INITIATIVES BRIKCS

DOWN DRAUGHT KILN (DDK)

FACTSHEETS ABOUT BRICK KILNS IN SOUTH AND SOUTH-EAST ASIA
INTRODUCTION AND HISTORY

The down draught kiln is an intermittent kiln in which the bricks are fired in batches. In this kiln, the hot gases from the burning fuel are first deflected to the roof of the kiln and then are drawn downwards by the chimney draught through the green bricks to fire them.

Till the end of 18th century, bricks were almost exclusively fired in freely stacked heaps of clamp kilns. However, in early 19th century, various technological modifications were tried aimed at improving the product quality and energy efficiency of the kilns. In the process, first up draught and then the down draught kilns were developed.

One of the advantages of this kiln is that the fuel and fuel residue do not come into contact with the kiln charge and therefore no pollutants are deposited on the surface of the products.

GEOGRAPHICAL DISTRIBUTION

About the Kiln

<table>
<thead>
<tr>
<th>Kiln</th>
<th>Nature of enterprise</th>
<th>Level of mechanization</th>
<th>Brick produced</th>
<th>Production capacity</th>
<th>Operational season</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERMITTENT</td>
<td>INDUSTRIAL</td>
<td>MANUAL</td>
<td>SOLID</td>
<td>SMALL Between 0.5-1 million bricks</td>
<td>DRY SEASON</td>
</tr>
</tbody>
</table>

Enterprises using this Technology

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of enterprises</th>
<th>Total production billion bricks/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>India²</td>
<td>~300</td>
<td>~0.24</td>
</tr>
</tbody>
</table>

% Contribution to the total brick production in India

~1%

Out of the total annual production of around 250 billion bricks in India, only around 0.24 billion bricks are produced by Hoffman kiln technology.
Down draught kiln (DDK) is an intermittent kiln in which bricks are fired in batches. It consists of a firing chamber/kiln (1.1) connected with a chimney (1.2) through an underground flue duct (1.3). Fireboxes (1.4) are provided at the bottom of the chamber on both sides where burning of fuel takes place. The kiln structure is permanently built with fired bricks and the inner surface of the kiln is constructed with refractory bricks.

The bricks stacked in the chamber/kiln are not in direct contact with the flames. The hot gasses from the burning fuel are deflected to the roof of the kiln (3.1). They are then drawn downwards by the chimney draught through the green bricks to fire them (3.2).

Fuel (usually firewood, twigs and branches) are fed in the fire-boxes by a single fireman. The fuel feeding is continued for around 30 hours. Afterwards the fireboxes are shut off and it is left for cooling for 2-3 days. The total time required for a batch from loading & firing of green bricks to cooling and unloading of fired bricks is around 7 - 10 days.

There is uniform heat distribution in a DDK and therefore, the percentage of good quality products is high.

DDK has limited heat recovery feature. During firing, the kiln structure also gets heated up along with the bricks and while cooling, the heat contained in the bricks and kiln structure lost into the atmosphere.

Usually 2 chambers are connected to a single chimney and are fired alternately. In some cases there are 4 chambers also connected to a single chimney. Each chamber has a capacity of firing 20,000 - 40,000 bricks in a batch.
FACTSHEETS ABOUT BRICK KILNS IN SOUTH AND SOUTH-EAST ASIA

DOWN DRAUGHT KILN (DDK)

AIR EMISSIONS AND IMPACTS

FUELS AND ENERGY

FINANCIAL PERFORMANCE

PRODUCT QUALITY

OCCUPATIONAL HEALTH AND SAFETY

MEASURED EMISSION FACTORS

<table>
<thead>
<tr>
<th>g/kg of fired bricks</th>
<th>CO2</th>
<th>Black Carbon</th>
<th>PM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>282.4</td>
<td>0.29</td>
<td>1.56</td>
<td>5.78</td>
</tr>
</tbody>
</table>

As emission factors are measured for only one kiln, range of values for emission factors is not available.

MEASURED PM EMISSIONS

Average: 531 mg/Nm³

(RE: 240-1088 mg/Nm³)

EMISSION STANDARDS

Notified for PM only

China (PM (mg/Nm³))

India 1200

COMMENTS ON EMISSIONS

Incomplete combustion in a down draught kiln results in high emission of air pollutants.

SOLID BRICKS

Beware of incomplete combustion and limited heat recovery features, down draught kilns are inefficient.

SPECIFIC ENERGY CONSUMPTION

Energy consumed for firing 1 kg of fired brick

Average: 2.97 MJ/kg of fired bricks

(Range: 2.80 – 3.14 MJ/kg of fired brick)

MAIN CAUSES FOR HEAT LOSS

The main sources of heat loss in a down draught kiln are incomplete combustion and the heat losses from the kiln structure, hot-fired bricks and flue gases.

INFERIOR ~ 10%

LOSSES & BREAKAGES ~ 5%

GOOD ~ 85%

BETTER DISTRIBUTION IN THE KILN RESULT IN UNIFORM TEMPERATURE ACROSS THE KILN CROSS-SECTION. THIS RESULTS IN UNIFORM QUALITY OF BRICKS ACROSS THE KILN CROSS-SECTION.

INFERIOR BRICK

UNDER-FIRED AND OVER-BURNT

GOOD BRICK

EXPOSURE TO RESPIRABLE SUSPENDED PARTICULATE MATTER

Firemen feeding fuel and cleaning the fireboxes (removal of ashes) are exposed to high concentration of air pollutants.

FIREMEN HAVE THE RISK OF DEVELOPING RESPIRATORY TRACT INFECTIONS AND CARDIOVASCULAR DISEASES.

EXPOSURE TO THERMAL STRESS

In a down draught kiln, the fuel is fed through fireboxes which remain open during the entire duration of fuel feeding. The firemen are thus directly exposed to the flames.

THE FIREMEN BEAR SIGNIFICANT THERMAL STRESS AND RISK OF CONSEQUENT DISEASES AND DEHYDRATION.

RISK OF ACCIDENTS

In a down draught 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 down draught kiln enterprises are not always complied with the International Labour Standards on occupational health and safety drawn up by ILO.
**CONCLUSION**

Performance of down draught kiln is compared with the most commonly used intermittent kiln technology in the region which is clamps.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>DOWN DRAFT KILN</th>
<th>CLAMPS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AIR EMISSION</strong> (g/kg FIRED BRICK)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>282.4</td>
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<td>NA</td>
<td></td>
</tr>
</tbody>
</table>
| **FUEL & ENERGY**  
(SEC (MJ/kg fired brick)) |                 |        |          |
|                                  | 2.97            | 2.1    |          |
| **FINANCIAL PERFORMANCE** |                 |        |          |
| Capital Cost (USD)                | 20,000 – 30,000 | NA     |          |
| Production Capacity               | 20,000 – 40,000 bricks/batch | 10,000 – 200,000 bricks/batch |          |
| Simple Payback                    | -1.0 years      | NA     |          |
| **PRODUCT QUALITY**               |                 |        |          |
| Types of product                  | All types of products | Only solid products |          |
| Good Quality Product              | 85 %            | -50 %  |          |
| **OHS**                           |                 |        |          |
| Exposure to dust                  |                 |        |          |
| Exposure to Thermal               |                 |        |          |
| Risk of accidents                 |                 |        |          |

Though the SEC of down draught kiln is higher compared to clamps, the quality of fired bricks in a down draught kiln is usually better compared to clamps.

As the clamps do not have a kiln structure, no capital cost is considered for setting up of a clamp.

All types of products can be fired in a down draught kiln while only solid bricks can be fired in a clamp.

Down draught kiln offers better OHS conditions as compared to clamp kilns.

### ACKNOWLEDGEMENT

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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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### REFERENCES

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5. Ibid. 3
6. Ibid. 3
7. 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
8. Ibid.