Kiln corrosion protection

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With internal corrosion of kiln shells becoming a more frequent and serious problem at cement plants, 3L&T explore the causes behind this issue and detail one particular protection measure that has been applied at a number of cement plants across the world, with specific reference to case studies in Mexico and the Philippines.

Many cement kilns experience severe corrosion under the refractory. There are currently two trends being observed that seem to correlate with the aggressive corrosion: higher sulphur in the fuel and most importantly, the increased use of alternative fuels.

Figure 1 shows the corrosion rate of a kiln that was protected with a sacrificial stainless steel sheet. Shell thickness loss was more than 1.3mm in just 11 months in service. Obviously this is not a good corrosion protection system.

Several cement plants have installed a new ceramic material technology called KilnGard-600SCW which is simple to install, easy to inspect and possess excellent corrosion and abrasion protection characteristics, state 3L&T.

Many cement kilns in Mexico, Colombia, Brazil, Philippines, Honduras and Guatemala have been protected with this new ceramic coating and several other projects are ongoing, including one kiln in Malaysia and a repeat project in Mexico.

Considering the overall investment for a new kiln, this can be a cost-effective solution, adding more years to their useful life.

Figure 1: corrosion in a new cement kiln

Figure 2 shows the inside of a cement kiln after removing the refractory. After six years of operation, the shell thickness went from 30mm to 19mm in some areas.

Corrosion under the refractory

A rotary cement kiln has a very diverse environment on the inside, and is basically a complex chemical reactor with several temperature zones and compositions. Additionally, the raw materials composition, the type of fuel used and the operating conditions will influence the corrosion occurring in a cement kiln.

Of all the variables of interest, the chemical composition of the raw meal being used (specifically its chloride and sulphur contents) and the type of alternative fuels used in the kiln

Figure 2: close view of a corroded area

Figure 3: rust scale from a kiln after 12 months of operation

Figure 4: spray application of KilnGard-600SCW

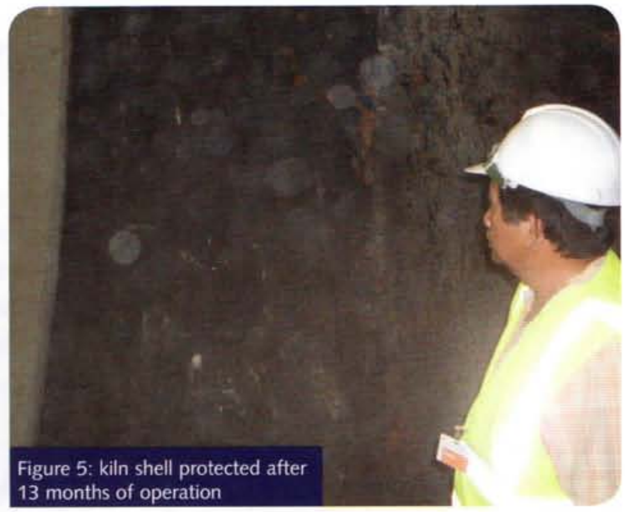

Figure 5: kiln shell protected after 13 months of operation

are probably the two most important, particularly in terms of their contribution to internal corrosion. Chlorides and sulphur originate mainly from the fuel but in some plants can also be present either in the limestone or in the combustion air.

The vapours of sulphur oxides and chlorides can leak through cracks in the refractory, reach the inside of the shell and produce acid condensates which can be very aggressive. Figure 3, shows a large piece of shell rust with 3-4mm thickness.

Field applications

A cement plant in Mexico has experienced severe corrosion of the kiln shell under the refractory. The plant had to replace a 20m length section of one of the kilns due to reduced thickness. There was a correlation with the increase in use of alternative fuels. Typically the corroded steel delaminates in thick layers, which are strongly magnetic. This usually corresponds to the Fe_3O_4 type of iron oxide.

This was a good opportunity to install the new nano-ceramic material developed by 3L&T to extend the useful life of the kiln shell. This material is applied by air spray on a sandblasted steel surface, the recommended thickness is 0.5mm. After drying at room temperature for about 12 hours, the bricks can be installed as usual. The ceramic coating attains its maximum physical and chemical properties after heating the kiln during the start-up process. Figure 4 illustrates the spray application process.

A cement plant in the Philippines has made several applications of KilnGard-600SCW based on the good results obtained. After every refractory removal, several coated areas receive some mechanical damage and need some recoating. Figure 5 shows the visual inspection of a kiln section that was protected a year before, there is no shell thickness loss.

A good way to confirm the corrosion protection of the kiln shell is by measuring the metal thickness along the kiln. The recommended distance for monitoring is every metre. The initial measured spots will be marked so that the follow-up measurements are done in the same location. Figure 6 illustrates the results of these measurements for a kiln protected with KilnGard-600SCW, the shell thickness is practically the same after 12 months in service.

Conclusions

Corrosion is a relatively new additional problem in cement plants. When kiln corrossion happens it can be very costly. There are many different components to and it is a difficult battle to keep under control. Several plants have used coating and linings that did not provide adequate protection.

In many cement plant kilns, shell corrosion has been more aggressive in recent years. This is due to a combination of factors, mainly more sulphur and chlorides in the gases.

This growing market requirement has led 3L&T to develop a new ceramic material that has demonstrated its effectiveness under severe conditions of temperature, abrasion and chemical attack.

This new ceramic coating, KilnGard-600SCW, can be applied during the kiln shutdown. The new refractory is installed on top of it and is cured in place during the normal start-up of the operation.

The KilnGard-600SCW applications described in this article are just the beginning. An experienced engineer told 3L&T some years ago: "There is a lot of corrosion out there" and as a result the company feels proud to be able to provide a solution.

Figure 6: thickness measurements in a protected kiln shell