Advanced Raw Mill Control with the SpectraFlow Airslide Online Analyzer at Kipaş Cement, Kahramanmaraş (Turkey)

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Fig 1: View of the modern Kipaş Cement Factory in Kaharamanmaraş, South-Eastern Turkey

SpectraFlow is the only online analyzer solution without any radioactive sources, neutron tubes or other hazardous components. Therefore SpectraFlow can be imported, operated and maintained without any permits or licences, which brings significant advantages to the customers. Beside being the only safe online analysing method, the well-known near-infrared technology (NIR) also delivers highly accurate measurement results, which makes SpectraFlow the most advance online analyzer on the market. Kipaş Cement is a state-of-the-art cement plant in Kaharamanmaraş (southern Turkey) with two modern kiln lines producing 2.9 Mio tons of clinker and 3.5 Mio tons of cement per year. Kiln Line 1 is in operation since 2008, while line 2 is in operation since late 2013. At Kipaş Cement two SpectraFlow Online Analyzers are installed after the raw mills of line 1 and the new line 2 and are in operation since April 2014, while the software was optimized until June 2014. This article is summarizing the results of the SpectraFlow Analyzer based control of the raw mills and is showing the optimized performance since July 2014.

The SpectraFlow Online Analyzer

SpectraFlow is used in cement plants to measure the raw material after the crusher to optimize the stockpile blending or after the raw mill to optimize the feeder setpoints before the raw mill. After the crusher the analyzer is mounted over the conveyor belt, while after the raw mill the analyzer is installed on the airslide. The analyzer data are either directly read by a control software, which is adjusting the feeder setpoints automatically every two to three minutes or are reported into the control room, where the operators are adjusting the feeder setpoints manually according 15- or 30-minutes average analyses. Kipaş is using the online analyzers together with a control software. Therefore the raw mill control is completely automated.

Fig 2: The SpectraFlow Analyzer after the Raw Mill at Kiln Line 1

Fig 3: The SpectraFlow Analyzer after the Raw Mill at Kiln Line 2

The SpectraFlow Online Airslide Analyzer for Raw Mill Control

To control the raw mill efficiently a highly accurate analysis method is needed, as the variations of each constituent are in a very small range. Compared to the crossbelt application after the crusher, where the measurement range is wide (e.g. CaO 10-55 %, SiO 0 – 70 %,….), the measurement range at the raw mill is very small. The most important constituents vary only in the range of CaO 40-44 %, SiO_2 13-16 %, Al_2O_3 2-4 % and Fe_2O_3 2-3%. The calculated LSF is a very sensible ratio and small changes of CaO and SiO_2 have a significant influence on the LSF calculation. Because of this, it is necessary to have a very accurate measurement method at the raw mill to efficiently control the feeder setpoints. SpectraFlow is the most accurate online analysis method for controlling the raw mill, as measuring homogeneous powder in the airslide, delivers very accurate measurement results. All other online analyzers based on Prompt Gama Neutron Activation (PGNA) technology have to be placed on the conveyor belt before the raw mill, as transmission methods don't allow an installation on the airslide. An installation on the airslide brings significant advantages and a higher measurement accuracy as SpectraFlow is independent of the following effects:

- Strong layering and changing layer thickness of the raw materials
- Iron Ore is a neutron absorber and changing iron ore contents are decreasing the measurement accuracy of transmission methods before the raw mill
- Changing belt loads

Time delays are especially with Vertical Mills very low, as the retention times of the raw material inside vertical mills is only some minutes. In ball mills the retention time is longer, however much shorter than in ball mills used for cement grinding, as the fineness of the raw meal is lower than of finish cement. Average retention times of the raw material inside ball mills are 10 minutes, which

is no problem for the control of the weight feeders. However Kipaş is using state-of-the-art vertical mills with a throughput of 320 t/h (line 1) resp. 400 t/h (line 2).

The accuracy of the SpectraFlow Online Analyzer compared with XRF

To be able to adjust the weight feeders efficiently it is absolutely crucial to have a very accurate online measurement of the raw meal. The SpectraFlow Online Analyzer provides the most accurate online analysis of the raw meal. In Kipaş several tests were performed, where the SpectraFlow Online Analyzer values were compared with XRF measured samples out of the airslide. The comparison in Fig. 4 – Fig. 7 are made over 8 days, when an hourly composite sample was collected by the automatic sampler out of the airslide and delivered to the laboratory. The sample was measured by XRF (EDX) fused-bed analysis. The results show, that SpectraFlow measures according the XRF reference values very accurate. When comparing the analytical results, the very small measurement range has to be considered (CaO min. 43.00% - max 43.80; SiO_2 min. 13.20% - max. 14.00; Al_2O_3 min. 3.20% - max. 3.55%; Fe_2O_3 min. 2.10% - max. 2.45%). With CaO, Fe_2O_3 and Al_2O_3 it can be stated, that the measurement results of the XRF and SpectraFlow are exactly the same, with SiO_2 it has to be considered, that SiO_2 has a higher error, when samples are taken out of the airslide. SpectraFlow measures also the SiO_2 with a very high accuracy and therefore there is a certain deviation between the XRF values and the SpectraFlow values. However these deviations are very small and a clear dynamic matching can still be seen.

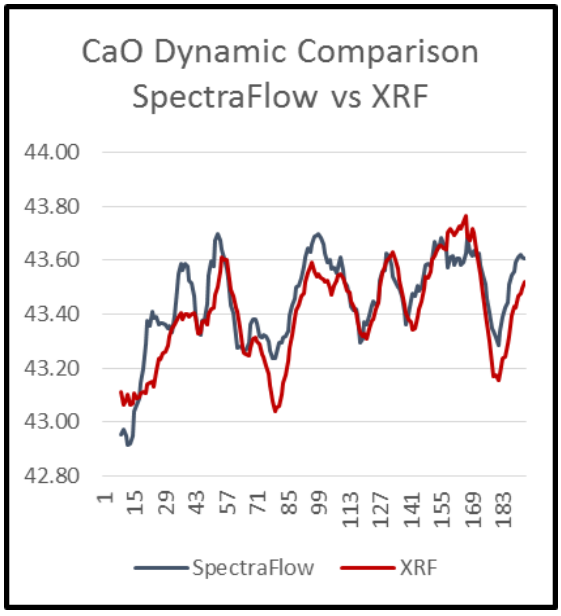

Fig 4: Comparison of CaO measured by SpectraFlow and XRF over 190 samples (8 days)

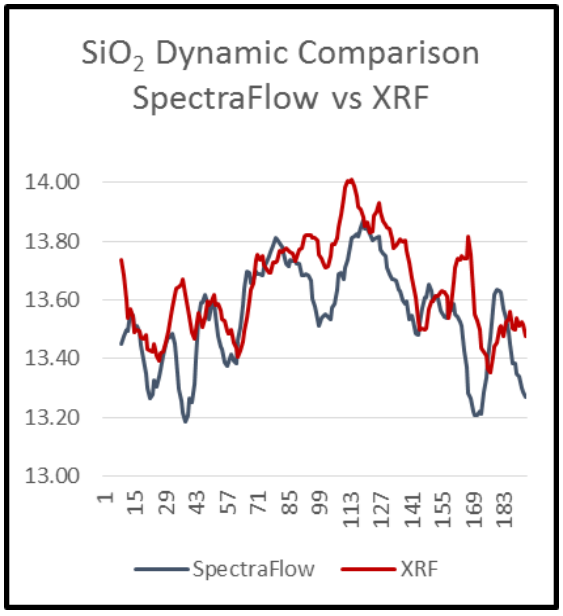

Fig 5: Comparison of SiO_2 measured by SpectraFlow and XRF over 190 samples (8 days)

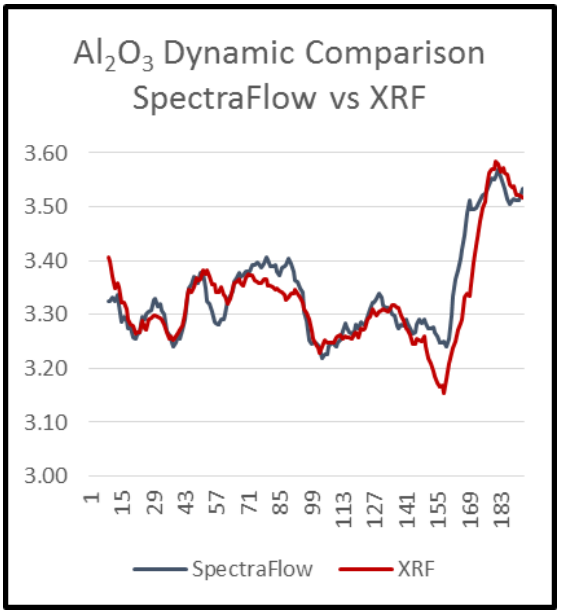

Fig 6: Comparison of Fe_2O_3 measured by SpectraFlow and XRF over 190 samples (8 days)

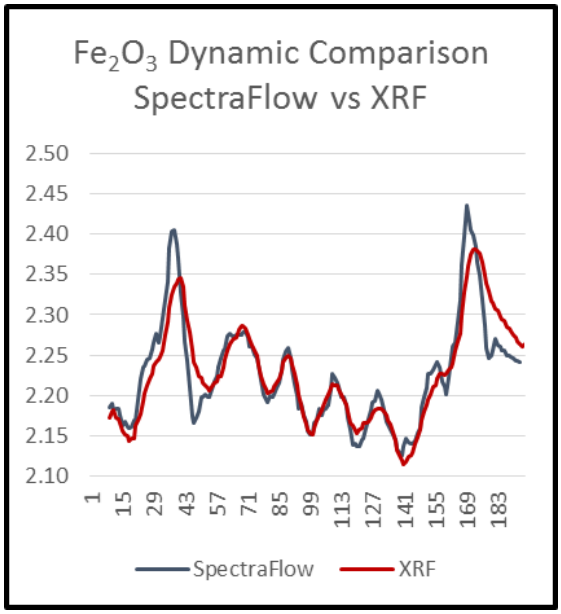

Fig 7: Comparison of Al_2O_3 measured by SpectraFlow and XRF over 190 samples (8 days)

The results of the SpectraFlow Online Analyzer based control of the additive feeders at the raw mill

The very high quality of the final clinker of Kipaş mainly results from the very stable raw mill operation of both kiln lines. Although the raw material feed is coming from a circular stockpile, which brings significant chemical variations to the raw mill feed the LSF Standard Deviation is very low, due to the high frequency adjustments of the weight feeders according the SpectraFlow Online Analyzer results. High grade limestone additive is used to compensate the variations coming from the stockpile. Before the implementation of the SpectraFlow Analyzer the weight feeders before the raw mill were adjusted hourly, while with the new setup the raw mix proportioning software is adjusting the weight feeder every 2-3 minutes. This results in a very low standard deviation of the LSF and a very stable kiln feed.

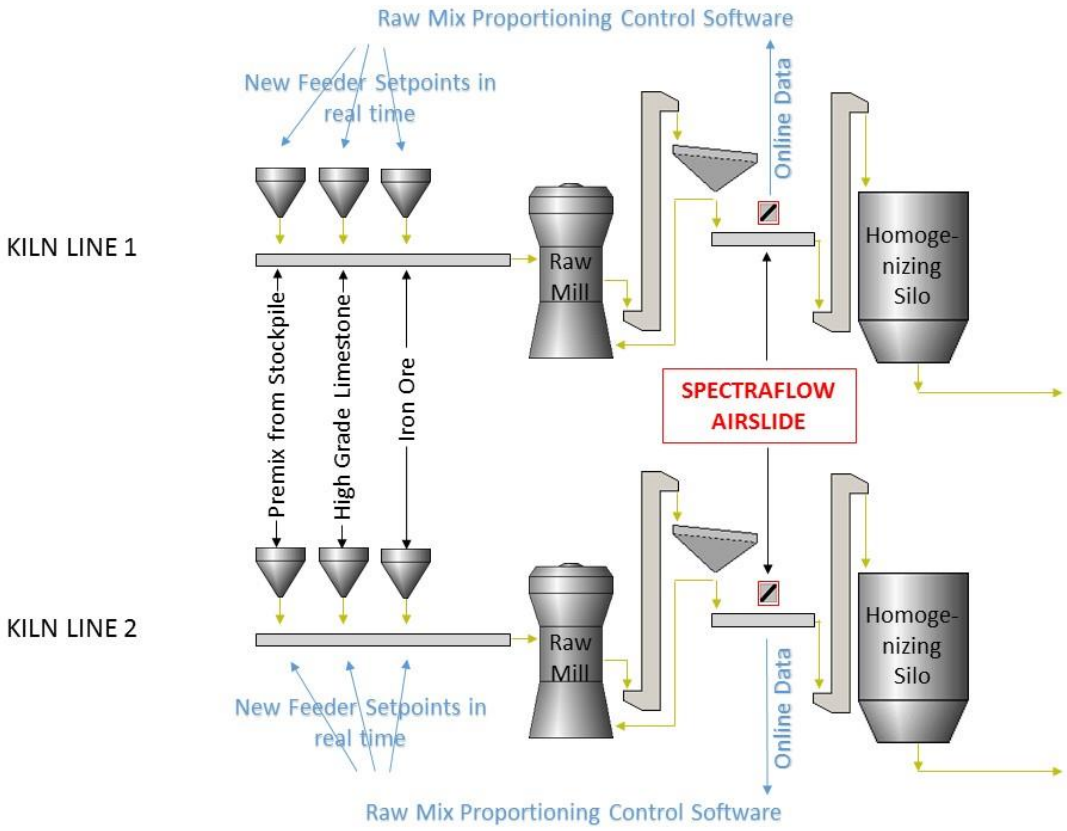

Fig 8: Flow sheet of the Raw Mill operation at Kipaş Cement. Beside the Premix from the stockpile also High Grade Limestone and Iron Ore is used to achieve the LSF setpoint at the raw mill. The SpectraFlow Online Analyzers are installed after the raw mill and the control software is adjusting the weight feeders before the raw mill

When comparing the LSF Standard Deviation after the raw mill before the implementation of the SpectraFlow Online Analyzer and the Raw Mix Proportioning Software it gets obvious, that the chemical stability of the raw meal is significantly optimized. Although Kipaş already had a good performance before the implementation of the SpectraFlow Online Analyzers and Control Software it was possible to even further improve the performance. While before the SpectraFlow Online Analyzer installation the LFS standard deviation measured by XRF (hourly raw meal samples over 24 hours) was 3.20 it was optimized to currently 2.69 (Line 1) resp. 2.80 (Line 2). It also has been considered, that the LSF setpoint at the raw mills was changed frequently between 99 and 101. This means, that these XRF results have to be corrected by 1 (Standard Deviation of 99 to 101), which results to a very low final LSF Standard Deviation of 1.69 (Line 1) resp. 1.80 (Line 2). This is also the lowest possible LSF Standard Deviation able to be measured by a sampling station and a XRF EDX device as installed at Kipaş Cement. The sampling and analytical error of the XRF results lead to a LSF Standard Deviation of around 2. After the raw mill, with three different raw materials a better sampling is hardly possible as performed at the raw mills of Kipaş Cement. SpectraFlow has no sampling error and delivers therefore more accurate results than the sampled-based XRF. When observing the SpectraFlow results the average LSF standard deviation is at 1.65 (Line 1) and 1.45 (Line 2) not corrected by the changing setpoints. When correcting the values the LSF Standard Deviation of SpectraFlow goes beyond 1, which is kiln feed quality after the raw mill.

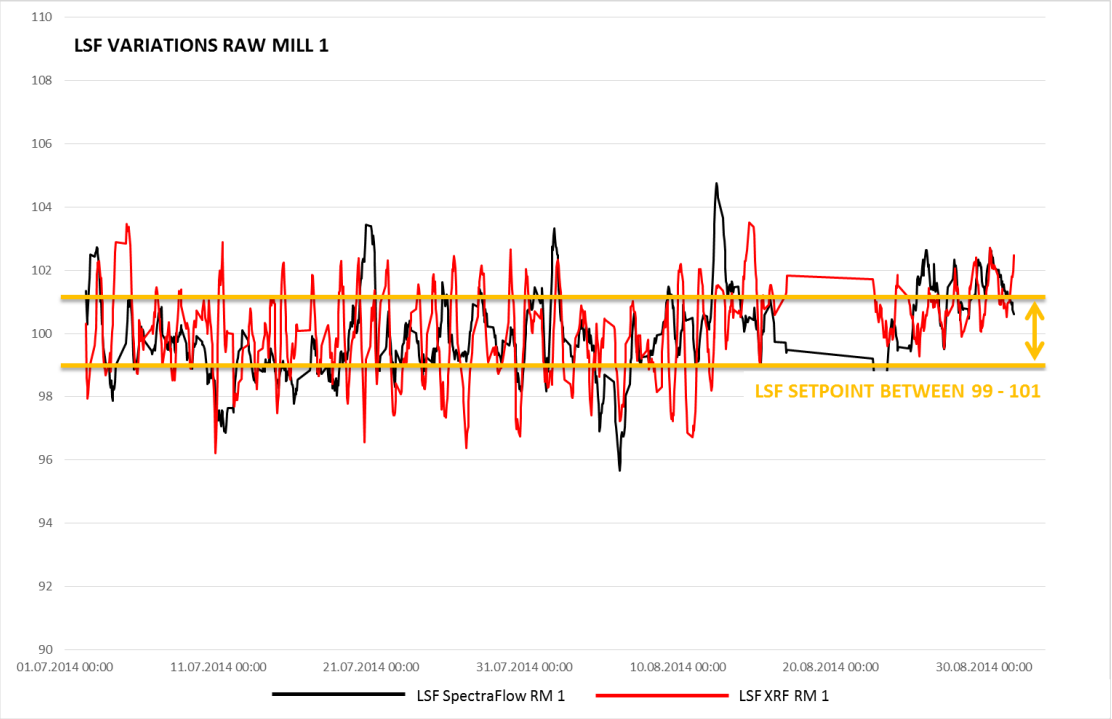

Fig 9: LSF Variations at Raw Mill 1 measured by SpectraFlow and XRF. The LSF Standard Deviation based on XRF is 2.69, while based on SpectraFlow 1.65. The setpoint was frequently changed by the operators between 99 and 101 (=Standard Deviation approx. 1), which means the LSF Standard Deviation includes these setpoint changes. To see the real LSF Standard Deviation without any setpoint changes these values have to be corrected by 1.

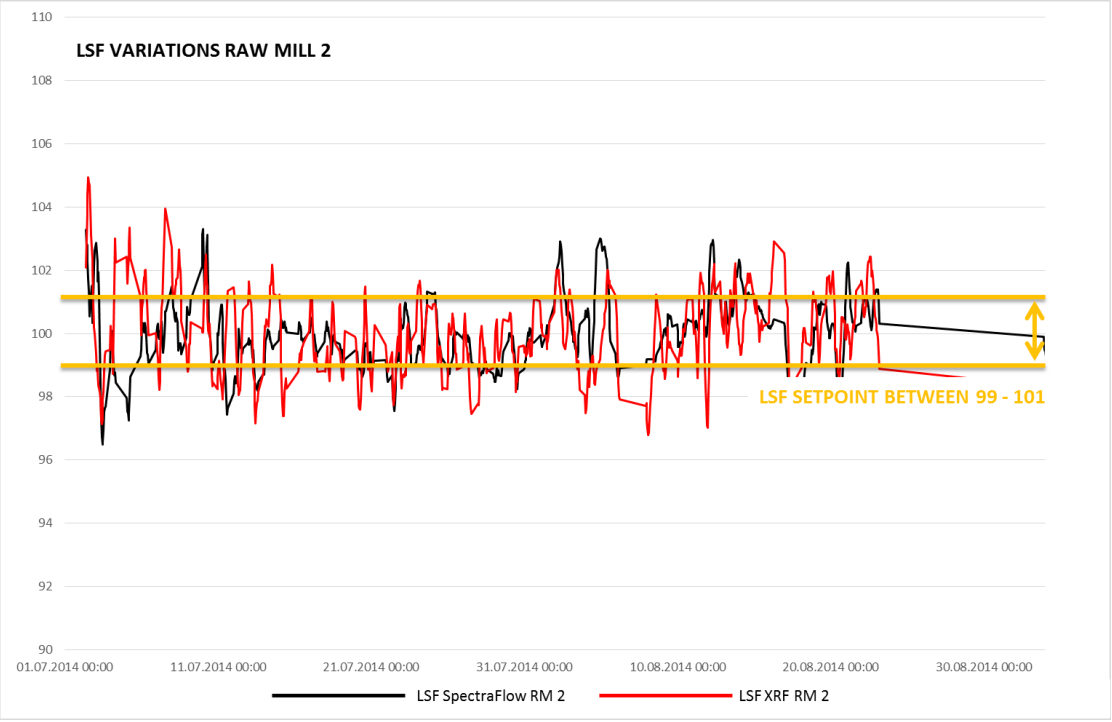

Fig 10: LSF Variations at Raw Mill 2 measured by SpectraFlow and XRF. The LSF Standard Deviation based on XRF is 2.80, while based on SpectraFlow 1.45. The setpoint was frequently changed by the operators between 99 and 101 and therefore the corrected values are at approx. 1.8 (XRF based) and well below 1 (SpectraFlow based)

Summary

Two SpectraFlow Online Analyzers were installed on both raw mills since June 2014 at Kipaş Cement together with a control software adjusting the setpoints of the weight feeders automatically. Kipaş had before a LSF Standard Deviation (hourly values over 24 hours) measured by XRF of approx. 3.20, while after the installation this was decreased to 2.69 (Line 1) and 2.80 (Line 2). However as the LSF setpoint was changed by the operators frequently (between 99 and 101) the LSF Standard Deviation is actually lower as these changes have to be considered. The Standard Deviation of 99-101 is approx. 1 and therefore the real LSF Standard Deviation is below 2.00 at both lines. A lower LSF Standard Deviation at the raw mill is hardly possible to determine by the sampling station and the energy dispersive XRF. The SpectraFlow Online Analyzer is showing an average LSF Standard Deviation of 1.65 (hourly values over 24 hours) for line 1 and 1.45 for line 2. These values are not considering the setpoint changes by the operators. Considering these setpoint changes the LSF Standard Deviation is well below 1.00, which is kiln feed quality at the raw mill.