Successful Application of Model Base Predictive Control for Production and Thermal Efficiency Optimization of High Temperature Melters

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Many thanks to:
Glass Service has started in 1990 as a private company in Vsetín, Czech Republic.
Glass Service employs > 70 people, mainly ex-managers and engineers from glass industry.
Glass service is an engineering & consulting company that develops software tools and advanced equipment to support the glass industry in order to optimize the glass melting production process.
Glass Service conducts its own R&D and provides laboratory services for our customers.
Number of Glass Service customers is over 200 in more than 40 countries worldwide.
Company mission: increase quality and yield of our customer with reducing costs for melting and emissions.
EXPERT SYSTEM ES III™ ARCHITECTURE

... PLANT INFORMATION SYSTEM FEATURES
1. **ESIII™** is a comprehensive supervisory advanced control tool
2. **ESIII™** is designed for high temperature melting and conditioning processes
3. **ESIII™** stabilizes long and short term processes
4. **ESIII™** provides full automatic control of melt production temperatures
5. **ESIII™** brings consistent operation to furnace: 24/7 without operator intervention
6. **ESIII™** uses energy sources efficient – saving energy and costs
7. **ESIII™** optimizes combustion – emission control
8. **ESIII™** stable furnace operation – impact on furnace lifetime
Production scheme from limestone to clinker

Rotating kiln dimensions:
- length 180 m (592 ft)
- diameter 5.5 m (18 ft)

- limestone mill
- dust filter
- preheater
- homogenisation silos
- dryer
- mixing bed (intermediate storage)
- crusher
- quarry
- clinker storage

View on flame inside kiln
**ESIII™ Kiln Control Objectives?**

- Stable and efficient production process
- Optimal energy usage, energy cost savings
- More stable free lime control
- Good quality product
- Reduce NOx production
- Through stable kiln operation longer kiln lifetime
Special burner supplies up to 9 (alternative) fuels

The long dry kiln (No 8) was installed in 1960 and measures 180m in length and 5.5m in diameter. The kiln line has a two-stage preheater with no precalcer. Heat consumption of the kiln is 25.64 GJ/t clinker, and it is equipped with a planetary cooler. Kiln capacity is approximately 3000tpd.

An FLSmidth Swirl burner has been adapted to burn alternative fuels via an extra burning tube mounted on top of the main burner.

- Cokes
- Lignite
- Sewage sludge
- SBI/PPDF (plastics, carpet)
- Paper sludge
- Animal meal
- Glycol bottom
- Anode dust

Each fuel has own heat value and price

The alternative fuel substitution rate at the plant is even higher than at CBR’s Liehe facility. Maxshmidt’s 90% substitution rate of traditional fuels has been achieved by processing fuels like sewage, paper sludge, plastic, animal meal, glycol bottom, firecokes and anode dust. HeidelbergCement has a strategic plan for the use of alternative fuels and reached a substitution rate of 33% in 2006 that will rise to 40.2% in 2007. By 2011 around 95% of the ENCI’s fuels should come from alternative fuel products. ENCI’s impressive 90% substitution rate already exceeds the HeidelbergCement group’s long-term substitution rate targets.

A recent investment at the plant in this respect is the SBI installation. SBI refers to a secondary fuel installation that is aimed at reducing fuel costs; it handles coarse fuels such as paper sludge, paper and plastic derived fuels and, in the past, shredded non-free tires. Material is unloaded and stored in a separate building on site and is handled by an automated grab system. Two dedicated bunkers and two feeders transport the material to rotating valves from where the material is pneumatically transported to the kiln’s coarse waste fuel burner. Limitations of the SBI include truck unloading capacity, crane capacity, burnout of the coarser fuels as opposed to the fine fuels burnout, equipment availability and chlorine buildup in the kiln.

Early in 2007 the plant added an additional simple feeder unit for the feeding of extra low calorific coarse fuels.
ESIII™ finds optimal mixture of 9 fuels with required total heat value at minimal costs

ESIII™ compensates instantaneously in case supply of one of the fuels is plugged

At this moment we selected ESIII™ to compensate and control the kiln with fuel 3 (cokes) only, we can easily add more fuels for compensation.

Supply of SBI (plastics) gets often plugged.

Compensations for SBI plugging by operator using fuel 1 (lignite), but not for all breaks.

Clearly ESIII™ reacts to all instabilities in SBI supply, also the short breaks.
ESIII™ Actions and Targets

**Actions:**
- Total heat input
- Rotation rate of combustion air fan
- Kiln feed of raw materials
- Kiln rotation rate

**Targets:**
- Kiln rotation power (torque, indirect melt temperature indicator)
- Level of free lime – quality of the product
- O2
- CO2
- NOx
- Flue gas temperatures in cyclones
ESIII™ Model base Predictive Control (MPC)

TARGETS
- Fuel heat

ACTIONS
- Fan
- Kiln feed

DISTURBANCES
- Fuel heat value correction
- Klinker outflow

Variables:
- O₂
- NOₓ
- CO₂
- Torque
- Flue T1
- Flue T2
ESIII™ gets kiln out of instable ‘cycling’ mode, stabilizes process and product quality.

Kiln in ‘cycling’ mode

Kiln out of ‘cycling’ after ESIII™ start
ESIII™ Kiln Control Benefits

- Stable operation of kiln according to prescribed setpoints.
- Control of level of free lime in clinker – product quality control.
- Set up of optimal 9 fuel package with required heat value and minimum costs.
- Fast compensation for fuel plugging – less chance for ‘cycling mode’, maintaining total heat input.
- Stabilizing the process: get kiln out of ‘cycling’.
- Full automatic kiln control without operator intervention.
Thank you for your attention

We welcome CZ/SK partners to cooperate with us on further implementation of ESIII™ to the cement industry

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