Lafarge, Whitehall Opts for PGNA Analyser

Steve Foster, Executive Vice President, SABIA, Inc., and Jonathan Graham, Process Manager, Lafarge North America Whitehall Plant, explain an innovative adaptation to online raw mix control at the Whitehall plant.

Introduction

Located in the Lehigh Valley near Bethlehem, Pennsylvania, just a mile away from Coplay, the US birthplace of cement production during the late 19th Century, the Whitehall Plant fired up its first cement kiln in 1899. Originally built by the Whitehall Portland Cement Company, the plant is owned today by Lafarge North America.

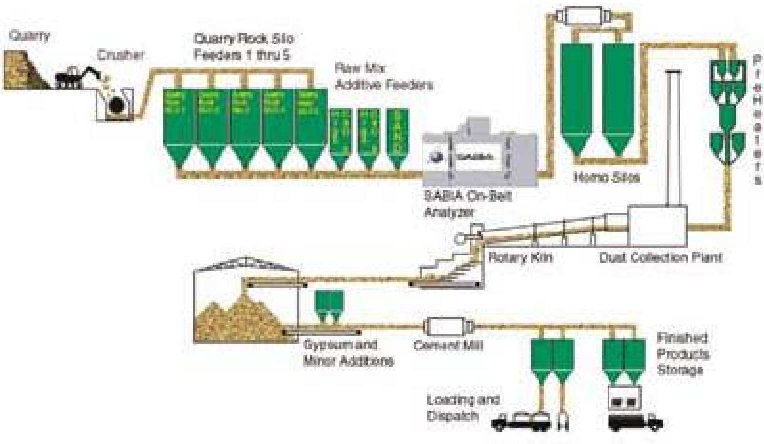

Figure 1. The plant layout.

The plant produces ten different types of cement, addressing a wide market with 700 000 tpa cement production, utilising two preheater kilns and two raw mills. The relatively urban plant setting requires careful plant operation (minimal dust and noise) and limits the plant's footprint.

Whitehall's quarry contains relatively low and variable calcium concentrations in one of the company's most heterogeneous quarries. Due to the high silica and alumina content, the raw mix also includes purchased limestone. Reducing quarry variability and improving raw-mix control tend to reduce the use of purchased material, an important cost factor for the plant. Investment cost aside, the limitations on available land area prohibit traditional space-intensive prehomogenisation blending-bed solutions,[1] leaving mainly high-frequency control as the possible means to improve control capability.

Whitehall pioneered on-line analysis application with the use of a Westinghouse XEG (X- ray Emission Gauge) to continuously analyse calcium and iron of a raw-mill sample, used from the 1960s until the early 1990s (the unit becoming obsolete).

Since the decommissioning of the XEG analyser, rigorous sample-based raw-mix control schemes and procedures evolved to cope with the quarry variability[2]. While these procedures and reduced quarry variability had resulted in reduced raw-mix variability, further benefit seemed possible with the use of modern on-line analysis.

Lafarge Whitehall decided to implement an online raw-mix control strategy utilising a SABIA model XL-5000 nuclear elemental analyser (PGNA – Prompt Gamma Neutron Activation[3]) in conjunction with the company's proprietary raw-mix-control software, QMC.

Process flow/application

Quarried and purchased materials arrive by truck into the crusher area. A gate system directs crushed materials to each of eight assigned storage silos. Weighfeeders dose each material according to percentage set points onto a collection belt. The feeders include five for quarry limestone and one each for high-grade limestone, alternate raw material and sand. The collection belt dumps to the boot of a vertical bucket conveyor, then to a drag chain conveyor, and to a common bin, which feeds two ball mills.

Pulverised product from the mills is then transported, in common, pneumatically to six homogenisation silos, prior to feeding two kilns.

The analyser installation was planned at the end of the collection belt, just prior to the drop point to the raw-mill bucket conveyor. It provided high-frequency raw-mix chemistry signal to the QMC software, but the project faced several challenges:

- The collection belt had very little room for installation of an analyser.
- The belt is narrow (24 in.) with low material loading (maximum possible about 60 kg/m).
- The materials have variable moisture contents with significant layering.

Analyser installation, commissioning and static tests

The analyser was delivered in late August 2007, and installation/commissioning took place in August and September.

Mechanical installation of the analyser on the collection belt went smoothly, despite the confined space, because of the analyser's flexible design and thorough planning for power, signal cables, signal interface with the plant, etc. Actual installation, insertion of nuclear sources and powering up the analyser took less than three days. Opportunities to access the belt occurred rarely (sometimes both mills were down simultaneously

Figure 2. Lafarge Whitehall analyser location before and after installation.

only every few weeks), so installation and testing windows had to be planned well in advance.

In most raw-mix applications of a PGNA analyser, a belt weigh scale would provide a signal for closed-loop belt load control of a variable-frequency drive (VFD) to ensure uniform belt loading. In this case, there simply was no room available for the installation of a weigh scale.

Initially, the tph signal consisted of the sum of feeder flow demand signals as the assumed equivalent analyser belt-weight scale signal.

Prior to analyser delivery, the customer had prepared and characterised a set of six static reference standards for use in calibration and performance validation. Each standard consisted of mixtures from the array of site materials, targeted to yield an appropriate chemical range. The standards worked well except for two points. The outliers most likely occurred due to errors of sample preparation, as the outlier mixtures had the worst sampling fundamentals. Tests also occurred using the actual raw material on a stopped belt.

Operation, dynamic tests and compensation

During the first few months of implementation, the team

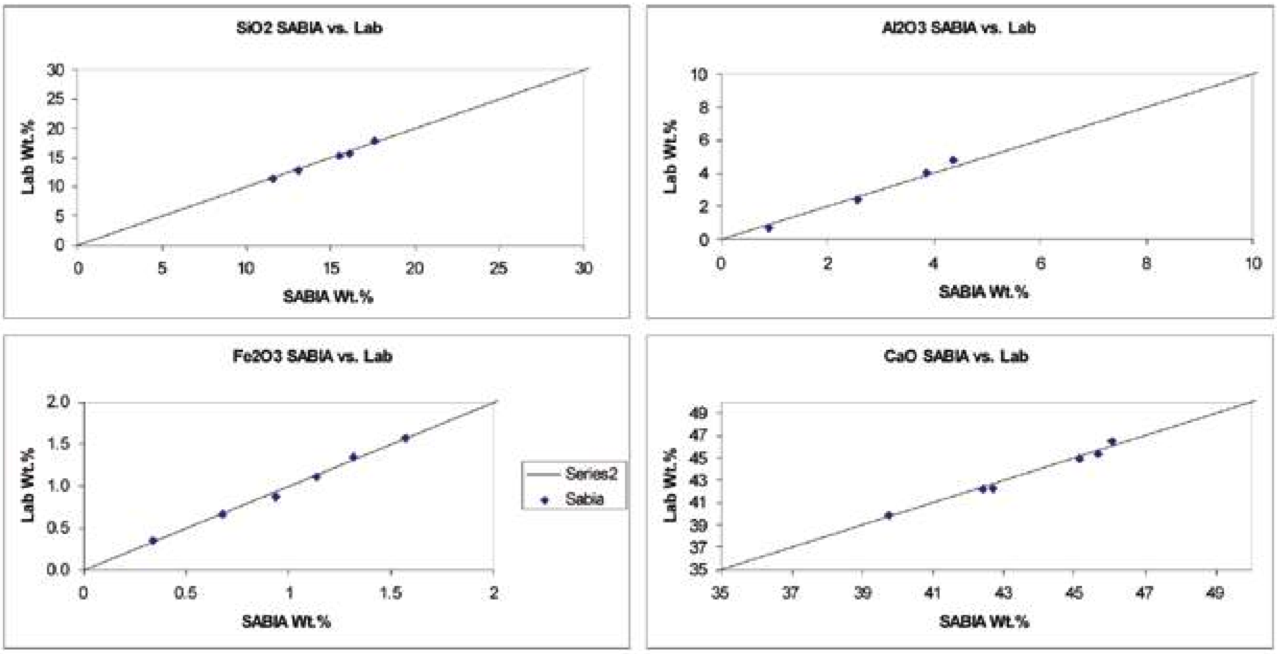

Figure 3. Analyser accuracy and static precision performance on static reference standards made from site materials.

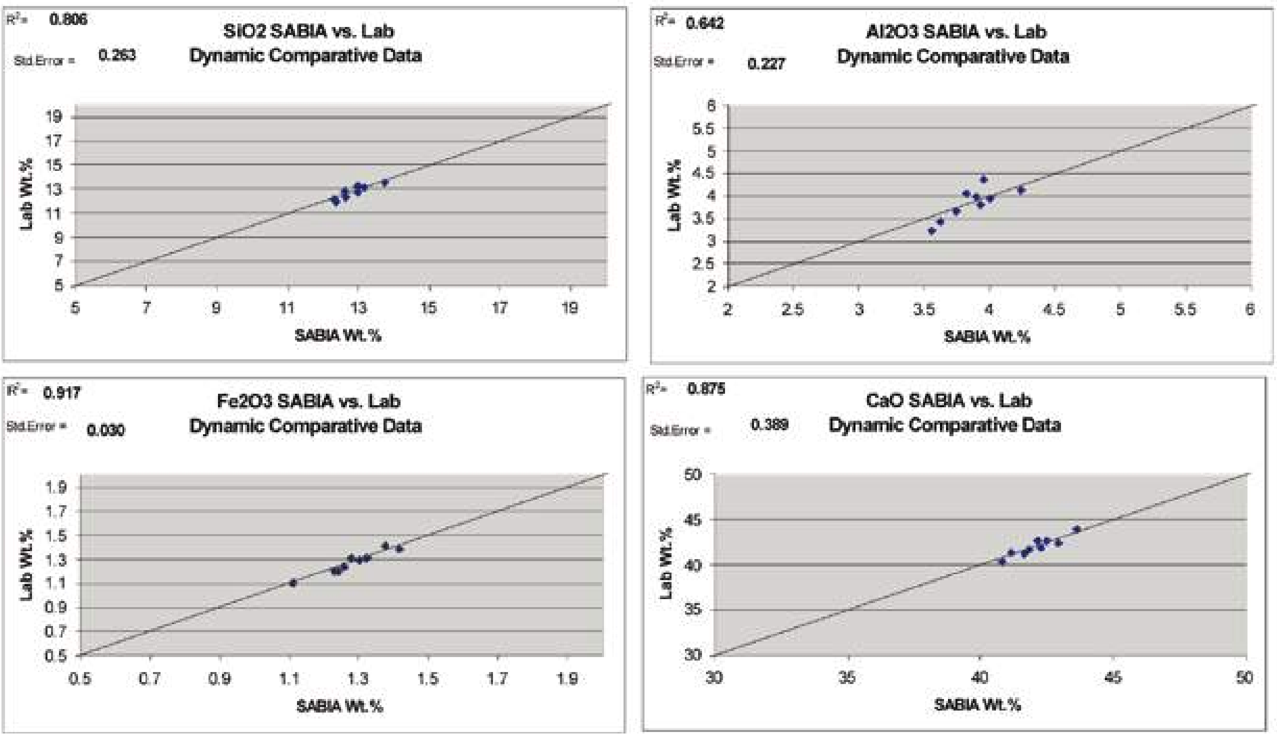

Figure 4. Analyser dynamic accuracy performance on dynamic bump test data.

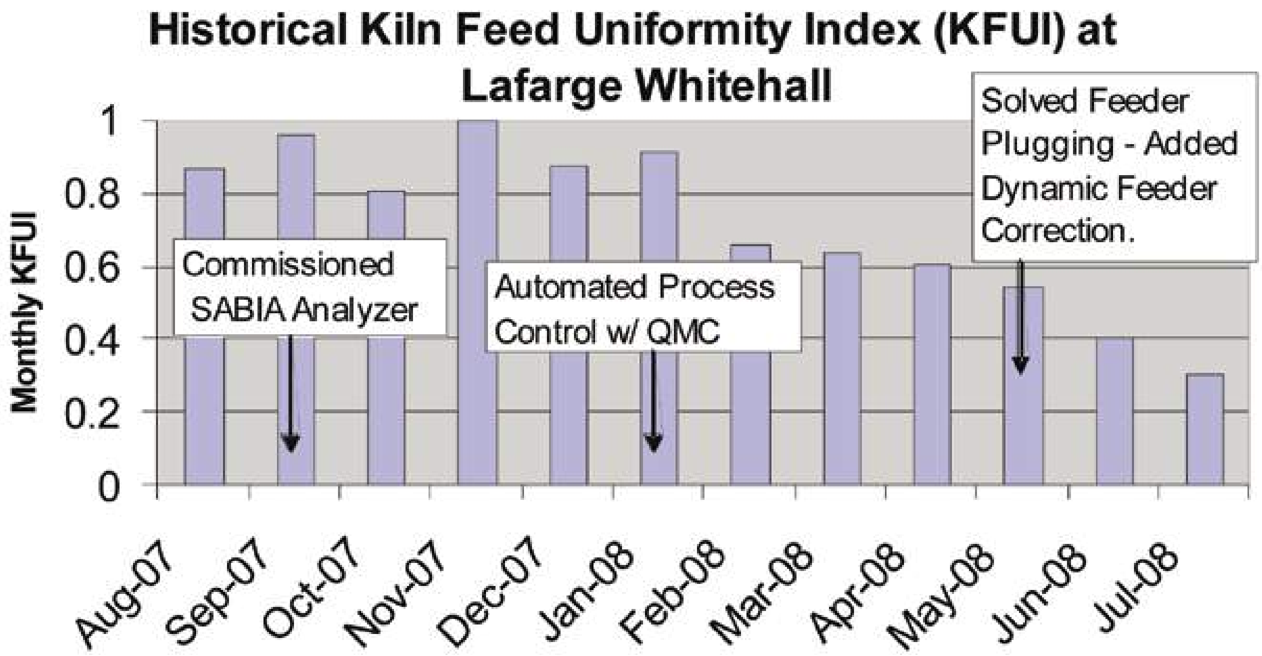

Figure 5. Historical C_3S variability at the Whitehall plant.

ascertained that problems with a weigh-belt feeder not centering material on the belt properly and fugitive material resulting from belt overload conditions affected the analysis. Relatively simple measures largely rectified these conditions.

Once installation was complete, the analyser ran for several weeks with original sampling and lab analysis in place for comparison purposes. The data showed that dynamic comparative data could further enhance the calibration. A special procedure developed by Lafarge was implemented to obtain dynamic data with significant range for all the oxides, without disrupting kiln-feed chemistry. Figure 4 shows the late February calibration results, based on data gathered in January and February.

During this period, the plant project manager organised a task force, including plant process and quality representatives, Lafarge regional and technical centre experts and SABIA, to identify appropriate tasks with completion dates and weekly accountability to ensure the ultimate and timely success of the project. The task force followed up on the necessary completion of clean up items such as data handoffs, documentation, etc. Significantly, the team focused on belt loading instability achieved by the VFD using the sum of feeder demand signals. A thorough examination of the data revealed that the analyser results included a signal that correlated well with the actual dynamic belt loading. The data showed that available analyser data could potentially achieve a much better belt loading control than the sum of feeder demand signals. At that point, the VFD control was switched to the signal from the analyser, with excellent results. This was the first time in the cement industry that a belt-loading control loop used a signal from a PGNA analyser.

Results

An intermittent small shift between the analyser and the lab results became the next major focus of attention. In order to track down this subtle shift, a SABIA Senior Engineer, Rick Evans, went to the site to work with Whitehall Operations personnel. Several problems were corrected, including a fairly significant feeder plugging problem, but the observed shift still persisted. The next effort involved a cooperative effort to explore correlations to explain the shifts. The acquisition of a very large minute-by-minute data set from the existing Lafarge data historian system proved very effective. The shift largely correlated to the significantly layered addition (and occasional shifting thereof) of the calcium and silica materials from their respective feeders. A methodology developed to dynamically compensate for the layering effect in real-time proved successful. A webcam system installed by Whitehall also proved helpful, as SABIA could remotely monitor belt conditions associated with calibration shifts and compare the visual information to events in the data set.

Conclusion

The historical graph of Lafarge kiln feed uniformity in Figure 5 shows that the plant entered a new era of improved uniformity. In addition to the presumed benefits of fuel savings, improved product consistency, lower kiln maintenance cost and purchased material savings, the site has reduced physical samples by 50%, with the intent of additional future reductions.

Certainly, any cement plant application of an on-belt analyser will best succeed if installed on a belt with a weigh scale and well mixed materials on it. But, through teamwork, determination, and innovation, the Whitehall team has succeeded, despite layering problems and without a weigh scale. As of December 2008, the plant has achieved a period of record low kiln feed variability. This accomplishment is a tribute to the combined SABIA/Lafarge team working on the problems.

The success of the project also warrants special thanks to Don Stafford, James Bond, Tom Nikles and Lorraine Faccenda.

References

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