

First experiences with the new kiln line in Woessingen

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Summary

In Woessingen two kiln lines of semi-dry technology were replaced by a single pre-heater/pre-calciner kiln. The lay-out allows / caters for a very high alternative fuel substitution rate based on a broad fuel portfolio. The project was executed lot-by-lot and finished in only 19 months. Very soon after start-up the rated capacity of the kiln was reached, already using an important amount of alternative fuels. The clinker and cement quality was improved. A strong project management, a comprehensive training of the entire plant team and a strong external start-up team have been the main factors for the success of this very complex project.

1 Introduction

In 2007 Lafarge decided on major modernisation of its clinker production in Woessingen, which was based on two semi-dry kiln lines of 500 and 1.100 t/d clinker capacity, in operation since 1961 and 1971. The scope of the project was [1, 2]

- to reduce the specific CO₂ emissions of the burning process
- to have highest flexibility in respect of usage of different kind of alternative fuels and raw materials
- to improve the cement quality (uniformity, strength development and strength level, workability)

To keep the investment cost on a low level the existing technical equipment was to be used wherever feasible.

2 Technical solution

The project was integrated into the existing plant infrastructure. Quarry, raw mill, clinker storage and dispatch were kept in their current condition. The following installations have been the subject of modification/ replacement: Raw mill filter, raw meal handling, pre-heater, kiln, Cl-bypass, conditioning tower, clinker cooler, clinker transport, primary and alternative fuel supply, additional alternative fuel storage, refurbishment and capacity increase of one cement mill, all related filter systems, electrical substations, control system.

Lafarge opted for a 5-stage pre-heater/pre-calciner kiln with combustion chamber, tertiary air duct and chlorine bypass (10%). The fuel split between main burner and calciner is 40% / 60%. The layout of the burning system is based on a potential alternative fuel substitution rate of 100%. This had a particular impact on the dimensioning of the meal and gas pipes, the cyclones, the ID and waste gas fans and the main kiln filter.

Table 1 shows the related fuel split to the different feeding points.

Table 1 Fuel split and feeding points

Fuel	Feeding point and substitution rate		
	Main burner	Combustion chamber	Calciner
Petcoke			
SSW – high calorific			
SSW – middle calorific			
Shredded tyres			
Animal meal			

The main properties of the concerned alternative fuels are listed in table 2.

Table 2 Main properties of alternative fuels

Fuel	LHV [GJ/t]	Grain size [mm]	Cl [M-%]
SSW ¹⁾ – high calorific	≥ 21	≤ 25 (2D) ²⁾	≤ 1
SSW – middle calorific	≥ 15	≤ 50 (2D) ≤ 10x10x10 (3D) ²⁾	≤ 1
Shredded tyres	≥ 15	≤ 70	≤ 0.4
Animal meal	≥ 18	≤ 5	≤ 0.4

¹⁾ SSW – solid shredded waste

²⁾ 2D / 3D – 2-/3-dimensional

The waste gas retention time in the combustion chamber / calciner / gooseneck system is around 7 seconds. The split induction of tertiary air to the combustion chamber allows a targeted combustion of the different fuels as well as a temperature control of the chamber itself. Another part of the tertiary air is fed to the calciner to ensure a proper combustion of the shredded tyres (s. figure 1).

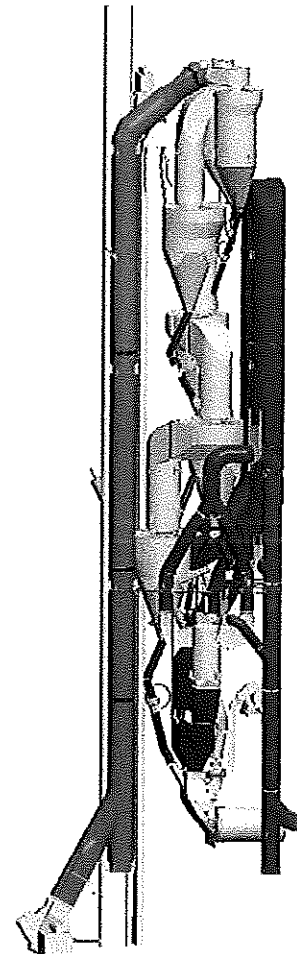


Figure 1 Elevation of pre-heater/pre-calciner

3 Project execution

The decision for this project was taken at a time when suppliers of engineering and equipment were strengthened by high demand. Due to the complexity of the project (demolishing, reconstruction, modification of existing equipment and civil structures, integration of new equipment) it was difficult to engage a turnkey contractor. Therefore several main lots were defined but the offers did not match given the time, cost and performance guarantees. Finally it was decided to go for a lot-by-lot strategy, ending up with 45 main contracts and almost 900 purchase orders. The very limited space on site was an additional challenge for the erection and material supply logistic [3].

The project was managed by the regional Lafarge engineering entity, supported by an external EPCm contractor, strongly assisted by a site project manager in Woessingen [4].

The time for the execution of the project, meaning the time between placing the first order and the lighting of the kiln, was only 19 months.

An overview about the suppliers of the main technical equipment is given in table 3.

Table 3 Supply of the main technical equipment

Shop	Suppliers
Pre-heater, calciner, combustion chamber, bypass	A TEC
Cooler [5]	IKN
Filter (kiln, cooler, bypass)	Redecam
Burner	Unitherm

4 Safety

There was a special safety organisation set up for the construction site. The safety manager was supported by three site safety supervisors. Each supplier had to have a safety instructor on site. Each worker on site had to go through a specific safety training, after having successfully passed the Web-based safety induction of Lafarge Zement.

These strong efforts paid off. The project was executed in 520,000 working hours without LTI (reportable incident).

5 First results after six weeks of operation

5.1 Kiln operation

Figure 2 shows the evolution of kiln capacity and alternative fuel substitution rate for the first six weeks of operation.

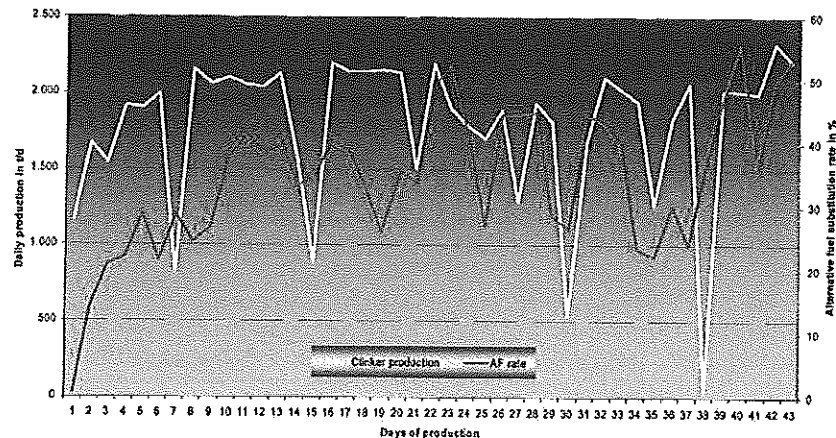


Figure 2 Daily clinker production and alternative fuel substitution rate

The kiln reached its rated capacity of 2,200 t/d already after seven days. After two days part of the fuel to the combustion chamber was switched to solid shredded waste which very soon reached a substitution rate of around 40%.

The kiln itself is very easy to operate. By its broad fuel mix and the several feeding points, fluctuation in the fuel dosing can be easily compensated. After reaching the necessary kiln inlet temperature for starting the kiln feed, the kiln feed can be pushed to rated capacity within two hours.

The fuel split between the main burner and the calciner shifted from 44/56% at the beginning to now 40/60%. The percentage of alternative fuel in the main burner (SSW HC, animal meal) is stable and close to 25%. In the calciner it moved from 43% to 63% (SSW HC, shredded tyres). On a single day a substitution rate totalling nearly 60% was achieved.

The few major impacts on the kiln reliability were caused by recurring problems with the frequency converter of the fan of the main filter, adjustment

of the kiln thrust roller and blockage of the gas conditioning tower outlet screw. Twice the kiln was stopped to ensure a safe cleaning of the pre-heater and for cleaning the drying chamber of the raw mill.

Some operational key figures are shown in table 4.

Table 4 Guaranteed values and first operational results

Item	Guaranteed value (kiln) @ 60% alternative fuel	First operational results
Kiln capacity [t/d]	2.200	up to 2.320
Specific heat consumption [kJ/kg ck]	≤ 3.400	3.200 – 3.400
NO _x without SNCR [mg/Nm ³ , dry, @ 10% O ₂]	≤ 500	320 – 550
Free lime [M-%]	≤ 1.5	0.8 – 2.5
Alternative fuel rate [%]		up to 61

The rated capacity is not an issue and the specific heat consumption ranges within the expected level. The very promising level of NO_x emission, achieved without any secondary reduction measure, is a precondition to be able to reach lower emissions by using the SNCR once it is required. A prerequisite for this low emission seems to be an alternative fuel substitution rate of at least 30%.

5.2 Alternative fuel usage

Due to the general layout and the low NO_x emission limit the kiln has to run with a high amount of alternative fuels. This results in high requirements regarding the quality of the alternative fuels and the reliability of the required dosing and transport facilities.

SSW MC could only be used for a short period as the final storage and dosing system is still being erected. This material is a major pillar of the future fuel portfolio.

Shredded tyres are already used to a small amount. Optimisation work has still to be done on the transport devices up to the feeding point into the calciner. At today's substitution level a proper combustion is ensured and also coarser material is fully burnt out in the calciner/gooseneck area. A breakthrough of tyre residues to the kiln inlet could not be detected.

5.3 Quality

Compared to the clinker of the former semi-dry process the Alite content of the clinker of the new line increased by 13 points (25%). This causes a significant increase in the early strength level. It allows us to reduce the specific power consumption as, taking into account customer requirements, cements can be produced at a lower level of fineness than before.

By adapting the raw mix this type of burning process allows us to reach a higher alkali-sulphatisation ratio which enhances the workability and improves the setting.

This results for the customers in improved properties of fresh concrete in combination with a reduced water demand of the cement.

The change from the "old" cement to the "new" one was carefully prepared a long time in advance and done in close cooperation with the customers, closely accompanied by our technical sales force and the concrete laboratory of the plant.

6 Key success factors

Some criteria have been crucial for the success of this complex and challenging project:

- a strong project management
- a dedicated safety team with no compromise on safety
- a fully motivated plant team
- a comprehensive training of the entire plant team on the new technology. This training covered nearly 33,000 hours and was executed on site, off site (in other Lafarge plants worldwide already running such kind of equipment, in the workshops of the suppliers), partly as classroom training but to a major part in a very practical way.
- having a strong start-up team based on external experts from other Lafarge plants, Lafarge Technical Centres and the main equipment suppliers on site
- early "ownership" after start-up by the plant team and shifting the start-up support team to a coaching role

7 Outlook

The first weeks of operation already proved the principal layout of the new kiln line and the high expectations regarding fuel mix, alternative fuel substitution rate and quality improvement.

The coming weeks and months will be dedicated to the further stabilisation of the kiln reliability and the full utilisation of SSW MC and shredded tyres.

The final adjustment of the cement quality is underway.

References

- [1] N.N.: An Important step for energy efficiency and environmental protection. ZKG International 61 (2008) No. 5, pp 17-23.
- [2] N.N.: Lafarge Wössingen: Environmental modernisation begins. GlobalCementMagazine, (2008) No. 5, pp 26-27.
- [3] Bourrain, G.: Modernization while plant is in operation. ZKG International 61 (2008) No. 10, pp 24-31.
- [4] Perschall, B.: Modernization of the Lafarge plant in Woessingen: Next step completed. ZKG International 62 (2009) No. 1, pp 19-22
- [5] Hammerich, J.: A new clinker cooler for Woessingen - Installed in existing plant. ZKG International 62 (2009) No. 3, pp 24-28.