Kiln drive performance

Cement plant operations rely heavily on the performance of the kiln and the stability of its running behaviour. Maintaining the ability to rotate the kiln when shell deformation occurs can prove challenging, but the kiln drive system can play a key role.

■ *by* ***Carlos Jorge,*** *CMD Gears, France*

In the vast majority of integrated cement plants, kiln drive systems include a girth gear and pinion. This basic concept has been around for more than a century and has not significantly been updated since. Conventional kiln drives (shown in Figure 1) therefore include:

- a girth gear, mounted on to the kiln via an elastic assembly system
- a pinion meshing with the girth gear. This pinion usually has wider teeth than the girth gear to cope with the axial movement of the kiln
- a gearbox driving the pinion through a gear coupling.

However, the weakness of this drive system is usually the open gear set (pinion and girth gear). Indeed, with the girth gear following the kiln movement and deformation, while the pinion is fixed to the ground, proper meshing between the pinion teeth and the girth gear teeth cannot be achieved.

Effect on kiln running behaviour

The kiln running behaviour greatly impacts running conditions of the pinion and girth gear. Indeed deformation of the kiln shell can alter the girth gear geometry in the following ways:

Figure 1: conventional kiln drive systems

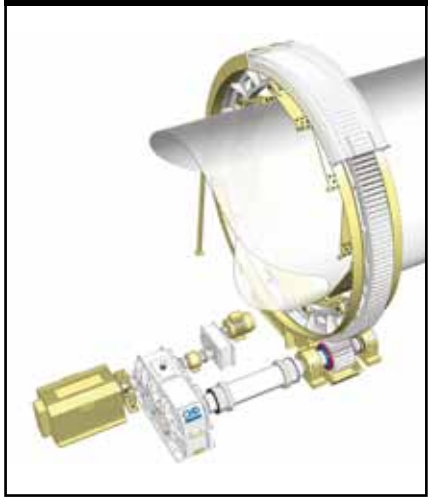


Figure 2: thermal readings of running kiln

- a thermal deformation or mechanical kiln shell crack will impact the centre distance between the pinion and girth gear and result in wobbling
- kiln shell eccentricity will impact on the geometry of the girth gear (axial and radial runout) and will affect the centre distance and/or alignment between the pinion and girth gear
- deformation and movement of the kiln shell will negatively affect working conditions of the pinion and girth gear.

Recent developments in the way kilns are run, such as the use of alternative fuels, can impose higher kiln shell temperatures and can even amplify the issues listed above.

Top cement companies recorded that an average of 10 per cent of newly-installed kilns face a forced stoppage within the first year of operation and 50 per cent over 12 years of operation.

In recent years, self aligning pinions have been introduced to improve pinion/gear meshing. However, this type of pinion only addresses the tilting of the girth gear and not its movement or runout, and thus only partially addresses the problem.

The Bogiflex® KGD concept

This led CMD to develop a completely new system to remedy such issues. The solution was actually already in CMD's toolbox: the basic Bogiflex concept was created in the 1960s and used in a number of applications in the steel and sugar manufacturing industries. The Bogiflex is a floating and self-aligning gearbox. Its self alignment capability is enabled by the fact that the gearbox output pinion, thanks to extra degrees of freedom, automatically self-aligns to the driven gear wheel.

At the turn of the century, the decision was taken to develop a modern version of the Bogiflex for kilns. This marked the start of a fruitful partnership with Holcim which resulted in the creation and application of a new generation of kiln drive system.

The Bogiflex KGD (Kiln Gear Drive) is a drive system that floats on and self aligns to the kiln girth gear. It follows the movement of the girth gear, and therefore the kiln shell, in every direction. It compensates for any kiln deformation or movement and ensures that meshing conditions between the pinion and girth gear always remain constant.

Figure 3: radial run-out readings

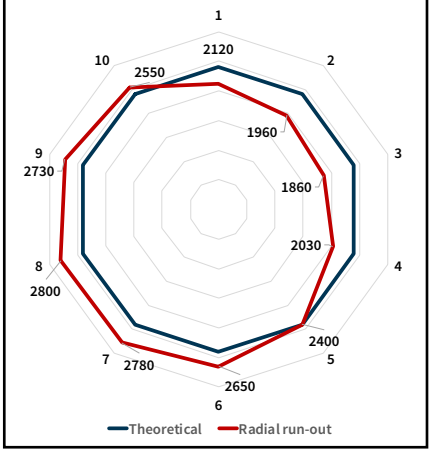


Figure 4: axial run-out readings (1/100mm)

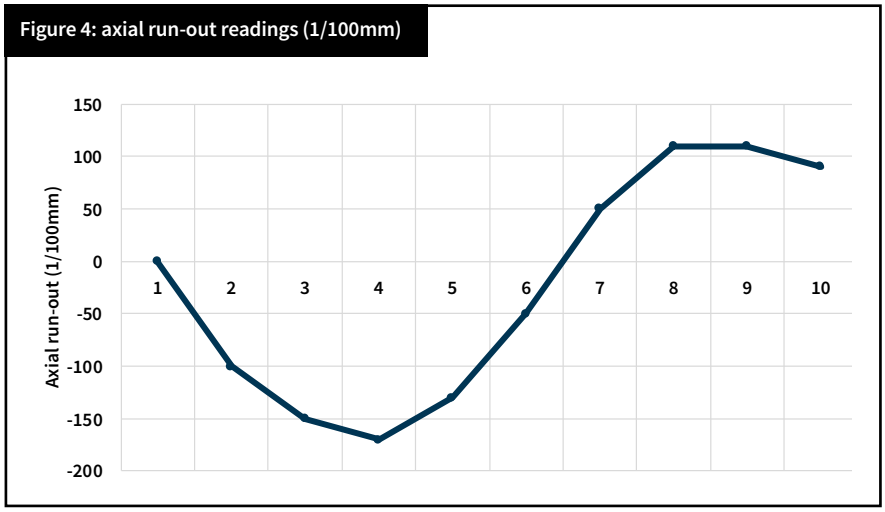


Table 1: Bogiflex KGD range

KGD size	Kiln shell diameter (ϕm)	Maximum driven torque at the shell (Nm)
KGD20	up to 4.6	1,000,000
KGD26	4.6-5.2	2,300,000
KGD32	>5.2	4,000,000+

The Bogiflex KGD includes the following components:

- girth gear, mounted on the kiln via tangential blades. Manufactured entirely by CMD and sister company Ferry Capitain, cast in its patented girth gear material – Ferrynod®.
- the Bogiflex itself, meshing with the girth gear, and supported by the reaction arm
- cardan shaft
- primary gearbox
- auxiliary drive
- lubrication units
- girth gear cover.

The girth gear and Bogiflex were designed to be standard components which enables commonality of spare parts.

Figure 5: Bogiflex KGD mounted on kiln

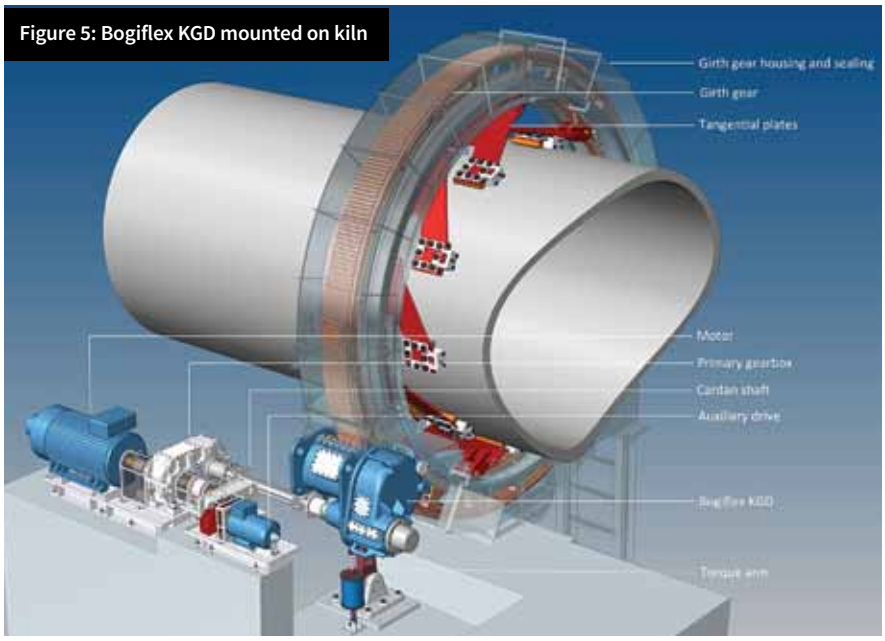


Figure 9: Bogiflex KGD20 during installation

Figure 6: cross-section of Bogiflex KGD

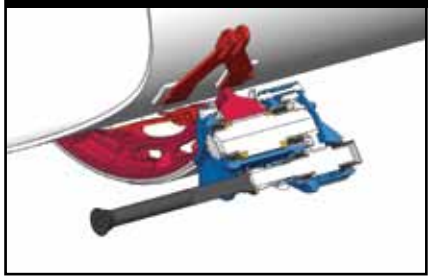


Figure 7: Bogiflex KGD axial and tilting movement capacity

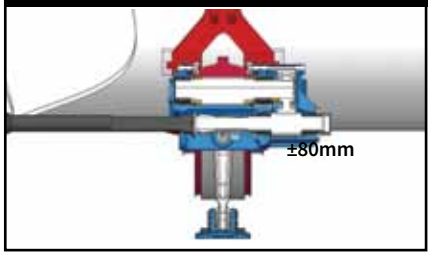
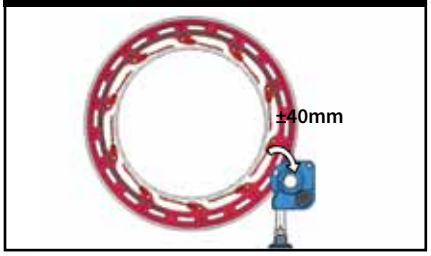


Figure 8: Bogiflex KGD radial movement capacity



The tuning of the drive reduction ratio is obtained by adjusting the specification of the primary gearbox.

There are three standard sizes of Bogiflex KGD units covering most existing kiln sizes – even up to the largest kiln capacities of over 10,000tpd. Table 1 shows the KGD range.

How it works

The Bogiflex itself includes the main pinion, meshing with the girth gear. Two pinion rollers are mounted on the pinion shaft, at each side of the pinion, and roll onto two girth gear external tracks (which are machined on each side of the girth gear teeth). Thanks to the 'pushing effect' (the sum of forces applied on the pinion is a force orientated towards the girth gear), the pinion rollers are permanently in contact with the girth gear tracks. This maintains a constant position of the pinion versus the girth gear, and therefore constant centre distance and alignment.

Another set of rollers, mounted in the Bogiflex casing, roll onto two girth gear internal tracks. They are only useful to maintain the Bogiflex in position when the kiln is stopped or rolling backwards.

The freedom of movement of the Bogiflex is allowed by the possibility of axial movement of the input pinion inside the Bogiflex, and by the fact that the Bogiflex is linked to the foundations via an articulated reaction arm.

Low- and high-viscosity oil circulation systems are supplied with the Bogiflex. Thanks to integrated monitoring, they ensure safety of the drive.

Benefits

Some of the more obvious advantages of the Bogiflex concept include:

- constant position of the pinion to the girth gear, and therefore constant meshing conditions and excellent load repartition on the pinion and gear teeth
- a direct consequence is the increase of pinion and girth gear life
- reduction of shutdown risk thanks to stable working conditions
- no more pinion alignment required, backlash and foot root clearance are constant.

The globalisation and standardisation of the concept also brings other advantages:

- improved safety of the integrated oil circulation systems
- Integrated monitoring system (including vibration, temperature and torque sensors) is available
- standardised spare parts that can be shared between several plants
- reduced foundation requirements (the Bogiflex itself is only supported by a reaction arm), which allows for use on new kilns as well as for the replacement of existing drives.

Proven in the field

The Bogiflex has proven to be a cost effective solution for kiln drive applications, as underlined by a net present value calulation carried out by Holcim. It has also proven to operate for more than 10 years without any forced stoppages. Moreover, the system's versatility enables it to be used on new or existing kiln drive replacements.

A total of 14 units have been ordered to date – six for existing kilns (capacity increase and/or kiln shell behaviour) and eight for new projects. These units are performing as designed, and the kilns are now driven reliably and resiliently. ■