5 HOFFMAN KILN TECHNOLOGY

INTRODUCTION AND HISTORY[1,2]

Hoffman kiln is a continuous, moving fire kiln in which the fire is always burning and moving forward through the bricks stacked in the circular, elliptical or rectangular shaped closed circuit with arched roof. The fire movement is caused by the draught provided by a chimney or a fan.

Hoffman kiln was developed and patented by Friedrich Hoffman in Germany in the year 1858. These kilns were once widely used in Europe for bricks, ceramics and lime production. Hoffman kiln technology was introduced in India in the Malabar coastal region (south-west coast) by the German missionaries in 19th century and is still prevalent in the same region.

The original design of Hoffman kiln had a circular circuit built around a central chimney. However, this design has been modified with time and now Hoffman kilns with elliptical or rectangular shape are more in practice.

GEOGRAPHICAL DISTRIBUTION

NUMBER OF OPERATIONAL ENTERPRISES AND TOTAL PRODUCTION*

Country	Number of enterprises	Total production billion bricks/year
India[3]	~500	~2

*Numbers are estimates only

% CONTRIBUTION TO THE TOTAL BRICK PRODUCTION IN INDIA

~1%

Out of the total annual production of around 250 billion bricks in India, only around 2 billion bricks are produced by Hoffman kiln technology

ABOUT THE KILN

Kiln

CONTINUOUS MOVING FIRE

ENTERPRISES USING THIS TECHNOLOGY

Nature of enterprise

INDUSTRIAL

Level of mechanization

SEMI MECHANIZED

Brick produced

SOLID & HOLLOW

Production capacity

MEDIUM
Between
1-10 million bricks

Operational season

PERENNIAL

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DESCRIPTION AND WORKING

1

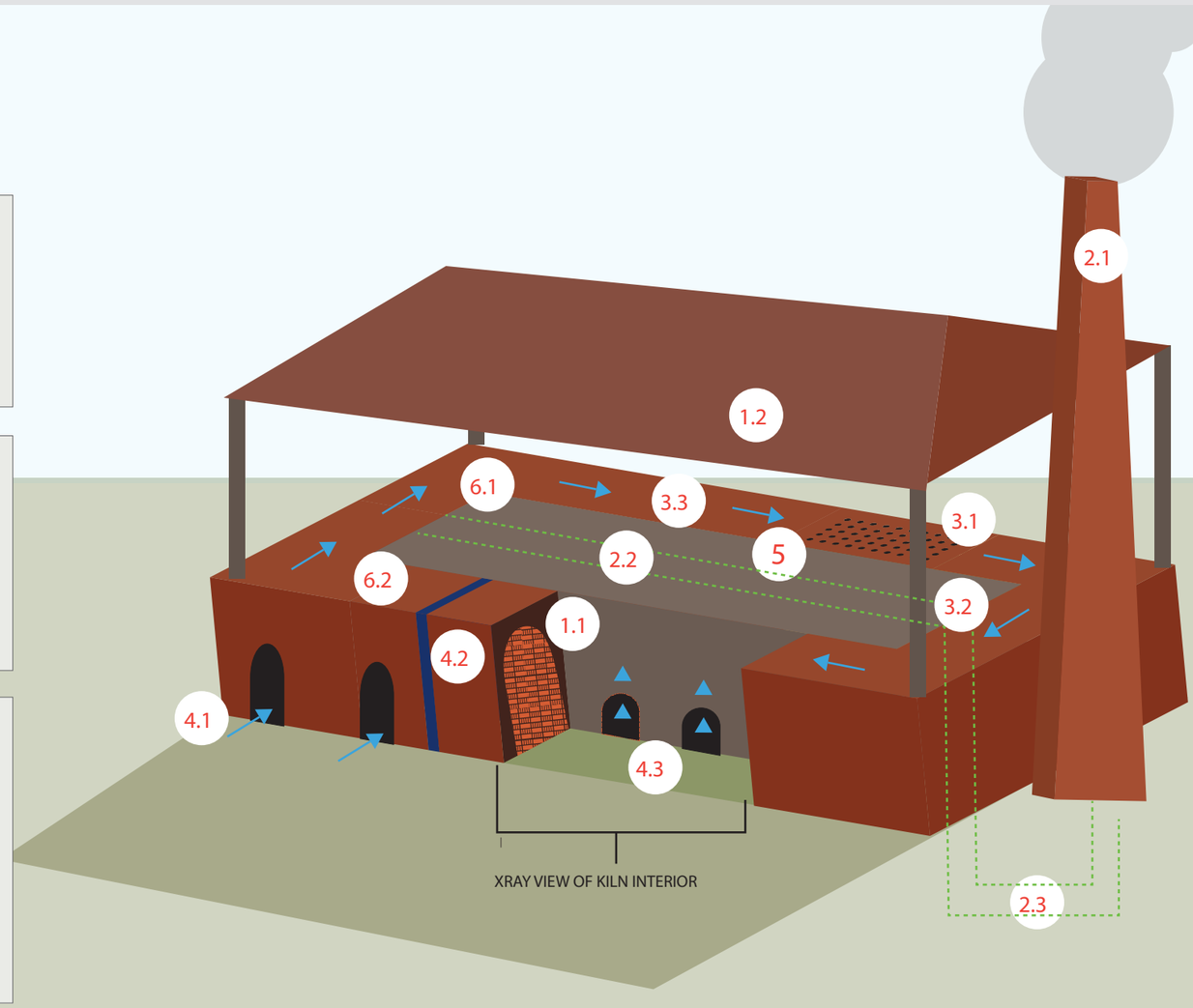
In a Hoffman kiln, the fire moves through the bricks stacked in an elliptical or rectangular shaped annular circuit (central perimeter 80 – 90 m) which is covered with an arched roof (1.1). The kiln structure is usually covered with a shade (1.2) to protect it from rains.

2

The fire movement is caused by the draught provided by a chimney (2.1) (25 – 35 m high) which is located on one side of the kiln. Sometimes a fan is also used to augment the draught. The chimney is connected to the central flue duct (2.2) of the kiln through an underground duct (2.3).

3

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



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4.1 Air Inlet: Air enters into the kiln from the back end of the cooling zone which is kept open to allow air entrance.
4.2 Seal to guide flue gas: The front end of the preheating zone is sealed to guide the flue gas to the chimney through the flue gas duct system.
4.3 The kiln is connected to the central flue duct through openings provided in the inner wall of the kiln. Openings just before the seal are kept open to allow entrance of flue gases from the kiln to the central flue duct.

5

Feed holes are provided in the kiln roof for feeding of fuels. Solid fuels (mainly firewood or coal) are fed from the feed holes by a single fireman standing on the roof of the kiln. Fuel is fed at an interval of every 15-20 minutes and each fuel feeding lasts for 5-10 minutes.

6

The fire travels a distance of around 10 m in 24 hours and fires 10,000 to 20,000 bricks. Daily, fired bricks are unloaded from the back end of the brick cooling zone (6.1) and an equivalent batch of green bricks is loaded ahead of the brick preheating zone (6.2).

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AIR EMISSIONS AND IMPACTS

MEASURED EMISSION FACTORS

g/kg of fired bricks			
CO2	Black Carbon	PM	CO
Measured values for emission factors of pollutants are not available for Hoffman kilns in India.			

MEASURED PM EMISSIONS[4]

Average: 260 mg/Nm^3

(Range: 200-315 mg/Nm^3)

EMISSION STANDARDS

Notified for PM only

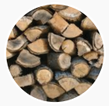
Country	PM (mg/Nm^3)
India	Emission standard has not been notified for Hoffman kilns.

COMMENTS ON EMISSIONS

Better combustion in well operated Hoffman kilns results in low particulate matter emissions.

FUELS AND ENERGY

COMMONLY USED FUELS



Biomass
(mainly firewood)

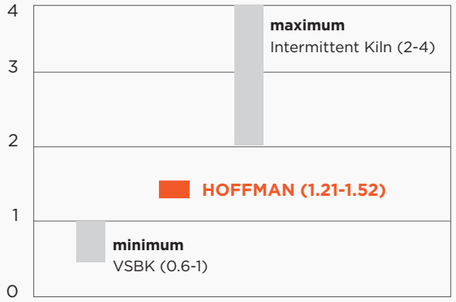
Coal

SPECIFIC ENERGY CONSUMPTION[5]

Energy consumed for firing 1 kg of fired brick

Average: 1.36 MJ/kg of fired bricks
(Range: 1.21 – 1.52MJ/kg of fired brick)

MJ/kg of fired brick



Note: Measured at firing temperature of 650-800°C

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

MAIN CAUSES FOR HEAT LOSS

The main sources of heat loss in a Hoffman kiln are the heat losses in the flue gases, fired bricks and high thermal mass of the kiln structure.

FINANCIAL PERFORMANCE

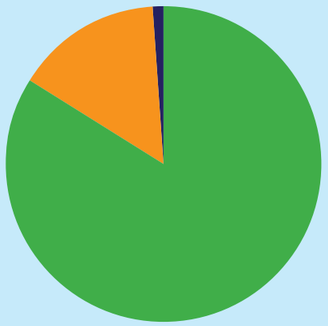
Capital cost of kiln technology

For annual production capacity of 3 – 6 million bricks, excluding land and working capital cost

100,000 to 150,000 USD

Capital cost breakdown

Construction Material	82 %
Labour	15%
Equipment	3%



Production capacity	10,000 to 20,000 bricks per day	
Brick size	230 mm x 115 mm x 75 mm	
Number of Operators required	15-20	
Payback Period	Simple Payback	0.8 – 1.1 years
	Discounted Payback (@ 6.5%)	0.9 – 1.2 years

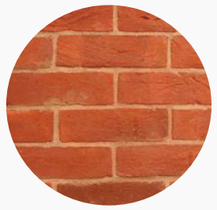
PRODUCT QUALITY

Product Quality
As per the local market perception

Better heat distribution and lower heat losses from kiln walls and roof result in uniform temperature across the kiln cross section in the firing zone thereby resulting in higher percentage of good quality bricks.

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

GOOD BRICK



INFERIOR BRICK
under-fired and over- burnt

OCCUPATIONAL HEALTH AND SAFETY

Exposure to Respirable Suspended Particulate Matter[6]
The concentration of air pollutants in the surrounding environment of a Hoffman kiln is quite low. However, the workers unloading the bricks are exposed to high concentration of dust because of ash of burned fuel.

The workers unloading the bricks have the risk of developing respiratory tract infections and cardio vascular diseases.

Exposure to Thermal Stress[7]
Workers unloading the bricks from the kiln are exposed to high temperature due to radiation from the hot kiln structure.

The workers unloading the bricks bear high thermal stress and the risk of consequent diseases and dehydration.

Risk of accidents
In a properly constructed Hoffman kiln, the risk of accidents is low.

Low risk of injuries to workers.

Compliance with ILO standards and remarks on migratory labour and conditions of labour
Practices followed at Hoffman kiln enterprises do not always comply with the International Labour Standards on occupational health and safety drawn up by ILO.[8]

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CONCLUSION

Performance of Hoffman kiln is compared with the most commonly used continuous kiln technology in the region which is FCBTK.

PARAMETERS		HOFFMAN KILN	FCBTK	COMMENTS
AIR EMISSION (g/kg fired brick)	CO_2	NA	131	NA
	Black Carbon	NA	0.13	
	PM	NA	1.18	
	CO	NA	2.0	
FUEL & ENERGY	SEC (MJ/kg fired brick)	1.36	1.30	The working principles of Hoffman kiln and FCBTK are similar and hence fuel consumption is comparable. In a FCBTK, heat loss from the kiln surfaces is prominent while in case of a Hoffman kiln, heat loss due to the thermal mass of the kiln structure is prominent.
FINANCIAL PERFORMANCE	Capital Cost (USD)	100,000-150,000	50,000-80,000	Hoffman kiln has a permanent roof and shade, hence the capital cost of setting up a Hoffman kiln is almost twice as much as FCBTK of similar annual production capacity. Hoffman kilns are usually used for the production of value added products like good quality solid bricks, hollow bricks, roofing tiles, etc. and the payback period of Hoffman kiln is comparable to FCBTK.
	Production Capacity	3-6 million bricks/year	3-8 million bricks/year	
	Simple Payback	0.8 - 1.1 years	0.4 - 1.1 years	
PRODUCT QUALITY	Types of product	All types of products	All types of products	Both the kiln technologies are suitable for firing all types of product. However, the quality of bricks fired in a Hoffman kiln is better as compared to those from FCBTKs. Also while a Hoffman kiln can be used exclusively for production of roofing tiles and hollow bricks, in an FCBTK such exclusive production is not possible.
	Good Quality Product	85 %	60 %	
OHS	Exposure to dust			Hoffman kiln enterprise offers better OHS conditions as compared to a FCBTK enterprise.
	Exposure to Thermal			
	Risk of accidents			

REFERENCES

1 Report on 'Small-scale brick making' published by International Labour Office, Switzerland, 1984. http://www.pssurvival.com/ps/bricks/Small-Scale_Brickmaking_1984.pdf

2 World Bank Report on 'Introducing Energy-efficient Clean Technologies in the Brick Sector of Bangladesh', 2011 available at https://openknowledge.worldbank.org/bitstream/handle/10986/2797/601550ESW0P1110e00201100Color0FINAL.pdf

3 Presentation by Punjab State Council for Science and Technology, India on the findings of the study on "Revision of Comprehensive Industry Document for Brick Kilns".

4 Ibid.

5 Ibid.

6 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

7 Ibid.

8 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 http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12030:0::NO:::#Occupational_safety_and_health

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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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