BRICK MANUFACTURING: AN OVERVIEW OF TECHNOLOGIES

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Fired-Clay Bricks Production Process
KILN CLASSIFICATION

Brick Kilns

Intermittent Kilns
- Intermittent kilns Without Stack
  - Clamp Kiln
- Intermittent kilns With Stack
  - Down-Draught Kiln

Continuous kilns
- Moving Fire Kilns
  - FCBTK
  - Zigzag Kiln
  - Hoffman Kiln
- Moving Ware Kilns
  - Tunnel Kiln
  - VSBK
OVERVIEW OF KILNS

• Fixed Chimney Bulls Trench Kiln
• Zigzag kiln
  – Natural Draught
  – Induced Draught
• Hoffman Kiln
• Vertical Shaft Brick Kiln
• Tunnel Kiln
• Clamp Kiln
• Down-Draught kiln
**Fixed Chimney Bull’s Trench Kiln (FCBTK)**

- Produces 60-65% of the total brick production in India.
- ~ 40,000 FCBTK operational in India.
**Fixed Chimney Bulls Trench Kiln (FCBTK): Working**

- **Animation**

- Fire moves in closed oval circuit through the brick stacked in Trench.

- Operates under natural draught mode.

- Three zones:
  - Firing zone
  - Pre-heating zone
  - Cooling zone

- Solid fuel fed from the top intermittently.

- Column type brick setting.
FIXED CHIMNEY BULLS TRENCH KILN (FCBTK) : WORKING
FIXED CHIMNEY BULLS TRENCH KILN (FCBTK) : MAIN FEATURES

- Production Capacity: 20,000 – 60,000 Bricks per day.
- Product Quality:
  - Class-I bricks: 50-60%
  - Underfired, over-fired or breakages: 40-50%
- Capital Investment (excluding land cost): Rs 30-50 lakh
- High emissions of PM and gaseous pollutants.
ZIGZAG KILN  
(NATURAL AND INDUCED DRAUGHT)

- Improved version of FCBTK.
- Central Building Research Institute (CBRI) first introduced the zigzag firing technology based during early 1970s.
- 3,000 – 4,000 kilns in India.
ZIGZAG KILN: WORKING

- **Animation**

- Fire moves in closed rectangular circuit through the brick stacked in trench.

- Operates under natural or induced draught mode.

- Three zones:
  - Firing zone
  - Pre-heating zone
  - Cooling zone

- Solid fuel fed from the top continuously.

- Chamber type brick setting.
ZIGZAG KILN: WORKING
ZIGZAG KILN: WORKING

- Brick Columns
- Central Openings
- Openings Near the Side Walls
ZIGZAG KILN: WORKING
ZIGZAG KILN: MAIN FEATURES

- Production Capacity: 20,000 – 60,000 Bricks per day.
- Up to 25% less fuel consumption compared to FCBTK.
- Product Quality:
  - Class-I bricks: 80% - 90%
  - Underfired, over-fired or breakages: 10-20%
- Capital Investment (excluding land cost): Rs 30-50 lakh
- Emits 70-80% lower PM as compared to FCBTKs.
**HOFFMAN KILN**

- Hoffman kiln was developed and patented by Friedrich Hoffman in Germany in the year 1858.
- In India, there are ~500 Hoffman kilns in operation.
The Hoffman Kiln: Working

- Fire moves in a closed rectangular circuit through the brick stacked in the annular space.
- Three zones:
  - Firing zone
  - Pre-heating zone
  - Cooling zone
- Operates under natural or induced draught mode.
- Solid fuel fed from the top intermittently.
Hoffman Kiln: Working
Hoffman Kiln: Working
**Hoffman Kiln: Main Features**

- Production Capacity: 10,000 - 20,000 bricks per day.
- The cost of setting up a Hoffman kiln is around 60 - 90 lakh.
- Can be operated all year around with a flexibility in production capacity.
- Suitable for any type of green bricks or tiles.
- Around 80% of the total bricks produced are of good quality.
- Relatively higher energy consumption because of high thermal mass.
**Vertical Shaft Brick Kiln (VSBK)**

- Developed in rural Chins during late 1960s and early 1970s.
- About 110 kilns installed in India.
**Vertical Shaft Brick Kiln (VSBK): Working**

**Animation**

- Shaft के ऊपरी हिस्से में दो चिमनियाँ लगी होती हैं जिनसे जली हुई गैसें बाहर निकलती हैं।

- शाफ्ट में कच्ची ईंटों की भराई शाफ्ट के ऊपरी हिस्से में की जाती है। ईंटों को पकाने के लिए आवश्यक ईंधन को भी कच्ची ईंटों के साथ ही भरा जाता है।

- शाफ्ट में ईंटों को पकाने के लिए धीरे धीरे निचे लाया जाता है। शाफ्ट के मध्य भाग में आग जल रही होती है जहां ईंटों की पकाई होती है।

- पकी हुई ईंटों को शाफ्ट के निचले हिस्से से जैक की सहायता से निकाला जाता है।

- ईंटों की पकाई के लिए आवश्यक हवा शाफ्ट में निचे से प्रवेश करती है एवं शाफ्ट में हवा का प्रवाह निचे से ऊपर की तरफ होता है।
LOADING OF BRICKS
**FUEL FEEDING**

- Additional fuel is loaded along with the bricks from top of the shaft
**Vertical Shaft Brick Kiln (VSBK): Main Features**

- Production Capacity: 5,000 – 30,000 bricks per day.
  - 4,000-5,000 bricks per day per shaft
- Consumes 30-40% less fuel as compared to FCBTK
- Requires less space area to setup as compared to other brick kilns.
- Capital Investment (excluding land cost): Rs 15-50 lakh
- Impact on product quality because of fast firing process
- Requires conveyor/lift (and electricity) for lifting of bricks to the top.
- Emits ~80% lower PM as compared to FCBTK.
TUNNEL KILN

- Hot air to dryer
- Fuel
- Flue gas to chimney

Unloaded Fired Brick

Firing zone

Trolley Car Movement

Green Bricks for Loading
TUNNEL KILN

- Developed around mid-19th century in Germany.
- In India, there are very few (~5) tunnel brick kiln units.
Tunnel Kiln: Working
TUNNEL KILN: WORKING

GREEN WARES AT KILN INLET

FINISHED PRODUCTS AT KILN OUTLET
TUNNEL KILN: MAIN FEATURES

- Production Capacity: 50,000 – 2,00,000 bricks per day.
- The cost of setting up a tunnel kiln is around Rs 4 - 10 crore.
- Can be operated all year around with a flexibility in production capacity.
- Suitable for any type of green bricks or tiles.
- Around 100% good quality (properly fired) products.
- Significantly less pollutant emission.
- Hollow blocks and any other type of bricks/block/tile can be produced.
CLAMP KILN

- The clamp is the most basic type of kiln since no permanent kiln structure is built.
- It consists essentially of a pile of green bricks interspersed with combustible material.
CLAMP KILN: WORKING

Coal fired clamp
CLAMP KILN: WORKING

Wood fired clamp

Rice husk fired clamp
CLAMP KILN: MAIN FEATURES

- Production Capacity: 10,000 - 200,000 bricks per batch.
- Types of Products:
  - Solid bricks
- Around 50-60% of the total bricks produced are of good quality.
- Suitable for solid fuels like coal and biomass.
- Concentration of air pollutants is very high around clamps.
- Larger clamps are relatively more energy efficient.
Down draught kilns
DOWN DRAUGHT KILNS – WORKING
DOWN DRAUGHT KILNS

• Key aspects
  – Relatively higher investment than clamps due to permanent kiln structure
  – Suitable for small to medium scale batch production
  – Can be used for year round production
  – Capital Investment (excluding land cost): Rs 14-20 lakh
  – Production capacity: 20,000 – 40,000 bricks per batch.
  – Good quality products: 85%
  – Type of products: All types
  – Quality of fired bricks better than clamp.
  – High sensible heat losses because of higher thermal mass of the kiln
  – Relatively better and homogeneous brick quality as compared to clamps because of uniform temperature distribution
**Energy Consumption – Firing Technologies**

- **Specific Energy Consumption (MJ/kg fired brick)**

![Graph showing energy consumption for different firing technologies.](image)

**Conventional**
- Clamps
- FCBTK

**Alternate**
- VSBK
- Zigzag HD
- Zigzag ND
- Tunnel

Source: Energy utilization in brick kilns, Sameer Maithel, PhD thesis, IIT Bombay,
ENVIRONMENT PERFORMANCE

- Suspended Particulate Matter* (g/kg fired brick)

* Preliminary Results based on monitoring by GKSPL, Enzen & Entec
### Comparison of Brick Kiln Technologies

<table>
<thead>
<tr>
<th>Energy Consumption</th>
<th>Environment Emissions</th>
<th>Product Quality</th>
<th>Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSBK</td>
<td>VSBK/Tunnel</td>
<td>Tunnel</td>
<td>Zigzag</td>
</tr>
<tr>
<td>Zigzag Kiln</td>
<td>Zigzag Kiln</td>
<td>Zigzag Kiln</td>
<td>FCBTK</td>
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<tr>
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<td>FCBTK/VSBK</td>
<td>VSBK/Tunnel</td>
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</tbody>
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**Conversion from FCBTK to Zigzag will move the industry one step ahead**
THANK YOU !!!

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