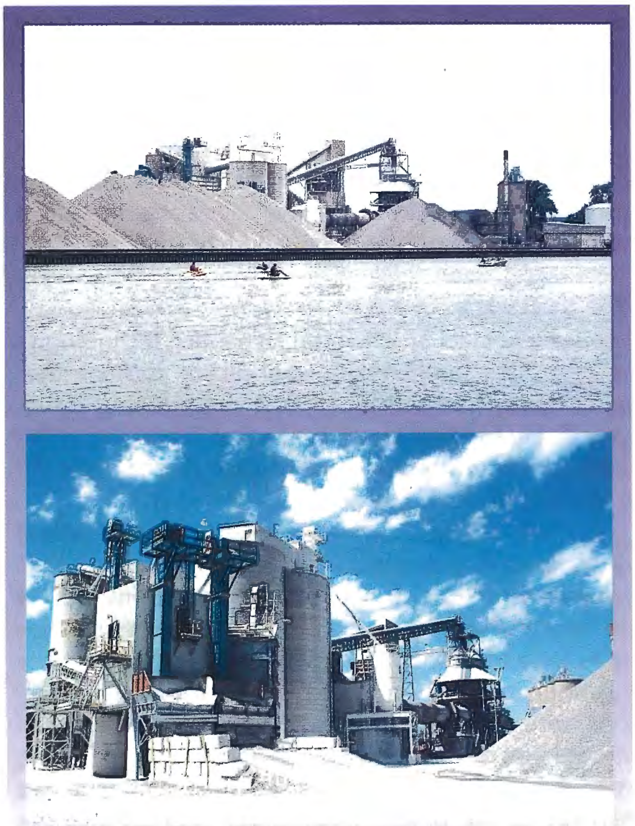
MICROWAVE COOLER LEVEL CONTROL

Steven Hutte and Mike Nast, Western Lime Corp., USA, discuss problems faced by the company's Green Bay facility during various attempts to find an appropriate automatic cooler level control system for the plant, and the recent successful installation of microwave cooler level control.

Introduction

Western Lime Corp.'s Green Bay Plant is located half a mile north west of downtown Green Bay, Wisconsin, on the Fox River. The plant has undertaken a series of upgrades since 1973, when there were five shaft kilns and one Corson kiln in operation. Of these kilns, only two of the shaft kilns were in operation by 1982, when it was decided that these two kilns in combination would be unable to meet the predicted demand for the high calcium lime that would be imposed on the Green Bay Plant. The solution was the installation of the No. 1 rotary kiln, a 250 tpd kiln, with a shaft type preheater which was originally commissioned in 1976 to burn gas and oil. In 1980, the Corson kiln was decommissioned and razed, and in 1982, the burner was changed and a Raymond 412 Bowl mill installed to fire coal. In 1986 all the shaft kilns were torn down and in their place was erected much needed warehouse space to store and ship bagged hydrated lime. This arrangement worked well for six years until again the demand started to exceed production capabilities of the Green Bay plant.



Western Lime Corp.'s Green Bay plant.

In 1988 plans were considered for increasing the production capabilities of the Green Bay plant. By January 1992 plans were finalised and construction began in late 1992 on another preheated rotary kiln. This kiln has a designed capacity of 350 tpd. This kiln also included in its design Western Lime's first attempt at automatic cooler level control.

Criteria

The criteria for the automatic cooler level control are as follows: for the level sensor to work in the cooler of the kilns, it would have to be able to function in a harsh environment. An intrusive unit would have to be able to withstand an upper cooler temperature in excess of 1500 °F. Outside the cooler, depending on the mounting location, the unit would have to withstand ambient temperatures of up to 500 °F. Allowances for sealing out ambient dust and exposure to moisture would have to be designed into the unit, and it would have to be compatible with the plant's PLC system with auxiliary contacts for high, low and self-diagnostic failure alarms.

Background

The design of the No. 2 rotary kiln at the Green Bay plant included a nuclear level sensor for cooler level control. This was a non-intrusive device that worked in the same manner as an X-ray machine to indicate the level of an 8 ft section of the cooler. The nuclear sensor worked well for the first two months of operation, however, operators then began to report inconsistencies in the level of the cooler. It was determined that the nuclear source was not sufficiently strong to penetrate the full cooler and the refractory lining. A 2 in. wide, 8 ft long vertical slot was designed for the opposing refractory wall to ensure penetration of the source to the receiver. Over time the slot would pack with the finished product and indicate a false level. This of course would drive the calibration of the unit up, forcing the programmed loop to feed more product out of the cooler hence a lower than desired level in the cooler.

Soon after, on a start-up of the No. 2 kiln, operators reported that the sensor was giving false level indication once again. Since the whole system was only shut down and the slot recently cleaned out this was obviously not the problem. For the entire kiln run, the operators were unable to rely on the accuracy of the level sensor and had to judge by looking into the cooler. After shutdown of the kiln, it was determined that

Kiln No. 1 (left), kiln No. 2 (centre) and the microwave sensor, which is mounted to the side of the firing hood (right).

a build up of dust on the cooler roof was the culprit of the false indication. In both of these instances, the level sensor was rendered inoperable until a shut down when the cooler could be cleaned out. These problems, combined with government regulations and permitting fees for the nuclear source, forced Western Lime to look for another alternative, and as a result, in early 1993, the nuclear level sensor was removed and sold to another lime company.

Later in 1993, a forthcoming upgrade of the kiln No. 1 cooler and firing hood again brought the subject of cooler level control to the fore and the search continued for a viable level control device to work in both of the kiln's coolers. It was decided to try a new type of capacitance level sensor for point level control. The sensor consisted of a ceramic capacitance disc, 4 in. in diameter, which when contacted by the product in the cooler would send an input to the PLC. The input would then speed the feed rate to lower the cooler level, and when product did not contact the disc, would slow the feed rate to raise the cooler level. Timers were employed in the ladder logic in conjunction with the sensor to dampen out false hits of product on the sensor disc.

It was decided that the best course of action would be to try the unit in kiln No. 2 and include the needed mechanical set-up in the No. 1 upgrade. Two bores were made into the east wall of the No. 2 cooler: the first at what was determined to be the desired angle of repose, and the second 9 in. below the first, to leave some mechanical adjustment flexibility in the level of the cooler. Four sleeves, 9 in. apart, were drawn into the cooler design for the No. 1 upgrade. The angle of repose was almost impossible to determine on paper, therefore some flexibility was needed to raise and lower the device for optimal positioning. The unit had to be calibrated when the ceramic disc was warm on a start-up of the kiln with the product near to its normal operating temperature. The first attempt at calibration failed within one hour because the temperature during start-up was not as high as normal operation, and over a four-week period the longest the unit functioned properly was for six hours. It was determined that the gradual fluctuation of the upper cooler temperature, in a 100 °F range, was too much to remain within the parameters of the sensor's electronic calibration. Cooling air was used on the backside of the disc to try and stabilise the temperature with no appreciable results. The ceramic sensor was eventually scrapped.

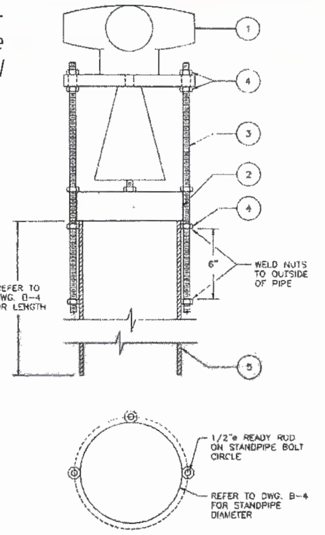
Over the next four years there were many inquiries and just as many guarantees that this or that device would work. Most vendors claimed that their particular level of control would work in any situation which the plant wished to 'accommodate' but none had been proven in the same type of application that was present in the two coolers at the Green Bay plant. Therefore Western Lime Corp. decided that it would not 'accommodate' any device which had not been proven in a similar application for at least one year. The plant also required that the device require only a minimal amount of downtime and maintenance.

The sensors

Through contacts at Universal Dynamics Technologies Inc., the plant learned of a level sensor package that the company had developed that was working for an extended period of time at another lime plant. The package was centred on a microwave sensor mounted to the side of the firing hood.

Two of the units were purchased and Universal Dynamics provided mounting drawings for multiple locations on the firing hood and specifications of how the sensor was to be mounted. Arrangements were made for a technician to be sent to the plant once the units were installed and wired. Once the mounting locations were established for each kiln, holes were bored into the side of the hoods, at the required angle, using a two-sided plywood template. A schedule 40 pipe was then cut to the proper dimensions, inserted into the bore and fully welded to the firing hood. Galvanised

Figure 1. Cross-section of the microwave level sensor package.



REF	QTY	MATERIAL LIST	SUPPLIED BY
1	1	LEVEL TRANSMITTER, U.D. TECH, MODEL PMLC 130-LIT	UNIVERSAL DYNAMICS
2	1	DUST SHIELD, U.D. TECH. MODEL MDF100	UNIVERSAL DYNAMICS
3	3	1/2" DIA. x 18" LONG, GALVANIZED READY ROD	WESTERN LIME
4	15	1/2" DIA GALVANIZED NUTS c/w 1 1/2"ø WASHER	WESTERN LIME
5	AS REQ'D	STANDPIPE, SCHEDULE 40 CS PIPE, TO BE WELDED ONTO TOP OF BIN	WESTERN LIME
Universal Dynamics	WESTERN LIME & CEMENT CO. MICROWAVE LEVEL TRANSMITTER INSTALLATION	SEO / UNI-9505b	99/05/20 / A-3

Table 1. Green Bay plant: equipment suppliers	
No. 1 kiln commissioned in 1975	
Kiln No. 1	Allis Chalmers, 10' x 155'
Coal mill	Raymond 4 12 bowl mill
Weighfeeder/belt scales	Merrick
Cooler/firing hood	Ferenco (Installed 1994)
Cooler fan	IAP
Cooler discharge feeders	FMC
ID fan	Zurn
MCC	Cutler Hammer, Square D
Kiln dust collectors	Wheelabrator (4 Modules)
Bag material	BHA (Woven Glass)
PLC	A-B 5/40
PC	NEC 486/33i (2 Total)
Programs	OS2 Factory Link/ Icom PLC-5 Ladder Logistics
No. 2 kiln commissioned in 1993	
Kiln No. 2	FL Smidth, 11'6 " x 170'
Kiln drive	Allen Bradley/variable speed/AC
Coal mill	Raymond 4 53 bowl mill
Weighfeeder/belt scales	Schenck
Cooler/firing hood	Fuller Co.
Cooler fan	Robinson
Cooler discharge feeders	Jeffery
ID fan	Barron
MCC	Cutler Hammer
Kiln dust collectors	Aeropulse Inc. (4 modules)
Bag material	27 oz. Huyglas
PLC	A-B 5/40
PC	NEC 486DX2/66 (2 total)
Programs	OS2 Factory Link/ Icom PLC-5 Ladder Logistics
Material handling	
Dust collectors	Micropul, CP Environmental
Elevators	Sullivan Strong Scott, Feeco
Product crushers	McLanahan Roll Crushers, Jeffery
Product screeners	Dillon, FMC
MCC	Cutler Hammer, Square D

threaded rod was then welded to the pipe at the proper points to mount the sensor and the sensor shield. The sensors were then mounted and wired (Figure 1).

Prior to start-up of the kilns, measurements were taken to determine the low level from the sensor to the lowest point that the plant wanted the product to fall. This was to establish a starting point since the sensors are calibrated from the low level to the high level. It was established that a 10 ft low level would suffice for both coolers. From that reference, the high level span could be determined once the kilns were in running status and therefore the high level required could be more accurately locked in. A sensor failure alarm was programmed with a measurement range, to ensure that if the sensor indicated this range for a preprogrammed amount of time, it would initiate an alarm condition. This range was set at 1 ft.

Universal Technologies Inc., sent a member of its process control department to the plant for the initial set-up of the units. He set up the parameters for both units identical for a starting point, and then checked the units using a laptop computer with specially designed software. Both units were found to operate smoothly and began to perform without problems. Soon thereafter the necessary programming was installed into the PLC and the level controls were set into automatic mode. Alterations were made to the individual sensors over the next couple of hours to zero in on the levels which were desired for the individual coolers. The sensors performed well overnight on automatic mode, and the operators noted that the levels did not change more than 2 in. The next day, one more diagnostic check was performed, which determined that there were no malfunctions.

Both sensors worked well for two weeks, and then the unit on the No. 2 kiln indicated a sensor failure alerting the operator to a problem. The control was immediately set to manual and the maintenance crew was notified of the problem. The cooler level had been dropping at a steady rate and the sensor was locked in at 98% full indication. It was determined that a build-up of dust on the sensor cone was indicating the false level. A quick shot of compressed plant air was all that was needed to clean the unit and this procedure was added to the weekly maintenance routine. As a result, there has not been a malfunction since. During extended kiln shutdown periods, the power to the units is turned off to prevent the sensor failure alarm from continually occurring due to lack of cooler level fluctuation.

Conclusion

The sensors have controlled the cooler levels in both kilns within a 4 in range. This tight level control has made major improvements in the overall process control, and the benefits include consistent airflow through the coolers. This in turn allows for more precise control of the process, better cooling of the product for lower, and more consistent cooler exit temperatures. The stability of the kilns has allowed for a more consistent and higher production. The quality of the lime produced has also become more consistent among the operators running the kilns.

Enquiry no: 8