TECHNICAL NOTE #19

Research into Atmospheric emissions from clamp kilns

TECHNICAL CONTRIBUTORS

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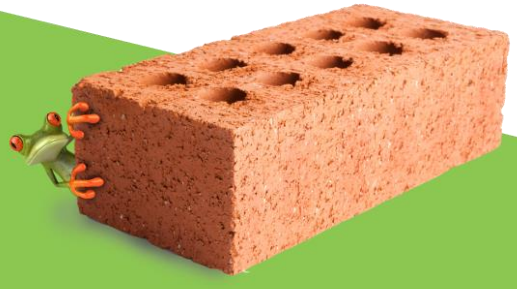
The University of Pretoria in collaboration with the Clay Brick Association of SA initiated a research study to build a small-scale model kiln that could fire bricks while accurately monitoring gaseous pollutants and particulate matter. This has provided a benchmark for Members to implement improvements to the process, to improve air quality and reduce emissions.

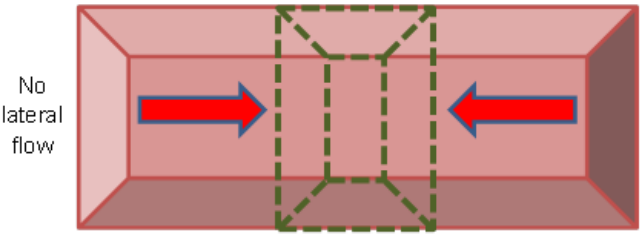


RESEARCH INTO ATMOSPHERIC EMISSIONS FROM CLAMP KILNS

The clamp kiln is the major clay brick production technique in South Africa. Globally, it is regarded as an energy-inefficient process with a high probability of air pollution.

The University of Pretoria, in collaboration with the South African Clay Brick Association, initiated a study to design and test a small-scale model kiln that could adequately fire bricks and accurately monitor gaseous pollutants and particulate matter. This has provided a benchmark for identifying improvements to the process to reduce emissions.

Figure 1: A full size clamp kiln. The model kilns takes a "slice" from the centre to duplicate firing conditions.



BACKGROUND - THE NATIONAL AMBIENT AIR QUALITY STANDARDS

Article 24 of the constitution of the RSA sets out that all South Africans have the right to an environment that is not harmful to their health or well-being. Various respiratory and other health problems are associated with the inhalation of polluted air.

In 2009, South Africa published it National Ambient Air Quality Standards which set legally enforceable ambient air pollution limits for all criteria pollutants. Ambient air quality guidelines and standards are based on the scientifically researched levels of impact of these pollutants, and are used by various organizations and countries.

Industries are controlled through the National Environmental Management: Air Quality Act (No. 39 of 2004) under a section referred to as Listed Activities and Minimum Emission Standards. Companies who undertake Listed Activities are required to compile comprehensive emission inventories for the entire site where the Activity is present.

Clamp kilns are a Listed Activity – their atmospheric emissions are believed to have a significant detrimental effect on the environment. Therefore clamp kiln operators need to apply for Atmospheric Emissions License.

Measuring emissions is understandably difficult with an open-air kiln. Initial readings at several brickyards produced wide-ranging results for comparable firings.

1. Firstly, each firing of the kiln is influenced by different environmental and climatic factors.

2. Secondly, any readings are severely distorted by wind speed and direction, humidity, emissions from coal-fired power stations, particulate dust from nearby farms and quarries, as well as vehicles within and outside the operation. It is impossible to tell which emissions are from the kiln itself, but it has always been assumed that ALL emissions must be from the kiln.

All these factors distort the measurements making AEL reporting inaccurate and unreliable. Without a baseline, how can one identify areas for improvement? There was just too much guesswork and too many assumptions.

About Clamp Kilns

Clamp kilns do not in fact have a permanent kiln structure. They are made up of batches of unburnt bricks packed in layers in a way that leaves voids. These voids are filled with an external fuel that fire-hardens the bricks in its vicinity. The unburnt brick piles are usually covered with insulation layers of fired bricks, to improve energy efficiency and keep firing temperatures consistent.

Figure 2: An open-air clamp kiln firing bricks

Clamp kilns are common in older brick manufacturers, and are reported to be a significant source of harmful emissions and reduced air quality. Because of the lack of consistent, scientific data on clamp kiln emissions, standard mathematical formulas are used nationally and internationally. From these factors, emissions are deduced based primarily on fuel quantity and type, and the number of bricks fired.

About the Research Project

For the past three years, The Environmental Engineering Group at The University of Pretoria (UP) has conducted notable research on air pollution arising from clamp kilns.

Lead researcher Oladapo Akinshipe and Dr Gerrit Kornelius of the University of Pretoria's Department of Chemical Engineering have been working with the Clay Brick Association of South Africa and participating CBA members around Gauteng who have provided clay brick products for test firing.

The air pollutants of concern in this study include:

- particulate matter - visible dust and smoke, also called PM
- nitrogen oxides (NOx) which are produced during high temperature combustion
- sulphur dioxides (SO_2)

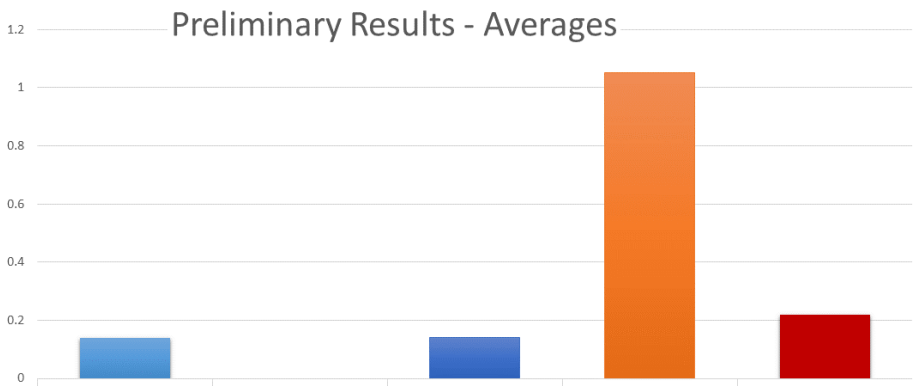
Figure 3: The model kiln provided real-world conditions for firing the clay brick, together with an accurate measurement system for measuring air emissions. The kiln was located far from general activities to ensure the minimum of contamination from other sources.

After several discussion sessions in the CBA technical committee, it was decided to construct a model kiln which would allow **only** kiln emissions to be measured. The principle is shown in the attached illustration, with all emissions being drawn by a fan through an exhaust dust, from which sampling can be done.

Twelve successful firings have been completed, each of about 25 000 to 30 000 bricks and lasting for 10-14 days have now been made. To ensure a realistic range of variables, the raw bricks, packing pattern and the firing technique being provided by four separate members of the Clay Brick Association of South Africa.

RESEARCH FINDINGS

The research findings are good news for stakeholders concerned about air pollution and air quality.



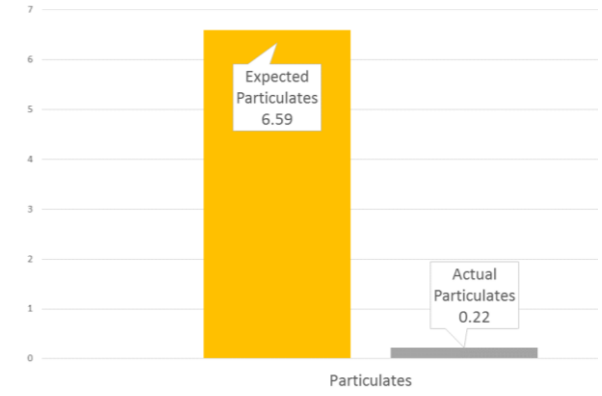
	Nitrous Oxide	Nitrogen Dioxide	Nitrogen Oxide	Supher Dioxide	Particulates
Average	0.14	0	0.14	1.05	0.22

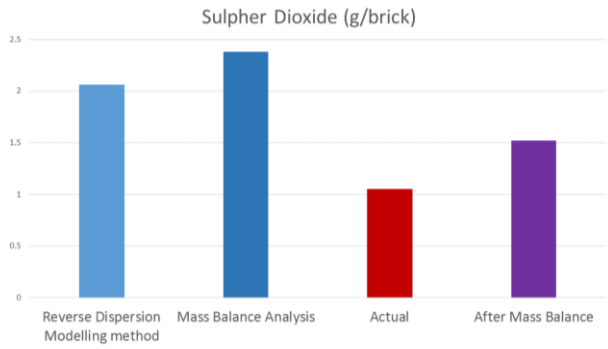
1. The **Particulate Matter emissions** are significantly lower than the standard factor obtained from best-practice literature.

2. **Nitrogen Oxide emissions** seem moderately lower than the standard factor.

3. The **Sulphur Dioxide emissions** (SO_2) are in direct proportion to the fuel used.

   Therefore the emission rate of this pollutant can be calculated from the amount of fuel used and the Sulphur content of that fuel. The measurement technique is valid because the kiln itself is the only source of this pollutant in a brick yard.





With the scientific facts available, CBA member can implement immediate improvements. Sulfur can be removed from fuels before burning, preventing formation of SO_2 when the fuel is burnt although these fuels come at a significantly higher cost.

Based on this research, emissions from nearby farming or dirt roads might be responsible for more of the ambient pollution than previously thought.

Further reports will be made as more results become available and the findings are analysed in greater detail. The model kiln facility remains available to CBA members for tests on packing, firing and ignition techniques that may improve air and brick quality.

Acknowledgements

On behalf of the Clay Brick Association of South Africa and its members, the CBA would like to that the lead researcher Oladapo Akinshipe as well as Dr Gerrit Kornelius of the University of Pretoria's Department of Chemical Engineering.

We would also like to express our appreciation to the NOVA Brick team for hosting the test facility, and to all the participating CBA members. Without their assistance and expertise, we would not have been able to achieve this important breakthrough in air quality management.