1 FIXED CHIMNEY BULL'S TRENCH KILN (FCBTK)

INTRODUCTION AND HISTORY

Fixed Chimney Bull's Trench Kiln (FCBTK) technology is the most widely used brick firing technology in South Asian countries. It is a continuous, moving fire kiln in which the fire is always burning and moving forward in the direction of air flow due to the draught provided by a chimney. The bricks are being warmed, fired and cooled simultaneously in different parts of the kiln.

It is a modified version of Bull's trench kiln introduced by a British engineer W. Bull in 1876[1] . Initially it had movable metal chimneys which were placed on the brick setting and were moved as the firing progressed. This technology was modified to more efficient and less polluting fixed chimney Bull's Trench Kilns and there was a large scale shift to fixed chimney Bull's trench kilns (FCBTKs) due to a regulatory ban on use of moving chimney kilns during 1990's in India, followed by similar regulations in Bangladesh and Nepal.

ABOUT THE KILN

Kiln

CONTINUOUS MOVING FIRE

ENTERPRISES USING THIS TECHNOLOGY

Nature of enterprise

INDUSTRIAL

Level of mechanization

MANUAL

Brick produced

SOLID

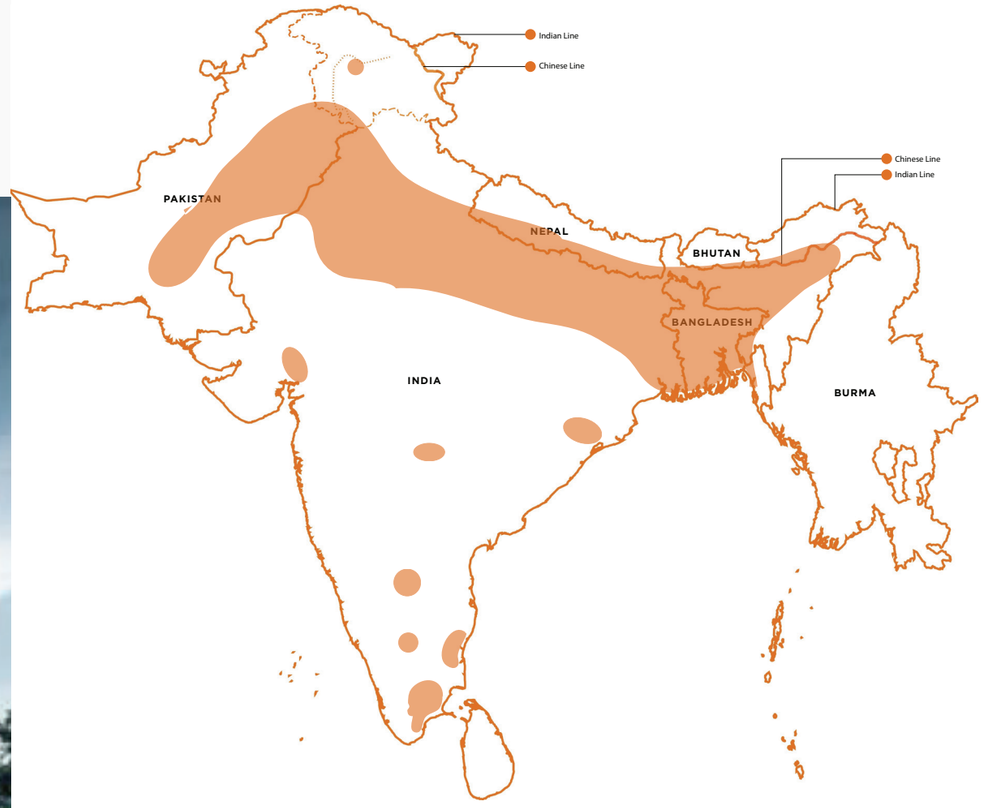
Production capacity

MEDIUM
Between
1-10 million bricks

Operational season

DRY SEASON

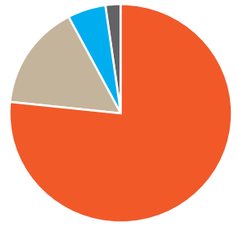
GEOGRAPHICAL DISTRIBUTION



NUMBER OF OPERATIONAL ENTERPRISES AND TOTAL PRODUCTION*

Country	Number of enterprises	Total production billion bricks/year
India[2,3]	35,000	185
Pakistan[4]	11,500	56
Bangladesh[5]	4,500	17.4
Nepal[6]	450	2.3
Total	51,450	260.7

*Numbers are estimates only



PER ANNUM CONTRIBUTION TO TOTAL BRICK PRODUCTION IN INDIA, PAKISTAN, BANGLADESH AND NEPAL

79% **Approximately** 260 BILLION BRICKS

1 FIXED CHIMNEY BULL'S TRENCH KILN (FCBTK)

DESCRIPTION AND WORKING

1

In FCBTK the fire moves in a closed circular or oval circuit (central perimeter 180-220 m) through the bricks stacked in the annular space between the outer and the inner wall of the kiln.

2

It operates under the natural draught provided by the chimney (20 – 38 m high) located at the center of the kiln.

3

The kiln does not have a permanent roof and bricks stacked in the kiln are covered with a layer of ash & brick dust, which acts as a temporary roof and inhibits the heat loss as well as seals the kiln from leakages.

4

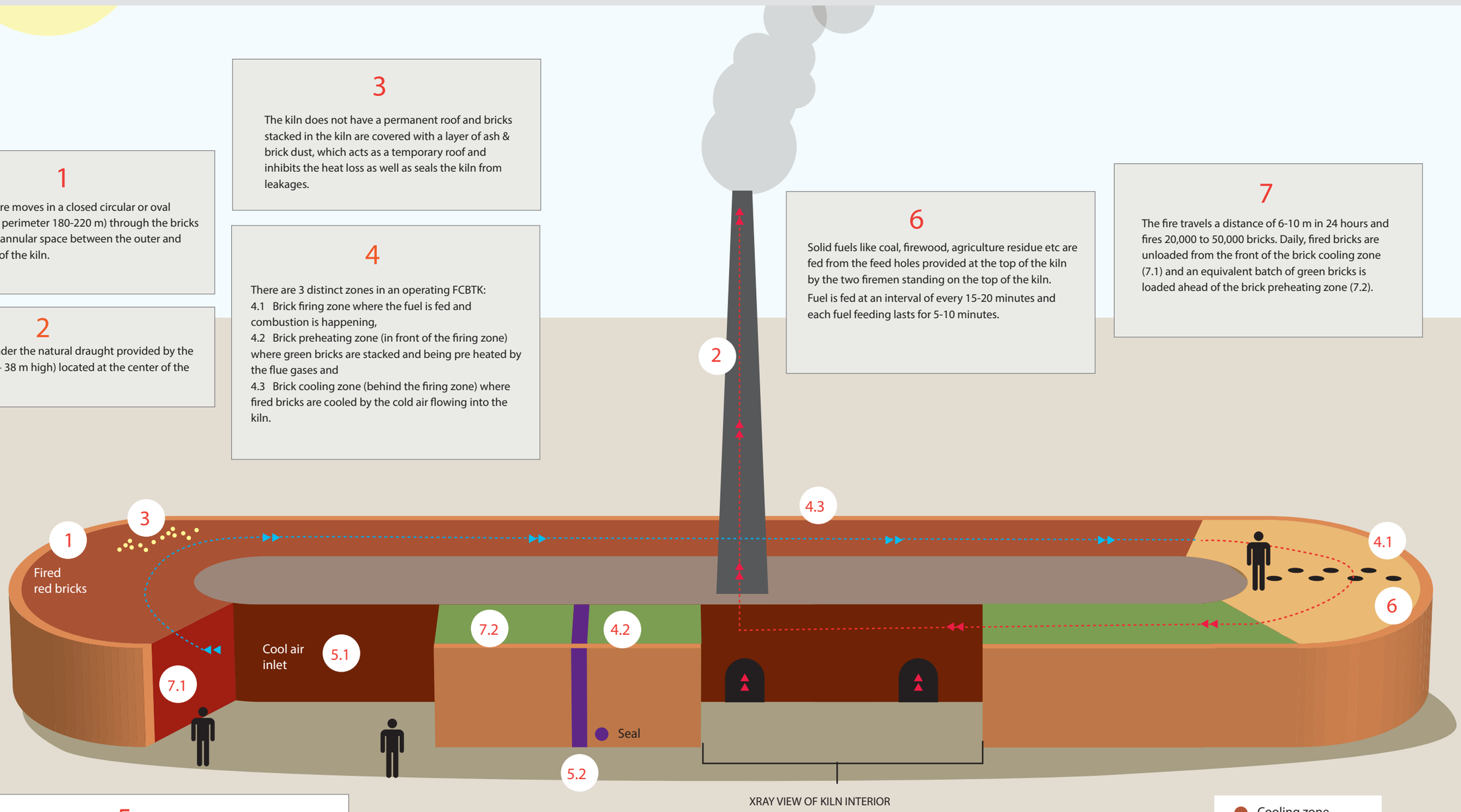
There are 3 distinct zones in an operating FCBTK:
4.1 Brick firing zone where the fuel is fed and combustion is happening,
4.2 Brick preheating zone (in front of the firing zone) where green bricks are stacked and being pre heated by the flue gases and
4.3 Brick cooling zone (behind the firing zone) where fired bricks are cooled by the cold air flowing into the kiln.

6

Solid fuels like coal, firewood, agriculture residue etc are fed from the feed holes provided at the top of the kiln by the two firemen standing on the top of the kiln.
Fuel is fed at an interval of every 15-20 minutes and each fuel feeding lasts for 5-10 minutes.

7

The fire travels a distance of 6-10 m in 24 hours and fires 20,000 to 50,000 bricks. Daily, fired bricks are unloaded from the front of the brick cooling zone (7.1) and an equivalent batch of green bricks is loaded ahead of the brick preheating zone (7.2).



XRAY VIEW OF KILN INTERIOR

5

5.1 Air Inlet: Air enters into the kiln from back end of the cooling zone which is kept open to allow air entrance.
5.2 Seal to guide flue gas: Front end of the preheating zone is sealed to guide the flue gas to chimney through the flue gas duct system.

- Cooling zone
- Firing zone
- Preheating zone
- Fuel feed holes

1 FIXED CHIMNEY BULL'S TRENCH KILN (FCBTK)

AIR EMISSIONS AND IMPACTS

MEASURED EMISSION FACTORS[7]

g/kg of fired bricks			
CO2	Black Carbon	PM	CO
Average			
131	0.13	1.18	2.0
Range			
94.7-163.8	0.07-0.28	0.26-2.63	1.09-3.36

MEASURED PM EMISSIONS

Average: 570 mg/Nm3

(Range: 150 – 1250 mg/Nm3)

EMISSION STANDARDS

Notified for PM only

Country	PM (mg/Nm^3)
India	1000 for small kilns < 15000 bricks per day 750 for large kilns > 15000 bricks per day
Pakistan	Emission standards not notified for brick kilns
Bangladesh	1000
Nepal	600 for forced draught kilns 700 for natural draught kilns

COMMENTS ON EMISSIONS

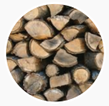
Poor fuel feeding practices and incomplete combustion in an FCBTK result in high emissions of PM and gaseous pollutants leading to poor air quality around FCBTK clusters.

A significant part of the PM emissions consist of smaller particles (PM_{10}, $PM_{2.5}$ and black carbon) which has adverse effects on human health and local vegetation.

FUELS AND ENERGY

COMMONLY USED FUELS

Coal
Most commonly used



Biomass
Eg. sawdust, firewood, biomass briquettes

Agricultural residue
Eg. mustard stalk, rice husk

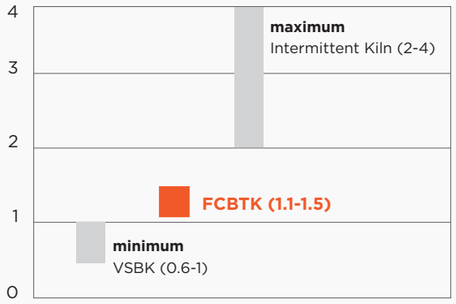
Industrial waste/by-products
Eg. pet-coke, used rubber tyres

SPECIFIC ENERGY CONSUMPTION[8]

Energy consumed for firing 1 kg of fired brick

Average: 1.30 MJ/kg of fired bricks
(Range: 1.1 – 1.46 MJ/kg of fired brick)

MJ/kg of fired brick



Note: Measured at firing temperature of 900-1100°C

FCBTK, being a continuous kiln and having good heat recovery features, is significantly more efficient compared to intermittent kilns but is less efficient compared to some of the other continuous kilns like VSBK and Zigzag.

MAIN CAUSES FOR HEAT LOSS

Incomplete combustion of coal and heat losses from the kiln surface are the two main sources of heat loss in an FCBTK.

FINANCIAL PERFORMANCE

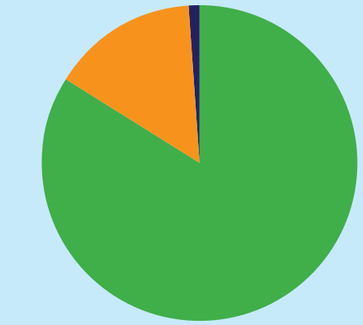
Capital cost of kiln technology

For annual production capacity of 3 – 8 million bricks, excluding land and working capital cost

50,000 to 80,000 USD

Capital cost breakdown

Construction Material	84 %
Labour	15%
Equipment	1%



Production capacity	20,000 to 50,000 bricks per day	
Brick size	230 mm x 115 mm x 75 mm	
Number of Operators required	30-40	
Payback Period	Simple Payback	0.4 – 1.1 years
	Discounted Payback (@ 6.5%)	0.4 – 1.2 years

PRODUCT QUALITY

Product Quality
As per the local market perception

GOOD ~ 60%

INFERIOR ~ 35%

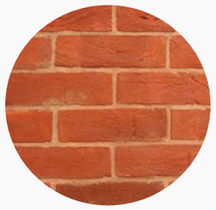
LOSSES & BREAKAGES ~ 5%

Non-uniform temperature across the cross-section of FCBTK results in under-fired bricks at the side walls and top corners and hence differences in the product quality.

Types of product that can be fired in the kiln	Solid bricks	✓
	Hollow/ Perforated bricks	✓
	Roof tiles	✓
	Floor tiles	✓

Usually only solid bricks and to some extent hollow bricks are fired in FCBTKs, however, other products can also be fired in combination with the solid bricks.

GOOD BRICK



INFERIOR BRICK

under-fired and over- burnt

OCCUPATIONAL HEALTH AND SAFETY

Exposure to Respirable Suspended Particulate Matter[9]

Flue gases exhausted from the chimney, ash covering and unpaved surfaces around an FCBTK result in very high concentration of dust in the surrounding environment and the workers are exposed to high concentration of respirable suspended particulate matter (RSPM).

This results in high incidence of respiratory tract infections and cardio vascular diseases among workers.

Exposure to Thermal Stress[10]

Workers such as fireman, while working on the kiln top are exposed directly to radiation from the kiln roof and flames.

This results in eye & skin diseases and dehydration among workers.

Risk of accidents

As the FCBTKs do not have a permanent roof, there is always a danger of caving-in of the brick setting or falling off the kiln structure and this poses serious risks of accidents.

High risk of injuries

Compliance with ILO standards and remarks on migratory labour and conditions of labour

Practices followed at FCBTK enterprises do not comply with the International Labour Standards on occupational health and safety drawn up by ILO.[11]

Majority of the workers of FCBTK are seasonal migrants and they along with their families work on the kilns. They live in temporary housing with poor access to basic amenities like safe drinking water, electricity, education, health and sanitation.

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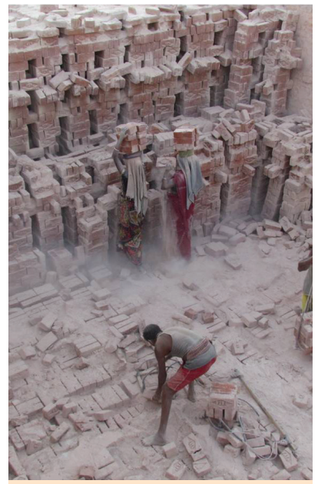
MARCH 2014

CONCLUSION

Facts about FCBTK, the most commonly used kiln.

PARAMETERS		FCBTK	COMMENTS
AIR EMISSION (g/kg FIRED BRICK)	CO2	131	Incomplete combustion in FCBTK results in high value of emissions. The average value of PM emissions lie within the notified limit, however, some of the kilns emit higher PM.
	Black Carbon	0.13	
	PM	1.18	
	CO	2.0	
FUEL & ENERGY	SEC (MJ/kg fired brick)	1.30	Incomplete combustion and heat losses result in increase in the fuel consumption in FCBTK.
FINANCIAL PERFORMANCE	Capital Cost (USD)	50,000-80,000	Low capital investment and high return is one of the main reasons for popularity of FCBTK technology among brick makers.
	Production Capacity	3-8 million bricks/year	
	Simple Payback	0.4 – 1.1 years	
PRODUCT QUALITY	Types of product	All types of product	Non-uniform temperature distribution across the kiln cross-section results in variation in product quality.
	Good Quality Product	60 %	
OHS	Exposure to dust		FCBTK has poor OHS conditions and it is a major shortcoming of this technology.
	Exposure to Thermal		
	Risk of accidents		



Unloading of fired bricks

Stacking of green brlcks

FOR MORE INFORMATION: www.gkspl.in/whats_new.html www.ecobrick.in

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9 Report on 'Occupational health and safety study (OHSS) of brick industry in the Kathmandu valley' by Department of Environmental Sciences and Engineering (DESE), Kathmandu University, Nepal

10 Ibid.

11 International Labour Standards are instruments drawn up by ILO in the form of conventions (the basic principles to be implemented) and recommendations (more detailed guidelines). Details on the standards for OHS can be found at http://www.ilo.org/global/%20standards/subjects-covered-by-international-labour-standards/occupational-safety-and-health/lang--en/index.htm. A list of all such instruments on OHS with their status is available at HYPERLINK "http://www.ilo.org/dyn/normlex/en/

ACKNOWLEDGEMENTS

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Note: In the initial stage of this initiative of developing factsheets on brick kiln technologies, factsheets are developed for South and South-East Asia and Latin America regions. Factsheets on brick kiln technologies of other regions will be developed over time.

Disclaimer: The country borders indicated on the map do not necessarily reflect the FDFA's official position. The red dotted line represents approximately the Line of actual Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

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