Vertical Shaft Brick Kiln (VSBK)

An effective South-South Technology Transfer for climate change mitigation in the Clay Brick sector

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Abstract

The Vertical Shaft Brick Kiln (VSBK) is an energy efficient and less polluting technology for the firing of clay brick. Internationally constantly improved with the support of the Swiss Agency for Development and Cooperation (SDC), it has reached a higher level of efficiency in South Africa during the South-South technology transfer.

The VSBK contributes positively to climate change mitigation due to an average 50% reduction in coal consumption and therefore CO_2 emissions compared to clamp kiln, the traditional South African firing technology. Due to the vertical structure and efficient combustion the emission of other gases and particles is also drastically reduced. Emissions are now easily measured and are below the new South African air quality standards.

The technology brings various economic and social benefits to the employers and workers, and is a good example of a clean and sustainable development contributing to South Africa's international climate change targets.

About SA-VSBK

The SA-VSBK is a South-South Technology Transfer project implemented in South Africa by Swisscontact (Swiss Foundation for Technical Co-operation) in collaboration with SKAT (Swiss Resource Centre and Consultancies for Development). The project is funded by the Swiss Agency for Development and Cooperation's (SDC) and part of their Global Climate Change Mitigation Programme, which in South Africa focuses on energy efficiency in the building sector.

The primary objective of the project is to introduce and disseminate the VSBK brick firing technology as a viable and sustainable alternative firing technology for the clay brick industry, with many positive impacts from the economic, environmental and social point of view.

The project is facilitating the transfer of the technology to the South African brick entrepreneurs, generally small and middle size family businesses enterprise.

The technology offers economic, environmental and social benefits to the clay brick manufacturers and therefore to the South African Air Quality. The project partners come from both the public and private sector, with a focus on creating a suitable business environment as well as knowledge download at various levels ensuring a successful transfer and take-up of the technology.

Figure 1: packing of fired clay bricks from the VSBK

South-South Technology Transfer

This project is an example of a successful South-South Technology transfer, where the technology and knowledge has been transferred directly from Asia (mainly India and Nepal) to South Africa. External intervention from the North has been limited and serves primarily as facilitator of this transfer.

The technology transfer entails various activities, including: 1) organization of workshops to discuss and adapt the technology to the local needs and conditions; 2) exchange of experts to discuss the changes, supervise the construction, and for local capacity building: to transfer and anchor the knowledge in the country to a wide range of service providers; 3) monitor the performance and support in the operation; 4) redesign and adapt the technology according to the lessons learned.

Introduction

South Africa is a very energy and coal intensive economy. The country is the 13th larger emitter of CO2 in the world and has per capita emissions of 8.9 tCO2. This is mainly due to their highly coal based economy. The South African government has during the climate conference COP17 in Durban last year committed to reduce emissions by 34% by 2020 compared to business as usual.

Energy efficient technologies provide the mechanisms to reduce Greenhouse Gas emissions in South Africa. This is particularly important for the clay brickmaking sector, a modern-state-of-the-art industry as far as mining and green (unfired) brick production is concerned.

However when it comes to firing, many brickmakers still make use of the clamp kiln process, a traditional firing methodology, which although has been improved upon over time, remains relatively energy inefficient and commensurate with Greenhouse Gas emissions.

Figure 2: Operation of a Clamp Kiln in South Africa

Now, faced with new environmental regulations, increasing coal costs and shrinking profits, South African brick entrepreneurs are actively looking for cleaner and more energy-efficient firing methods.

The introduction of Vertical Shaft Brick Kiln (VSBK) technology aims to provide a cleaner and more equitable solution in reducing energy consumption and diminishing gas and particulate emissions during the firing process.

What is VSBK?

The Vertical Shaft Brick Kiln (VSBK) technology is an energy-efficient updraft kiln comprising of a vertical shaft from which bricks are loaded at the top and removed at ground level in a continuous process. An unloading tunnel runs through the centre of each kiln allowing for access to both sides of the shaft.

Figure 3: Structure of VSBK by Langkloof Brick, Jeffrey's Bay, Eastern Cape, South Africa.

Internal body fuel is mixed into the bricks with a measured amount of external coal spread evenly between the layers of stacked bricks to control the firing temperature.

The position of the fire in each shaft in relation to the updraft is determined by the rate the bricks are removed and loaded into the shaft. This reuses the rising heat, making it very fuel-

efficient. The firing shaft is very well insulated on all four sides, so that heat loss is minimised.

Once the kiln reaches the specified temperature, the heat from the coal ignites the internal coal of the bricks so that very little heat is lost through exhaust gases or the kiln itself.

These exhaust gasses are used for the gradual preheating of the unfired bricks on top, thus reducing energy consumption and CO emissions by up to 50% compared to the more commonly used clamp kilns.

The Origins of VSBK Technology

The VSBK technology evolved in rural China. The original version of a Chinese Vertical Shaft Brick Kiln was adapted from the traditional updraft intermittent kiln in the early 1970s. In 1985 the Chinese government commissioned the Energy Research Institute to improve its energy efficiencies and by 2000, between 50 000 and 60 000 units were in operation throughout the country.

Through the support of SDC, the technology has since been enhanced and re-pioneered in Nepal, Pakistan, Afghanistan, India and Vietnam. In September 2011, South Africa's very first SA-VSBK pilot plant was inaugurated at Langkloof Bricks, in Jeffrey's Bay, in the Eastern Cape.

How Does the VSBK Work?

The VSBK works on the basis of a 'counter current principle'. When the lid is closed, the shaft and exhaust becomes an integral chimney system. The firing process of pre-heat, firing (vitrification) and cooling takes place within the shaft, as the bricks move down the shaft. Energy efficiency is derived through the verticality of the shaft and structural thermal efficiency.

The firing process is completed within a 24-hour period, a considerably short firing cycle, which tolerates very few mistakes. It is essential to have the appropriate knowledge in order to ensure efficient operation of the VSBK – and, thereby, the successful production of bricks that are consistent in quality.

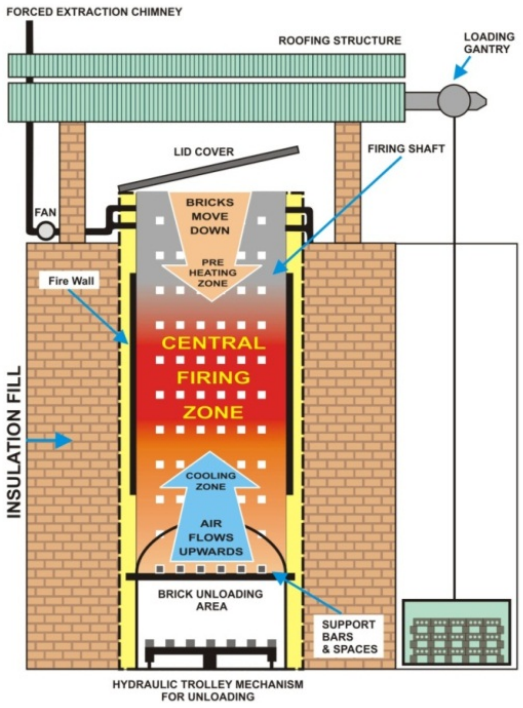

Figure 4: VSBK operational design

Benefits of the VSBK technology

The VSBK technology covers all three pillars of sustainable development and provides the following benefits:

Environmental Benefits

Each kiln will contribute to reduce by 600t per year the CO_2 emissions, which with a 50% of clamp kiln conversion to this cleaner clay brick technology as VSBK by 2020, it is estimated to achieve half a million tons CO_2 reduction per year.

Table 1: Comparison of average energy required for firing for the main firing technologies in South Africa.

Production Mechanism	**Firing Energy Required** (per Kg of fired brick)
Tunnel kiln	1.65 – 2.1 MJ/Kg
Transverse Arch kiln	2.0 – 4.0 MJ/Kg
Clamp kiln	1.7 – 4.2 MJ/Kg
VSBK Worldwide	0.84 1.1 MJ/Kg
SA-VSBK (Langkloof Bricks)	0.85 MJ/Kg and still improving!

All gases and particles as PM_{10}, NO_x, SO_x, VOC, etc. are considerably reduced and easily measurable as a single point source. This with considerable benefits both for the labours and for the overall air quality. (PM_{10} were measured at an average of 9.1 µg/m^2)

latest more updated emission results awaiting finalization

Economic benefits

With an energy consumption of 0.85 MJ/kg fired brick (compared to an average of 2.3 MJ/kg for clamp kiln) there is a coal saving of on average 50% reducing the embodied energy of the final brick and building.

Breakage in production are below 2% compared to the average of 15% allowing more final saleable product with the same inputs.

Social Benefits

The VSBK helps to retain jobs and requiring more skilled people it provide opportunity for skills development.

Improved health and safety on the working place with allow to a better working condition for the employees.

Challenges and barrier

Even if technology transfer has been successful and competences have been transferred to and anchored in South African local service providers and are ready to be multiplied, a wider uptake of the technology hasn't taken place yet. The main reason is that other challenges and barriers beside the technology still remain present. These challenges and barriers are: 1) Access to Finance to obtain preferential green credit lines to support the investment costs; 2) conservative mind set, cultural habit and traditional practice of business and operation; 3) lack of knowledge of detailed single operation practices and costs; 4) adverse investment climate due to national and international financial situation; 5) Environmental Impact Assessment (EIA) requirements and process taking longer than expected and discouraging these changes.

Future steps

To overcome these remaining barriers and challenges, SDC has decided to support an additional four years of the project which will still be implemented by Swisscontact. The project will be constructed with a specific market-develop focus and look at a wider facilitation of improving the energy efficiency of the overall clay brick sector in South Africa. Intervention in the market areas will be: 1) Supply of low carbon bricks with the further support of the VSBK technology but also of facilitation of other energy efficient practices; 2) Enabling the business and political Environment by facilitating the access to carbon and green financing products and enabling a better and easier access to information for informed political decision; 3) Increasing the Demand of low carbon bricks in the market across the clay brick users value chain.

Figure 5: Langkloof Brick's VSBK

"We believe the VSBK technology will fundamentally shift the way many clay brick manufacturers think about production in the future, from an economic, social and environmental perspective." - Nico Blake, Langkloof Bricks