

MID-KILN FUEL INJECTOR/MIXING AIR

PROVEN TECHNOLOGY REDUCES FUEL COSTS AND EMISSIONS IN LONG KILNS

THE ONGOING CHALLENGE ... Long kilns are not efficient in heat consumption like the new modern PH and PH/PC kilns. Typically, these long kilns consume at least 40% more fuel to produce a ton of clinker than PH and PH/PC kilns. They also produce approximately 40% more NOx than modern kilns. Replacing fossil fuel and reducing NOx in long cement kilns results in large savings in operational costs.

THE SOLUTION ... The Cadence Mid-Kiln Technology (MKT) is designed to replace a portion of fossil fuel with lower cost alternative fuels such as whole tires, non-hazardous materials, lump coals, etc. The results are outstanding:

- Typically, MKT replaced 15% of (total heat value) fossil fuel with alternative fuels
- Reduced NOx emissions through Staged Combustion

THE NEW CHALLENGE ... Pushing the tire replacement rate beyond 15% creates a new challenge: reduction in flame temperature. In cement processing, flame temperature is almost always a critical factor to produce quality clinker. MKT removes a portion of fossil fuel while maintaining the amount of excess air in the main flame. This mechanism creates a lower flame temperature. Increasing the alternative fuels beyond 15% substitution rate will likely result in a low flame temperature at which quality clinker cannot be made. This is called Reducing Condition and it should be avoided at all costs.

THE SOLUTION ... Cadence developed the Mixing Air Technology (MAT) to help cement kilns consume more alternative fuels. The MAT adds multiple high velocity jets of ambient air, uphill from the mid-kiln fuel injection point. These jets of air mix the layer of oxygen rich secondary combustion air from the top of the kiln with oxygen deficient air at the bottom of the kiln. This results in the following:

- Typically, MKT-MA replaced 30% of (total heat value) fossil fuel with alternative fuels
- Further NOx reduction through Staged Air Combustion
- Reduced SOx emissions
- No change in kiln production

REPLACE FOSSIL FUEL WITH ALTERNATIVE FUELS ... Alternative fuels are injected at the mid-kiln location to replace the main burner fossil fuel. The substitution rate depends on the main burner flame temperature and the sulfur volatilization. They generally limit the substitution rate by 15%. Why is main burner flame temperature considered a critical factor in determining the alternative fuel substitution rate? Using MKT, a portion of main burner fuel is replaced by the alt. fuel proportionally while the amount of excess air in the main flame is held constant. Even at the same excess air, the air-fuel ratio in the main flame now becomes larger. This causes a lower flame temperature. A higher substitution rate (>15%) results in a higher air-fuel ratio, which causes lower flame temperature.

Quality clinker is cooked at a proper temperature. That is why it is important to maintain flame temperature while utilizing MKT, because MKT has a tendency to reduce flame temperature.

DECREASED EMISSIONS ... MKT provided staged combustion in the kiln, which reduces NOx emissions. In cement processing, NOx is mainly a product of combustion. Most NOx is generated in the main burner flame area where temperatures are extremely hot and oxidized. Having control over the temperature or oxygen in the main flame will likely lead to control of NOx. What Cadence MKT does is replace a portion of the main burner fuel with alternative fuel at mid-kiln. This mechanism results in an increase in air-fuel ratio in the main flame, which leads to a lower flame temperature and decreased NOx.

BENEFITS OF CADENCE MIXING AIR ... De-stratifying gas layers within the kiln makes more oxygen available for combustion at the same CO and production levels. Typically, a 15% increase in the alternative fuel substitution rate is achievable. Also, combustion can be improved for harder to burn low volatile or high moisture alternative fuels in the main burner.

IMPROVED HEAT TRANSFER WITHIN THE KILN ... When gas stratification is eliminated, heat transfer is significantly enhanced. Under normal conditions, the hot combustion gases at the top of the kiln do not readily mix with the cooler gases on the bottom. The mixing air system imparts a rotational component to the kiln gas that brings hot gases in contact with the hot meal. Without the rotational movement of the kiln gas, the primary mechanism of heat transfer is the heating of the refractory at the top of the kiln and then rotating the refractory under the hot meal bed where heat transfer occurs.

FURTHER EMISSIONS REDUCTION ... Cadence MA creates staged combustion which results in Nitrogen Oxides reduction. In cement processing, NOx is mainly a product of combustion. Most NOx is generated in the main burner flame area where temperatures are extremely hot and oxidized. Having control over the temperature or oxygen at the main flame will likely lead to control of NOx. What Cadence MA does is replace a portion of the main flame combustion air with injected air. This mechanism results in less excess air available to form NOx in the main burner flame, which results in a significant NOx reduction.

Cadence MA helps to increase the ability of trapping volatile sulfur into kiln load and baghouse dust. This mechanism will reduce significantly the potential for sulfur build-up at the kiln back-end housing and improves kiln stability.

	Alt. Fuel Rate %	NOx (kg/Tonkk)	O2 %
MKT OFF MA OFF	0%	2.3	2.3%
MKT ON MA OFF	15%	1.2	1.7%
MKT ON MA ON	34%	.9	2.1%