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Report on Changes to the Pyro Processing System

TSB Cement Plant, Newberry, Florida

The Preheater/Calciner and Rotary kiln supplied by Polysius Corporation and installed in 1988-1999 commenced operation at the end of 1999.
The system consisted of the following principal equipment

Dopol 4-stage preheater/calciner
Stage 1 ..... 9,000 cuft
Stage 2 ..... 1,300 cuft
Stage 3 .....11,000 cuft
Stage 4.....17,000 cuft
Calciner .....16,500 cuft
Total Volume .....66,500 cuft

Rotary kiln
Shell inside diameter ... 13'-1 ½"
Diameter inside the refractory lining ... 12'-5"
Length ... 156'-6"

The manufacturer guaranteed the minimum capacity of the kiln system at 2,300 short tons per day. The equipment supplier, either as a guarantee or a limitation gave no hourly rating, but by implication, the hourly capacity was set at 95.8 tons, assuming an uninterrupted, constant operation of 24 hrs. This hourly rate found itself into the permit application and the operating permit as an upper allowable production rate.

The construction permit was issued for a maximum NOx emission of 2.8 lbs per ton clinker, with an interim allowable limit of 3.8 lbs per hour for the initial operating period of 2 years.
In the event the emissions of NOx exceeded the 2.8 lbs/hr limit during the 2 year grace period, the permit provided that the applicant convert the preheater/calciner to a "Multistage Combustion System" (MSC), as proposed and supplied by Polysius Corp. and that this system be operative and ready for compliance testing by the end of calendar year 2001, being the end of the 2 year period after commencement of operation.
The applicant met these requirements and the revised system was accepted as being in compliance with the permit conditions in February 2002.

During the initial two year start up period, the kiln system showed evidence, that the lower emission rate of 2.8 lbs NOx per ton clinker could be achieved on a consistent basis, provided that the kiln exit gases contained an oxygen content of not more than 1%. Under stable kiln conditions, with uniform kiln feed quality and fineness and uninterrupted kiln dust return to the blending silo or directly to preheater stage 3, this operation was possible.
The need to install the MSC system was seriously questioned by the permit holder, as the capital expense was significant and a further reduction of NOx emissions was neither assured nor deemed necessary.

A decision to proceed with the addition of the MSC system to the calciner was nevertheless made to attempt achieving compliance with the lower NOx limit at higher oxygen levels than the undesirable minimums required under normal operating conditions.

Among the many significant observations made during the first two plant start-up years was the fact that the kiln operation was substantially more stable at feed rates near the top of the permitted input levels. The trend clearly indicated, that the kiln system operated more efficiently at escalated production rates. When the clinker production was increased, total NOx emissions leveled out or even trended downward and showed notable reductions if expressed in lbs per ton of clinker produced.

A very explainable part of this observation lies in the basic heat requirement of the entire system, including heat losses, which become smaller at higher production rates as a percentage of the total heat requirement to convert raw mix to clinker.

MSC System – Mechanical Changes to Preheater/Calciner
A proven design for the Multi Stage Combustion System was proposed by Polysius, which added a significant amount of new volume to the system:

1. Take-off duct from calciner to mixing chamber ..... 4,300 cuft
2. Mixing chamber ..... 4,500 cuft

The additional volume created with the MSC system is ..... 8,800 cuft
This constitutes an increase of 13.2% in preheater/calciner volume.

A take-off duct from the tertiary duct to the top of the calciner provides hot air from the clinker cooler to oxidize the CO generated by the reduction of NOx. This duct also helps to more effectively distribute airflow through the system, all of which helps to boost the production capacity of the system.

The new volume creates a pool, in which the retention time in the system increased from 2.2 seconds to 3.2 seconds. Heat transfer from the hot gas to the material to be heated/calcined improves with additional reaction time.

Due to the above modification the expanded calciner ducting is also able to digest a larger amount of fuel. In fact, the operating experience since the installation of the MSC system suggests that more kiln feed is required to maintain the ideal ratio of coal input between the rotary kiln and the calciner. The ratio is important to obtain the most efficient heat consumption and therefore the lowest rate of emission of the combustion products.

To verify this theory, short-term trial runs were conducted at clinker production rates equal to a daily level of 2,650 tons. The recorded emission rates at the higher kiln output are shown in the comparison below.

Comparison of Operating Data

The changes in the emission rates under typical operating conditions depicting the three principal modes of operation are as follows.

Prior to installing the MSC system
Clinker Production: 2,200-2,300 tons per day

NOx	2.8	lbs/ton clinker
CO	3.6	lbs/ton clinker
SO2	0.28	lbs/ton clinker
PM total	0.31	lbs/ton/clinker

After installing the MSC system
Clinker Production 2,200-2,300 tons per day

NOx	2.55	lbs/ton clinker
CO	3.0	lbs/ton clinker
SO2	0.22	lbs/ton clinker
PM total	0.23	lbs/ton/clinker

After installing the MSC system
Clinker Production 2,650 tons per day

NOx	2.45	lbs/ton clinker
CO	2.5	lbs/ton clinker
SO2	0.16	lbs/ton clinker
PM total	0.17	lbs/ton/clinker

Conclusion

Due to the increased heat exchange capacity of the preheater/calciner system and its improved efficiency in converting raw feed to clinker, the permitted annual production

rate should be set at 800,000 tons clinker. At this rate, the annual emissions will remain below the levels granted in the Title V operating permit.
Florida Rock Industries, Inc. has carefully evaluated the measured and projected emissions and proposes to set the limits of several pollutants at significantly lower levels under an amended Title V permit, while taking advantage of the newly installed MSC system to improve the efficiency of the available production facility.

After observing the operation of the TSB Cement Plant since its start-up over two years ago and my visit of similar plants supplied by Polysius Corp. in Europe, Central and South America and the Middle East, it is my opinion that this plant has been conservatively engineered, as is typical for systems designed by Polysius Corp.. All ancillary equipment, i.e. the raw material preparation and the clinker cooling and transport systems and their associated emission controls are adequately sized for the moderate production increase proposed by Florida Rock Industries, Inc..

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