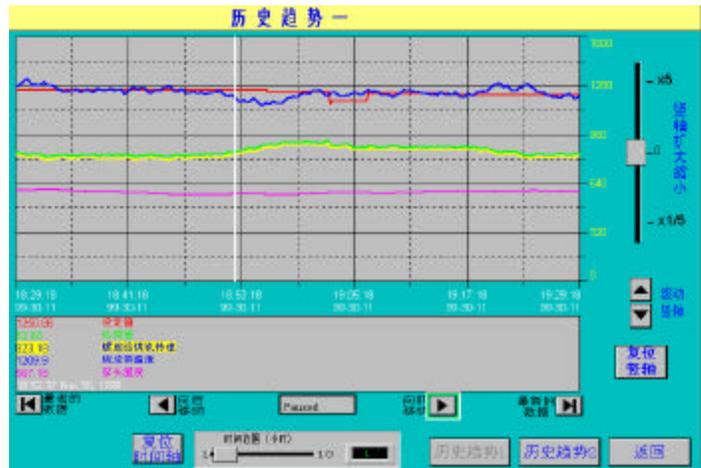


Model-Free Adaptive Control on Rotary Kilns

<i>Use of MFA Control</i>	<i>Benefits</i>
Anti-Delay MFA handles large time delays in kiln temperature loop.	Temperature control is improved by at least a 50% reduction in temperature variability.
Prevents product overheating.	Fuel or coal consumption is sharply reduced.
Feedforward and robust MFA controllers deal with large load changes.	Temperature and other key process variables remain under automatic control all the time.
Reduces variation in temperature and product quality variable.	Product quality, product grade, and production efficiency are improved and scrap is reduced.
Improves efficiency & productivity.	Full investment is returned in months if not sooner.



An Anti-delay MFA controller with feedforward and robust functions manipulates coal flow intelligently to achieve tight kiln temp (blue) control.



Case History: MFA Control at Zhong-Zhou Alumina Plant

A sintering process uses low-grade ore to manufacture alumina (aluminum oxide). A rotary kiln treats slurry mixed with low-grade ore, limestone and caustic soda at a high temperature. The kiln is coal-fired to a temperature of 1200-1300°C. The slowly rotating kiln is tilted to allow material to exit. The material goes through a digestion/clarification process to extract aluminum ore from bauxite and refine it to produce alumina.

Large time delays and other disturbances make control a challenge. Kiln temperatures must be kept in spec, although temperature fluctuations as high as +/-100 to 200°C are common. This is critical: too high a temperature causes excessive reactions and damages the refractory lining, yet too low a temperature causes insufficient reactions and poor yield. A

long time delay exists between the coal feeder speed change to the time it takes for burning coal to affect kiln temperature. The delay also varies when the material load and rotation speed change.

The process has a large Tau/T ratio of 5 (Tau=delay time, T=time constant). Since PID controller can only deal with a Tau/T ratio of 1 without de-tuning, kiln temperature loops are typically detuned or in manual control. The process also has disturbances from variations in ore inflow, suction airflow, and coal BTU value.

The rotary kiln is now controlled by a PLC monitored by HMI software running on PCs. MFA control software provides advanced regulatory control for the kiln, networked via the HMI software. An Anti-delay MFA controller maintains kiln temperature by manipulating screw speed of

the coal-feeding machine. It compensates for disturbances and uncertainties and implements robust bounds to prevent the furnace from running too hot or too cold.

A Feedforward MFA controller adjusts for slurry feed variations, and another MFA controller manipulates airflow based on the cross-limited control scheme to adjust the fuel-air ratio.

With MFA control, the kiln can be automatically controlled under all conditions. Temperature is controlled within the +/-30°C specification. Major energy savings are achieved due to less temperature variations and better combustion.

Manual control often produces low quality product or scrap. MFA control results in higher efficiency, quality and yield. The plant verifies that MFA control produces high-grade product in each batch.