basin
Wall Building
Newsletter
building advisory service and information network

VSBK-Newsletter 3

1. Introduction

This newsletter is about a special type of brick kiln named Vertical Shaft Brick Kiln, in short VSBK. It originates in China and has over the last 10 years been introduced in several other countries in Asia and even in Africa.
GTZ, the German government funded agency for technical co-operation is sponsoring this newsletter and it is distributed through the BASIN (Building Advisory Service and Information Network) network with four European members GATE-GTZ (German Appropriate Technology Exchange), ITDG (Intermediate Technology Development Group, UK), SKAT (Swiss Center for Appropriate Technology), CRATerre (France), and three members in developing countries: Shelter Forum in Kenya, CEVE (Centro Experimental de la Vivienda Económica in Argentina and the DA (Development Alternatives) in India.
The last VSBK newsletter was published in September 1996. Since then the VSBK technology has been maturing and succesfully transferred and disseminated in India. It has been further developed and could be an attractive option for small-scale and medium-size brick producers in many other countries.

2. Report from China

A team from the Swiss sponsored VSBK project in India went to China in May 1997. The purpose was not only to study VSBK technology there, but even more, to learn how the technology was disseminated in that county. The following are excerpts taken from the team's report:

„The VSBK technology was developed in the early 1970's, but the exact history is not clear. In 1983 the Energy Research Institute of Henan Academy of Sciences, initiated a project to improve the kiln. Two pilot plants were set up and the institute helped the rural county energy offices especially in Henen and Anhui provinces with dissemination of the technology.
It became clear that the success of the VSBK technology has not much to do with a planned strategy to disseminate this technology. The mass dissemination of the VSBK in the two provinces visited just happened due to very favorable conditions. The new economic reforms are favouring small business enterprises and at the same time they have increased the demand for building materials.

All VSBKs are constructed with the utmost economy of investment and most of them are identical since a new entrepreneur just copies the VSBK of his neighbour, mostly with the help of his neighbour. The height of the kiln is reduced by putting the unloading area below ground level. The ramp to the loading platform is constructed with green bricks. Very little is spent on maintenance. A clear sign of this is that many VSBKs are in a dilapidated state. Further, once the brick soil is exhausted around the kiln, the expensive unloading device is moved on to the next site. The VSBK is a moveable technology in China.
A VSBK is a low risk business in China; investment is low and brick demand high. In case the business is not running well, the entrepreneur can dismantle the kiln and sell the bricks as well as the loading and unloading devices. Most VSBK entrepreneurs are farmers who want to earn more money than farming provides. It is assumed that not everyone can get a business license. However, with the right connection land for brick business is made available. The farmer's risk is low since farming still provides the basic income for the family. It was observed that many hardware stores are also selling equipment for the VSBK such as trolleys, unloading gear and brick extruders“, (see Fig. 1).

VSBK Technology

The most commen shaft size of the kilns visited in China were 1x1 m, 1x1.5m and 1x1.75m. The most common height of the shaft accomodated 8 brick batches. Shaft linings were generally made from burnt red bricks. A few builders constructed the shaft from unburnt bricks in order to save money. Refractory bricks were not used

Fig. 1: Early VSBK in Henan, China.

by the ordinary farmer-entrepreneurs. The outer walls are of red bricks laid in clay mortar except for critical kiln areas such as arches where cement mortar is used. The kiln walls have a tendency to bulge and in many locations steel rods tied the outer walls together with timber stoppers at the ends. The gap between the inner and outer walls is filled with clay mixed with some biomass like wheat or straw for insulation. The loading platform is congested with green bricks and ventilation is rather poor. Nowhere an arrangement for evacuating exhaust gases was seen. The exhaust flue gases escape directly from the top of the shaft into the loading platform. It was learnt that the Government of China does not have any environmental standards or regulations for the brick industry as it is considered to be a "non-polluting" industry.

All bricks are made by extrusion. The extruder is a low cost simple machine driven by a diesel engine. The dried bricks are transported to the kiln in carts and lifted manually, with workers carrying 30 to 40 bricks at a time.

The cost of constructing a VSBK is Yuan 7500 equal to 900 US $. Maintenance cost of a kiln is around 50 $ per 2 million bricks.

A total of five training programmes for VSBK operation were carried out in 1987 by the Henan Energy Research Institute in Hunan and Anqui provinces. After 1987 no training programmes or workshops have been conducted. There is presently no structured government programme actively promoting the VSBK technology. In some counties the government is actively encouraging the construction of VSBKs, in others it is restricting it, mainly to protect agricultural land use.

Fig. 2: The Datia kiln after opening up the operation room on top.

3. Latest news from China

Mr. Yin Fuyin reports from Henan that the dissemination of VSBKs in China is facing problems. In order to protect arable land, the government restricts brick making from clay and encourages production of non-fired bricks, using industrial waste materials such as fly ash, cinder and coal gangue. For brick making using clay, hollow brick production is allowed. That means, VSBK producers will have to produce hollow bricks in the future. But for demonstration of hollow brick production funds are not available at the moment in China.

4. Bangladesh

Based on the experiences gained in India, the Swiss Development Cooperation (SDC) charged SKAT to send a team to Bangladesh to see if the brick producers there would be interested in the VSBK technology. SDC in Bangladesh has since the early nineties searched for ways to improve the building material sector.

The team recommended that the VSBK technology should be introduced in Bangladesh considering the benefits relating to energy saving, environment, economy, technology and even market aspects. However, the team could not identify an ideal partner organisation, which could carry out the proposed programme. The most likely local partner, Bangladesh Brick Manufacturers' Association, was mainly interested in improvements to the existing BTK (Bull's Trench Kiln) technology. At this point, no local organisation has qualified to carry out the recommended project.

5. India

The Swiss Development Co-operation (SDC) is sponsoring a project for improving energy use in the building material sector of India. A local NGO, Development Alternatives (DA) is co-ordinating the component for brick kilns. The BASIN member SKAT (Swiss Centre for Appropriate Technology) is handling the back-stopping for the project.

Up to now, four VSBKs have been constructed in India:

- VSBK-1 Datia, Madhya Pradesh: 1m x 1.5m +1m x 1m, 11 batches high;
- VSBK-2 Kankia, Orissa: 1.75m x 1.75m +1.75m x 1.75m, 9 batches high;
- VSBK-3 Palghat, Kerala: 1m x 2m +1m x 1.75m, 11 batches high;
- VSBK-4 Pune, Maharashtra: 1m x 2m + 1.25m x 2m, 8 batches high;

In 2000 three more VSBKs are planned for construction in India. One VSBK will be in Agra. It has not been decided where the other two VSBKs will be located, (see Map 1).

Datia: VSBK-1:

Datia is located in Madya Pradesh close to Jhansi. Here the first VSBK in India was constructed in March 1996 (Fig. 2). It was put up as an experimental kiln and has been operated by Development Alternatives (DA). Initially, the shafts were constructed only 8 batches high but were later extended to 11 batches. The kiln has two different shaft sizes. The small shaft was made for the chain pulley system. The larger shaft was fitted with a single-screw unloading device, the first of its kind outside China. The kiln has been modified to improve work environment and lowering emission of harmful gases to the general environment. The results have been incorporated in the newer VSBK unit in India. This season extruded brick production has been started using a diesel powered Chinese extruder.

Kankia: VSBK-2:

The DA-Swiss project wanted to operate at least two VSBK units during the pilot phase. For testing purposes, the second VSBK was to be located in another climatic condition. With a view to widen the dissemination of the technology, construction and operation should be carried out by another organisation working as a partner to DA. The choice fell on Gram Vikas, a grassroots voluntary organisation with headquarters at Mohuda village near Berhampur in the state of Orissa. Planning, construction, firing and training of local craftsmen was carried out with the assistance of DA experts and craftsmen who had learned from the first VSBK in Datia. Two Chinese experts were also available. Based on the experience gained from VSBK-1, the two shafts were extended to 1x1.75m and made 9 batches high. Single screw unloading systems

were used for both shafts.In Kankia brick firing was carried out during the rainy season, demonstrating one of the practical advantages of the VSBK technology.

Gram Vikas started the VSBK project to study the commercial viability of the VSBK technology in its entire scope. The management has assessed that it is economically viable.

Palgath: VSBK-3:

Comtrust, a large brick producer with more than 100 years' experience, has constructed a VSBK in Kerala State. Production started in April 1998 and is continued. Due to the high quality of green bricks the VSBK-fired bricks are better than bricks fired in the other VSBK units in India (Fig. 3 + 4).

Fig. 3: VSBK-3 in Palgath.

Fig. 4: Single-screw device VSBK-3.

Pune: VSBK-4:

A local organisation, MITCON-DAMLE has constructed a VSBK with shafts larger than anywhere else including China. DA is providing the expertise. Firing started in January 1999. The kiln is located with the green brick production area above the loading platform and with unloading at level with the main road. This means construction of a ramp or lifting device for green brick loading is avoided (Fig. 5).

The breakage rate of bricks is for all units in the range of 3 to 5%.

The present project phase is extended up to March 2000. A large number of people have been trained to construct and operate the kilns. The original Chinese technology has been further developed in terms of environmental safety, conditions for workers, and larger firing capacity. A number of experienced Indian experts are now available for guiding and training new groups. Some important manuals such as: VSBK design guide, VSBK construction guide, and VSBK operation guide have been prepared. A VSBK technology package is ready for wider dissemination.

With four VSBK units operating well, the pressure from brick entrepreneurs to acquire the VSBK technology know-how is increasing. Three more units are to be constructed during the next phase. The project is cautious not to expand the number of new units too rapidly. In the initial phase, it is important to ensure that all units work well so that the technology does not get a bad reputation from badly performing units handled by inexperienced operators. However, it is a fact that the VSBK technology is finally taking roots outside China.

Environment

The Indian government has introduced new regulations for brick kilns in order to improve the environment and living conditions in the brick producing areas. Development Alternatives (DA) introduced a number of changes to the original VSBK design to especially improve the environment for the kiln attendants on top of the kiln. This was tested in Datia on the first VSBK in India. The changes were:

- The walls around the loading platform were opened up to allow better ventilation;
- A monitor was installed in the roof to increase air ventilation;
- Chimneys were made higher to increase draught;
- Lids were fitted to cover the shaft opening. The lids would only be opened during loading of bricks and coal;
- The shaft was made higher so it now holds 11 batches of bricks;
- An additional row of flue holes was installed one batch below the regular flue outlets. The flue to these holes was opened while the lids were off during loading of bricks.

Fig. 5: VSBK-4 in Pune under construction.

Monitoring conditions, VSBK-1 in Datia		Workplace on top		Stack
		So2 µg/m3	NOx µg/m3	So2 µg/m3
Datia clay, partial internal coal	Lids open	547.5	48.1	88.6
	Lids closed	301.2	20.0	252.4
Datia clay, full internal coal	Lids open	208.3	73.2	150.0
	Lids closed	119.8	47.1	161.3
Bhognipur clay, no internal coal	Lids open	528.9	123.6	81.4
	Lids closed	190.0	40	205.0

The table above shows So^2 gas concentrations measured at the loading platform and in the stack after modifications were made.

When lids are closed, the So^2 is higher in the stack and lower at the workplace. The concentrations of NOx and CO are well below what is prescribed by the Indian Government.

Comparison of dust emissions for different kilns:

SPM mg/m^3 for:

1. BTK in India	1916
2. Nearby clamp	1913
3. VSBK	150

Energy Audit of VSBK

The Tata Energy Research Institute (TERI) carried out an energy audit of the Datia kiln from April to June 1996. The audit included both shafts of the kiln and different combinations of clay types and fuels. Below some typical figures are given.

TERI had also tested the energy consumption of BTKS in Bhognipur and of local clamp kilns around Datia. The results in MJ/kg fired brick compare like this:

MJ/kg per fired brick:

1. VSBK in Datia	0.79
2. BTK in Bhognipur	1.11
3. Lokal clamp in Datia	1.90

In May, the climatic conditions of Datia and Bhognipur are extreme with temperatures close to 50° C and very low humidity.

Energy monitoring results

The specific energy and fuel consumption for the three VSBK pilot plants in operation during the first half of 1998 was monitored by TERI as follows:

Flue gas analysis	in shaft	in chimney
Oxygen %	-14.2%	15.7%
Carbon monoxide %	- 0.66%	0.43%
Temperature °C	-115°C	198°C
Temperature of bricks loading on top		40° C
Temperature of bricks unloading at bottom		229° C
Heat balance for shaft measuring 1 x 1.5m:		
Dry flue gas		10.0%
CO formation		5.6%
Moisture removal		9.0%
Chemical reactions		31.7%
Residual heat in fired bricks		19.3%
Unburnt fuel loss		0.9%
Unaccounted loss		23.4%

Fuel	Fuel consumption kg/ 1000 bricks	Gross Calorific Value (kcal/kg)	MJ/ 1000 bricks	Specific energy consumption (MJ/kg of fired brick)
Coal	171.5	3470	2487.5	
Ricehusk	40	3040	508.3	
		Total	2995.8	1.12

VSBK Kankia; date of monitoring: April 9-10, 1998; Weight of fired brick: 2.68 kg

Fuel	Fuel consumption kg/ 1000 bricks	Gross Calorific Value (kcal/kg)	MJ/ 1000 bricks	Specific energy consumption (MJ/kg of fired brick)
Coal	69.4	4180	1212.6	
Coal dust	120	990	496.6	
Wheat Straw	20	3800	317.8	
		Total	2027.0	0.91

VSBK - Datia; date of monitoring: May 8-9, 1998; Weight of fired brick: 2.23 kg

Fuel	Fuel consumption kg/ 1000 bricks	Gross Calorific Value (kcal/kg)	MJ/ 1000 bricks	Specific energy consumption (MJ/kg of fired brick)
Coal (LICO)	79.65	6260	2084.3	
		Total	2084.3	0.77

VSBK - Palgath; date of monitoring: May 21-22, 1998; Weight of fired brick: 2.7 kg

General Assessment of the VSBK

Apart from a number of different brick engineers and producers, a general assessment on the VSBK was also received from Hans Bauchli, a Swiss brick producer who has visited the VSBK sites in India. His observations are as follows:

Positive:

- Adaptable system for market demand (number of shafts in operation);
- Lower energy consumption compared to other firing systems;
- Charging and discharging possible outside the firing channel;
- Can be operated in bad weather conditions;
- Smaller space requirements compared to other kiln systems.

Negative:

- More staff needed due to necessary day and night operation;
- Special skills required for managing and controlling the firing;
- Firing of different clay products not possible in the same shaft;
- Kiln walls can get damaged if bricks are overfired;
- Initital investment high compared to production capacity.

6. Vietnam

Last year a German business promotion project looked into how to improve the ceramic crockery business around Hanoi in North Vietnam. In that connection an analysis of the brick industry of that area was undertaken.

Scope of the brick industry

Based on the statistical yearbook 6,576 million bricks were produced in 1995 in Vietnam. Over the last 5 years the brick production has grown by about 13% per year, so the projection for 1996 was 7,430 million bricks. Viglacera (a State-owned corporation) claimed that they were operating all the modern plants in the North producing 500 million bricks/year. If it is assumed that in the South another 1,000 mill. bricks are produced in modern plants it leaves at least 5,000 million bricks for the small and medium size producers. These are mainly using clamp kilns for firing bricks so the traditional brick industry is consuming energy equal (brick kilns in the South mainly use firewood) to roughly 1,000 million tons of coal per year. Given that the clamp kilns are not energy efficient there is a potential for saving large amounts of energy through the introduction of better kiln technology.

Brick production at Bat Trang

In Bat Trang village more than 1000 family units are producing crockery fired up to 1300°C. Outside the village several groups of clamp kilns are situated. Each clamp kiln fires 50,000 to 100,000 bricks at a time. In one area the bricks were formed by one group using diesel-powered extruders and then sold to the brick firing units.

Production data for a typical brick kiln unit:

capacity:	100,000 bricks
construction cost:	10 million VD approx. 860 $)
fuel use:	coal 5, 2 tons + firewood 1-1.5 tons
energy consumption:	2.1 MJ/kg fired brick
fuel cost per firing:	coal - 5,000,000 VD briquette making - 560,000 VD firewood - 650,000 VD total: 6,210,000 VD
firing time:	10 days
stacking and drying bricks:	10 days
output: class A:	80% @220,000 VD/ 1000 bricks
class B&C:	15% @ 100,000 VD/ 1000 bricks
waste:	5%
workers:	10 (they can manage two units)
salary per worker:	15,000 - 20,000 VN/ day (no piece rate)
labour cost per firing:	3,000,000 VD
lease of land:	4 million VD/ year (400,000 VD/ 100 m^2)

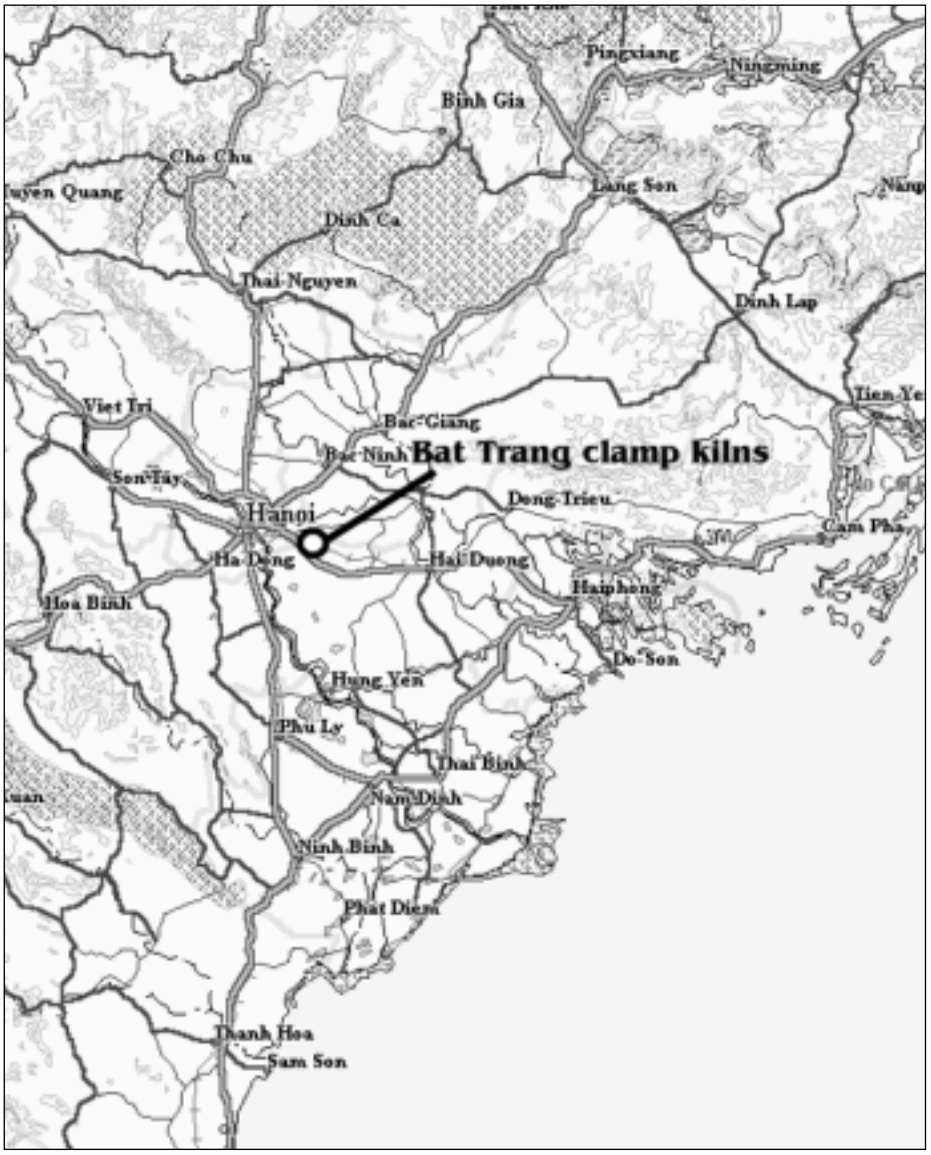

Fig. 6: Location of Bat Trang clamp kilns

The clamp kiln is a square brick wall structure inside which the bricks are stacked on top of a row of fireboxes. For each 5 green bricks one coal briquette is placed between the bricks. When the kiln is fully packed a wood fire is started in the fireboxes. Once this fire has ignited the coal briquettes inside the kiln, the firewood stoking is stopped and the fireboxes are closed up. The fire moves slowly up through the bricks during the next 8 to 10 days.

Energy consumption

Coal has been sent for testing of its heat value, but results were not available. One source has provided the figure 21.4 MJ/kg coal for grade 5. That means firing consumes around 2.1 MJ/kg fired brick. In India similar kilns use around 1,9 MJ/kg brick.

Improving present kilns:
Minor energy savings may be achieved by insulating the walls of the kilns, but hardly enough to justify the effort.

Tunnel kilns:
The state-owned Viglacera Corporation has 19 tunnel kilns for firing bricks in operation. These are constructed locally and use coal as fuel. 90% of the coal is mixed in with the clay (internal combustion bricks). The remaining 10% are stoked from the top of the kiln.

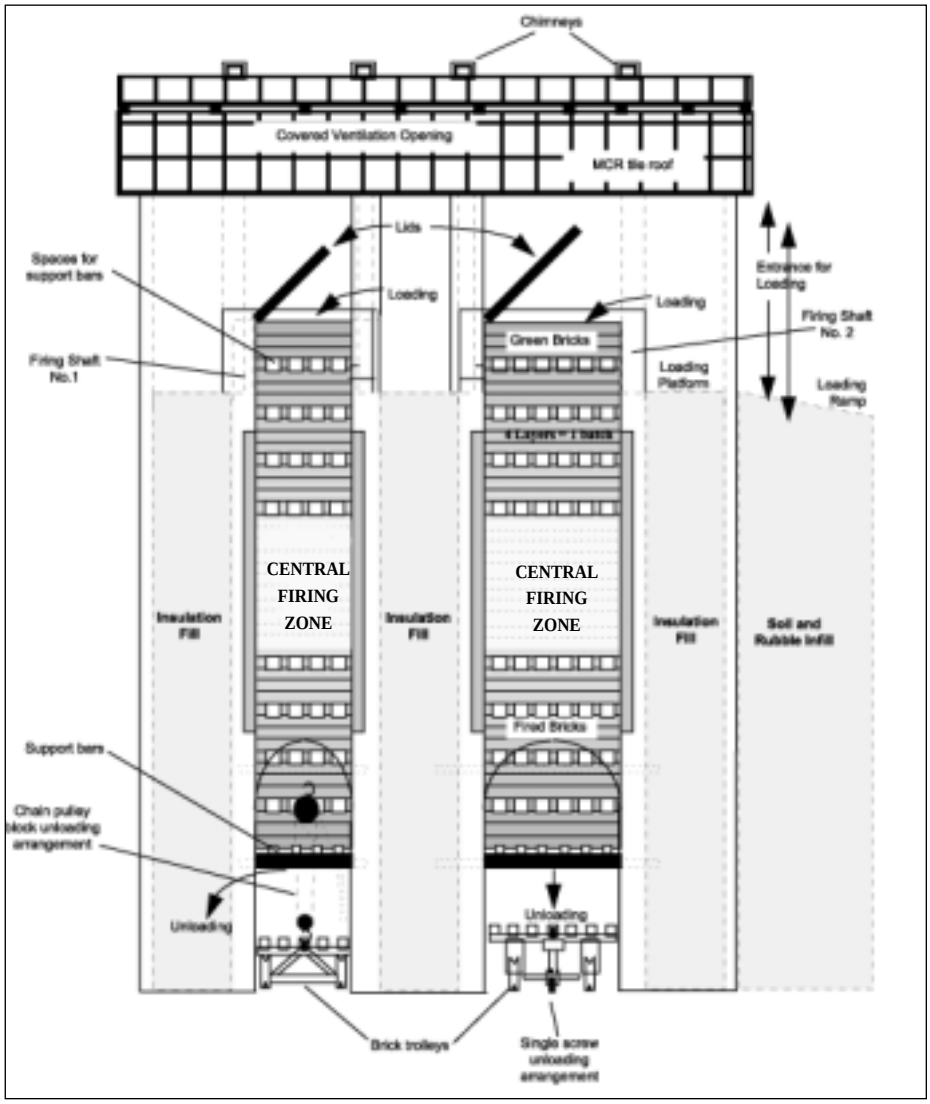

Fig. 7: Section through a VSBK

7. Pakistan

A project for improving the industrial environment in Peshawar has taken over the VSBK component from the former "VSBK Development Project." It was found out that the brick producers on the plains of the North West Frontier Province are not interested in the VSBK, because they do not consider it economically viable. Instead, it was now decided to introduce the VSBK technology in the mountainous areas of the province, where the demand favours smaller local brick producing units. In the plains a pilot scheme for reducing emissions from Bull's trench kilns has commenced.

Conclusion

By acknowledging that there are some limitations in the present VSBK technology, e.g. that only a limited number of shafts can be served by a single ramp or other devices for transporting dried "green" bricks to the loading platform, it has nevertheless been proven that the technology is particularly suitable in developing countries for small-scale production in rural or sub-urban areas with short transportation distances. A VSBKs' life span is between 10 to 15 years, if it is managed and maintained with care. With proper control mechanisms embedded within the kiln's management, the produced bricks should be of high quality. The energy consumption is lower than that of all other comparable kilns in operation.

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What is basin?

The building advisory service and information network (**basin**) - of which GATE/GTZ is one of the founding members - was set up in 1988 to provide information and advice on appropriate building technology and to create links with know-how resources in the world for all those in need of relevant information.

basin attaches importance to giving individual specialised support to its clients whilst balancing this with the comprehensive view that comes from the long and diverse experience of its partner organisations.

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