life.

An easy way to monitor root clearances is by inspecting the pitch lines on the side of the gear and pinion.

Kiln thrust alignment

Kiln thrust alignment is based on the principle that each roller must be very close to parallel with the kiln centreline. In this position, each roller has an equal reaction to kiln thrust.

It is important to note that kiln thrust can change during normal kiln operation. Some reasons for this include:

- Coating or rings can form increasing load, and then fall out decreasing load.
- Shells bow or "dog-leg" due to hot spots caused by refractory failure or uneven internal coatings.
- Tyre position changes on uneven roll face.
- Dust or loads can change tyre-to-roller contact face friction.
- Roller base slope changes.
- Kiln centreline alignment changes.
- Process variables change.

In most cases, process variables and the weather are beyond the operator's control. In order to maintain correct kiln thrust, one has to ensure that the surfaces the tyres ride on are very consistent. That means the base has to be on a slope, the roller face has to be flat and the roller axis has to be parallel to the kiln centreline.

Maintaining correct thrust is made significantly easier if one is careful to maintain these variables. It is important to remember that kiln thrust is not about the position of the kiln, but is all about each roller's relationship to the kiln. Some kilns do not have uphill thrust rollers. On those, it is critical to maintain downhill thrust.

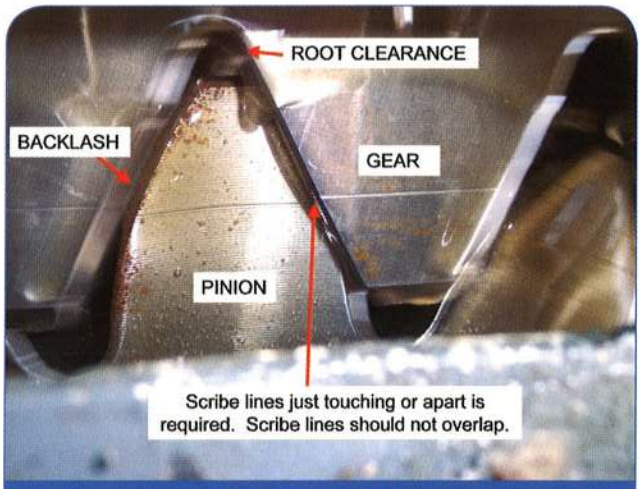

Figure 3. Scribe lines.

Kiln centreline alignment

Kiln centreline alignment can be viewed from many perspectives. The most common view is that of a perfectly straight tube that would minimise the shell stresses and the horsepower required. However, a perfect alignment such as this would do nothing to compensate for the unbalanced and ever changing load from pier to pier.

A maximum misalignment parameter has to be established for each kiln so that "intelligent misalignment" can be utilised to accommodate operational and design load issues. This can only be accomplished by combining the information gathered through shell alignment measurements, shell ovality measurements, a visual inspection of the kiln mechanical components and an understanding of the kiln maintenance history. When approached from the proper perspective, a kiln alignment programme will become an effective tool in minimising kiln problems.

Conclusion

Decades of kiln service have led to the development of the six essential concepts of kiln maintenance. These six items are things that can be maintained and controlled without affecting operation or extending shutdown time. They are critical to successful long term kiln operation. In summary they are:

- Check and correct carrying roll base slope.
- Maintain flat carrying roll faces.
- Optimise tyre clearance.
- Check gear root clearance.
- Adjust kiln thrust alignment.
- Adjust kiln centreline alignment.

A maintenance programme that incorporates these six essential concepts will experience far lower operating costs and less unplanned shutdowns.

Reprinted from April 2007 WORLD CEMENT
www.worldcement.com

A Company of Polysius Corp.

A-C Equipment Services Corporation

6737 West Washington Street

Suite 1400

Milwaukee, WI 53214

414/475-2554 FAX 414/475-3328

www.a-cequipment.com