Increasing competition within the cement industry and growing concerns about sustainable cement production have placed more rigorous demands on maintenance in cement plants, including the maintenance of the kiln. Therefore, kiln maintenance requires a more dedicated focus than ever.

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Driven by a competitive business climate and growing concerns about environmental protection, maintenance counts now more than ever before. Some decades ago, cement manufacturing equipment was less technically complex and more people were involved in keeping cement plants in operation. By optimising production processes and introducing state-of-the-art plant automation systems, many plants have significantly reduced their number of employees. Moreover, a steadily increasing alternative fuel (AF) usage rate and the introduction of new AF types involve modifications to existing plant layouts or even additional plant units.

As a core process of the entire cement plant, kiln operation consumes most of the thermal energy required for burning clinker. Ultimately, plant reliability is of high importance since interruptions to kiln operations lead to higher energy consumption and energy costs. As a result, the specific maintenance cost also increases and equipment life time decreases. The specific maintenance cost amounts approximately to 20-25 per cent of total production costs in the cement industry, ranking second after energy and fuel costs. According to VDZ best practice, a reliably-performing kiln system should achieve an equipment net availability of above 90 per cent. However, the age of many kiln lines is over 20 years, and maintenance efforts usually rise, especially in older production lines. Thus, proper maintenance of rotary kilns requires a more dedicated focus and an understanding of the prerequisites for the mechanical stability of the various interacting components.

**Maintenance strategy**

Maintenance must be managed in a way that equipment is stopped for maintenance only in a planned stoppage schedule. Any unplanned stoppage of the kiln system has a direct impact on production and energy losses. An additional heat-up costs more thermal energy and unnecessary thermal stress on the refractory lining. Such stoppages of the kiln system are usually caused by one or more of four root causes: axis misalignment, shell ovality, or flex, crank and axial misbalance. These can lead to failures due to hot bearings, shell cracks, roller and tyre wear and other similar reasons. Moreover, unplanned repair work consumes significantly more resources than a planned stoppage. To avoid all of the above-mentioned aspects and achieve the right productivity and high product quality as well as the targeted maintenance key performance indicators (KPIs), it is important to have a proper maintenance system in place, because plant maintenance significantly contributes to the overall performance of the plant and is expected to assure long and trouble-free operation.

A state-of-the-art maintenance strategy aims at ensuring continuous plant operation and avoiding interruptions. This can be achieved by establishing a preventive maintenance system in the plant. This approach is based on measuring the equipment’s condition to assess whether it will fail during some future period and then taking action to avoid the consequences of these failures. Such a system focusses on minimising “fix when it breaks”-activities by promoting condition- and time-based accurate and reliable inspections. By applying predictive technologies (ie, vibration monitoring...
analysis, infrared thermographs, ultrasonic detection, etc), the maintenance team can determine the condition of equipment and decide on necessary repairs.

**In-house maintenance inspections**

Very essential monitoring of the kiln system is carried out by the control room operators. They maintain process parameters such as the kiln rpm, kiln feed, power consumption, temperatures, pressure drops, kiln hood pressure and shell temperature during the operation. Although these parameters are mainly process-related, they have a direct impact on maintenance KPIs.

A well-functioning preventive maintenance department consists of planning and scheduling, condition monitoring, and lubrication groups, as these groups carry out preventive and proactive maintenance activities by nature. Lubrication charts and instructions should be developed and performed on a predetermined frequent basis. Condition monitoring groups carry out timely and condition-based monitoring activities on main equipment. The essential parameters of these activities such as their type, duration and frequency are usually defined by the preventive maintenance team and scheduled on a routine basis.

Apart from predictive technologies, statistical processes control techniques, and human senses are also used to monitor the equipment condition. A very simple tool for equipment condition monitoring is a checklist which can be implemented during walk-by inspections on main equipment on a daily or weekly basis. It is a systematic approach to walk-by inspection. In Figure 1 a maintenance inspector checks the gap between the thrust collar of the bearing bush and shaft collar.

In the case of an abnormality, an inspector raises a job notification that can later be converted into a work order, depending on its criticality. This approach is a more economically-feasible strategy as labour, materials and production schedules are used much more efficiently. However, it is a gradual process and a quick jump from breakdown to preventive maintenance is impossible. Experience shows that a successful transfer requires a couple of years until the system runs properly and the breakdown tasks come down to less than 25 per cent of the total maintenance activities. Such an analysis can be carried out based on maintenance KPI reports issued from computerised maintenance management systems.

**VDZ maintenance portfolio**

More sophisticated diagnosis and inspections can be provided by third-party experts. As a research institute with 140 years of experience, VDZ provides answers to almost any question about cement-based building materials according to the current state of science and technology. Nowadays, within its maintenance service portfolio, VDZ also offers proven independent expertise in the field of maintenance inspections and surveys of rotary equipment, eg, kiln, vessel, incinerator, dryer and cooler, as well as various services covering ball mill mechanics (crack test, accompanying assembly supervision and commissioning of new installations or after repair).

**Case study: ovality measurement**

Although ovality is sometimes influenced by alignment, it is always of interest and concern with respect to the mechanical stability of the refractory. Ovality, as it applies to an operating kiln shell, is the change of curvature or flexing of the shell during the course of each revolution. The first practical device to actually measure ovality was patented in 1953 by ERS Ka-reby of Stockholm, Sweden.

The kiln shell ovality measurement (also known as Shell-test) measures the elastic deformation on the areas adjacent to the loose tyres. An excessive ovality value will have a negative impact on the lifetime of the refractory bricks and must be kept under acceptable limits (which vary according to kiln diameter). VDZ conducts a kiln shell ovality measurement by means of the ‘Ovality Sensor’ (see Figure 2). The Ovality Sensor measures the changes of the roundness and curvature in the kiln shell during operation. This elastic deformation is called ovality and is primarily present in the area of a loose kiln tyre. The measurement gives accurate information about the degree of mechanical loads in the refractory and kiln shell, and allows defining the countermeasures in advance to increase the lifetime of the kiln components.

During a measurement campaign, high ovality and relative movement at tyre 2 was detected. The relative movement was also on the higher side. Both values were evaluated taking into account the actual shell and tyre temperatures as well as the kiln diameter. In Figure 3 the results of the ovality measurement at tyre 2 of a kiln with a diameter of 4m are shown.

After the completion of the measurements, the results and the accompanying data were evaluated. Based on the evaluation results, an action plan with various due dates for correction was elaborated by the VDZ team. VDZ recommended replacing the worn filler plates and stopping blocks, as the shell ovality and tyre migration values were out of range.
Case study: run-out measurement

Within the kiln inspection VDZ’s expert team conducted a kiln girth gear and tyre run-out measurement for a cement producer in Germany. For the measurement a multi-purpose measurement tool IDM (Inductive Distance Measurement) was used. The inductive distance measurement tool is a device that measures the distance or change of any distances without contact on any running equipment. It measures distances in perpendicular direction to any metal surface with a high accuracy, which basically replaces the traditional dial indicator and allows measuring on unclean surfaces during operation. It is typically used to check the condition of rotating parts during operation. By means of IDM, girth gears run-out and wobbling measurement on rotary kilns, rotary dryers and ball mills, roller shaft bending measurement of support rollers on rotary kilns, shaft movements in gear boxes and drives, and a roundness check of trunnions on ball mills can be conducted.

After the completion of the measurements the results were evaluated. For better visualisation a graph was used (see Figure 4) that is supported by the IDM software. Based on the evaluation results an action plan with various due dates for correction was elaborated by the VDZ team. VDZ recommended to check the clearance between girth gear and pinion and to repeat the run-out measurement in cold condition, during the plant shutdown, to get the confirmation of the results without any thermal influence. At stations 1 and 3 the tyre fixation systems and tyre filler plates should be monitored under different temperature and production conditions.

Conclusion

The maintenance system, as with other plant departments in the cement industry, relies on a skilled workforce. Therefore, a successful maintenance system should be accompanied and maintained by corresponding training with a dedicated focus on the various subjects. VDZ is constantly extending its support for cement producers to build, secure and update the knowledge and fundamental skills of their technical staff. Therefore, VDZ offers training and seminars in the field of maintenance management and maintenance measurement techniques. The plant maintenance course covers all topics concerning the high efficiency and availability of a cement plant’s key machinery. The measurement of rotary kilns and ball mills as well as independent expertise in mechanical maintenance and inspections are also among the major aspects. The practical part of the training is conducted in a cement plant.

REFERENCES

3 www.tomtom-tools.com, measurement tools for the cement industry