Dispelling myths in kiln mechanics

When mechanical issues are detected on a kiln, speculation and myths are rife, leading to confusion, uncertainty or even incorrect measures being taken. While the symptoms are usually easy to identify, root causes of and the solutions to the issue are harder to come by.

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The increasing pressure on cement plants worldwide to optimise maintenance expenses in the face of tighter budgets while improving equipment reliability leaves staff with a seemingly impossible task.

While in-house knowledge about equipment condition and corrective action makes a significant difference in making correct and timely decisions, kilns usually have a long lifespan. This results in maintenance teams only slowly gaining experience.

Easy-to-use tools that provide immediate and clear information about the condition of the kilns can help to address these challenges.

Today's available technology provides many opportunities to build smart specialised measurement tools that are able to measure and visualise the complete picture of mechanical effects at any time in the operating kiln. Simple-to-use condition monitoring tools that do not require any specialised knowledge in machine diagnostics or software handling are particularly useful. In addition, the tools should be small, robust and easy to transport.

Measuring straightness and roundness of the kiln shell with the kiln shell laser

Measuring of roller shaft bending with IDM toolkit to know if there is a crank present

Not all is as it seems

A closer look at different kilns shows that the links between different mechanical effects are often less clear than initially thought. Some issues may be seen at first as being related but subsquently reveal different root causes.

High axial run-out of kiln tyres

For example, a kiln tyre has a high axial run-out (wobbling). Often people mistakenly assume it is because the lateral stopper blocks exhibit wear. The often-used approach to straighten the tyre and fix it in position by relocating the blocks will not work satisfactorily. The blocks will

Measuring axial and radial run-out of the girth gear with an inductive distance measurement (IDM) tool kit. It is used in the same way to measure the wobble of kiln tyres

break or wear off after a short period of time because the tyres follow the shape of the kiln shell. Therefore, the axial run-out of the tyres is linked to the straightness of the kiln shell and not to the axial play between the stopper blocks. The solution is a corrective cut or shell replacement.

The axial run-out can be measured during normal kiln operation. To do so, contactless sensors are placed at one side of each tyre and changes in distance are collected and analysed.

To measure the roundness and the above-mentioned straightness of the kiln, a distance laser sensor is placed beside the kiln from where it measures the deformation. One or two kiln rotations are sufficient to display the shape of the measured cross-section. The measurement is repeated, typically every 1 or 2m along the kiln, until the whole kiln is displayed as a 3D model.

Broken shaft of support roller

A further myth attributes the wobble of the kiln tyre as the cause of a broken shaft of a support roller. But there is no relation, because the load on the shaft will remain approximately the same even when the contact between tyre and rollers is bad. Nevertheless, this type of problem heavily impacts the tyre and the support rollers due to the uneven load distribution, leading to cracks in the tyre and the roller surface. In other cases, the incorrect alignment of the kiln axis is believed to be the cause of the broken roller shaft. If the kiln axis is not properly aligned, the load is unevenly distributed between the rollers. Some can be overloaded and prone to developing cracks in the roller shaft.

However, this is often not the main reason. The cause is rather a cranked kiln shell. Cranks are divergences in the straightness of the kiln that cyclically affect the load on the support rollers and piers. It is the result of a slightly-bent kiln shell with tyres that are trying to rotate out of their centres.

There are two type of cranks, thermal cranks and permanent or mechanical cranks. A thermal crank is caused by the process, from uneven coating or refractory thickness inside the kiln, which causes an uneven circumferential temperature distribution in the kiln shell. The areas with different temperature have different thermal expansion and bend the kiln

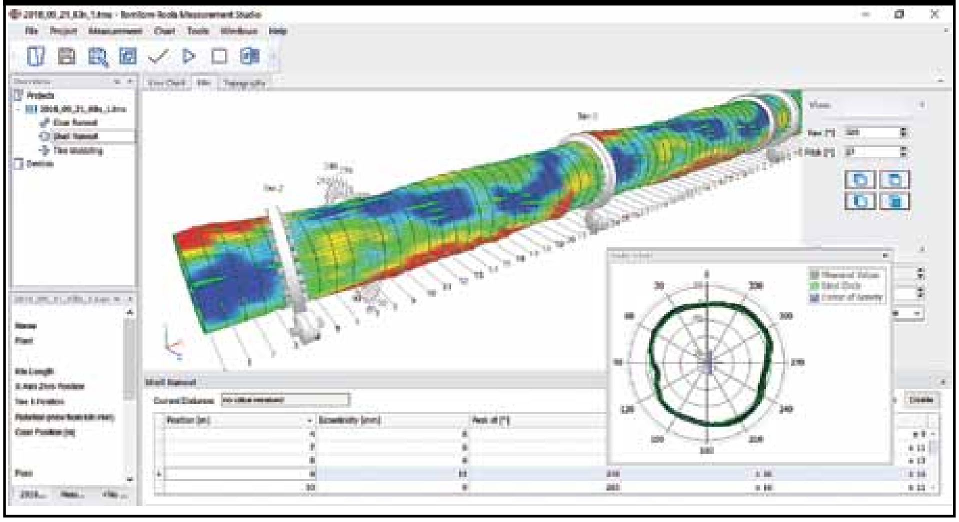
Kiln axis measurement during normal operational conditions. Surface points on the tyres are measured with the help of the target axle on a telescopic pole, the robotic theodolite and the specialised software – the Measurement Studio – that automatically calculates the kiln axis

The Symptom Matrix gives an approximate indication in what direction the root cause for a problem might be found

PROBABILITY	Symptoms / Damages: Crack – Kiln shell * – Longi-tudinal	Crack – Kiln shell * – Circum-ferencial	Crack – Support roller – Shaft	Crack – Support roller – Body	Crack – Support roller – Surface	Crack – Tire * – Body	Crack – Tire * – Surface	Wear – Between Tire & kiln shell	Wear – On roller and tire surface	Refractory failure – between Tires	Refractory failure – under Tires	Hot bearing – Support Roller – Radial	Hot bearing – Support Roller – Axial	Drive problems – Girth gear – High vibration	Drive problems – Girth gear – Pitting / Wear	PROBABILITY
A	Ovality	Kiln axis	Crank	Crank	Tire Wobbling	Crank	Tire Wobbling	Lubrication	Dust	Shell deformat.	Ovality	Geometry	Skewing	Tooth profile	Contami-nation	A
B				Design	Cylindricity	Tire Wobbling	Cylindricity	Relative movement	Lack of Lubrication	Installation	Installation			Gear split	Lubrication	B
C		Corrosion	Kiln axis		Inclination		Inclination		Skewing	Thermal shock	Shell Deformat.	Contami-nation	Contami-nation	No backlash	Alignment	C
D		Crank		Kiln axis	Oil on surface	Kiln Axis	Kiln axis		Inclination	Unstable coating	Thermal shock	Kiln axis	Wear on roller	Alignment		D
E					Kiln axis	Heavy coating				Chemical attack	Unstable coating	Lubrication	Lubrication	Crank	Crank	E
F											Chemical attack	Crank	Wobbling			F

** significantly increased in combination with high temperature*

Screenshot of the Measurement Studio, showing the 3D model of a kiln



on a relatively new kiln line. The middle tyre cracked and had to be replaced after only three years in operation. A further tyre developed cracks two years later and was replaced as well. A continuous measurement of the roller shaft bending made evident that frequently-occurring thermal cranks were causing the issues.

A more stable coating formation inside the kiln was required. This could be achieved by improving the process. Days with cranks became rare exceptions and the tyres have remained in a healthy condition for more than 10 years.

slightly. A permanent or mechanical crank can originate from an error during assembly, overheating (hotspot) or loss of rotation in hot conditions.

A strong crank can lift a tyre completely from its support rollers by each kiln revolution and has a devastating impact on all affected kiln tyres, support rollers and foundations. But even smaller cranks, which are not visible, can be very stressful for the whole kiln and will lead sooner or later to a breakdown.

The cyclical load changes on the support rollers caused by the cranks are pushing the rollers slightly out of the normal position whereas the roller shafts are bending. This movement can be measured with inductive sensors under the rollers.

Crack in the kiln tyre

A crack in a kiln tyre is usually a serious issue because there is often no spare available on short notice and there is no solution for a reliable repair. But many rumours can arise – eg, "The thermal expansion of the kiln broke the tyre, because there was not sufficient clearance between them."

The kiln shell is quite thin when compared to the cross-section of the tyre. The result of a clearance issue would be a constriction in the kiln shell, not a crack in a tyre.

Cracks in a kiln tyre can come from overload due to issues with the kiln axis or wobbling of the tyre. But in most cases, they come from the much stronger impact of cranks, same as the breakages of the roller shafts.

Mechanical kiln monitoring systems

The origin of the mechanical kiln monitoring (MKM) system can be traced back to TomTom-Tools' participation in a root cause analysis of broken kiln tyres

Crack in the kiln shell

If circumferential cracks in the kiln appear near the middle tyre and no visible issue exists in relation to corrosion or the quality of the welding seams, the issue is often a matter of incorrect alignment of the kiln. The centre of the three or more tyres are not in line and the kiln is cyclically bent with each kiln revolution. This causes high stress, leading to kiln shell fatigue and generates cracks typically in the circumferential welds near the middle tyre. Combining the above-mentioned and additional measurements in the same software into a single 3D model is a powerful tool. Effects can be easily visualised and understood by anybody using the TomTom-Tools Measurement Studio.

Modern and easy-to use tools help avoid pitfalls due to myths and lead to an improved understanding of the relationship between different effects, allowing better and faster decision-making. ■