



# THE UK CLAY BRICKMAKING PROCESS

<b>Contents</b>	<b>Page</b>
INTRODUCTION	3
PROCESS OVERVIEW	4
RAW MATERIALS	5
CLAY PREPARATION	6
FORMING METHODS	7 - 9
COLOURS & TEXTURES	10
DRYING	11
KILNS & FIRING	12
PACKING & DISTRIBUTION	17
PRODUCT QUALITY & COMPLIANCE	19



# INTRODUCTION

Clay bricks have featured as a construction product for thousands of years with evidence of their use dating as far back as the time of the Roman Empire. It is a material prevalent across the UK's built environment today and continues to be a fundamental ingredient in modern architecture.

Hampton Court Palace, shown in the image to the right, is an example of clay brick's longevity, standing for over 300 years.

Bricks are a versatile and sustainable building material, which when combined with good building-design, provide the following benefits:

1. Highly durable
2. Offer long-term performance
3. Low maintenance
4. High thermal mass
5. Reusable & recyclable
6. Provide healthy and comfortable environments



Hampton Court Palace

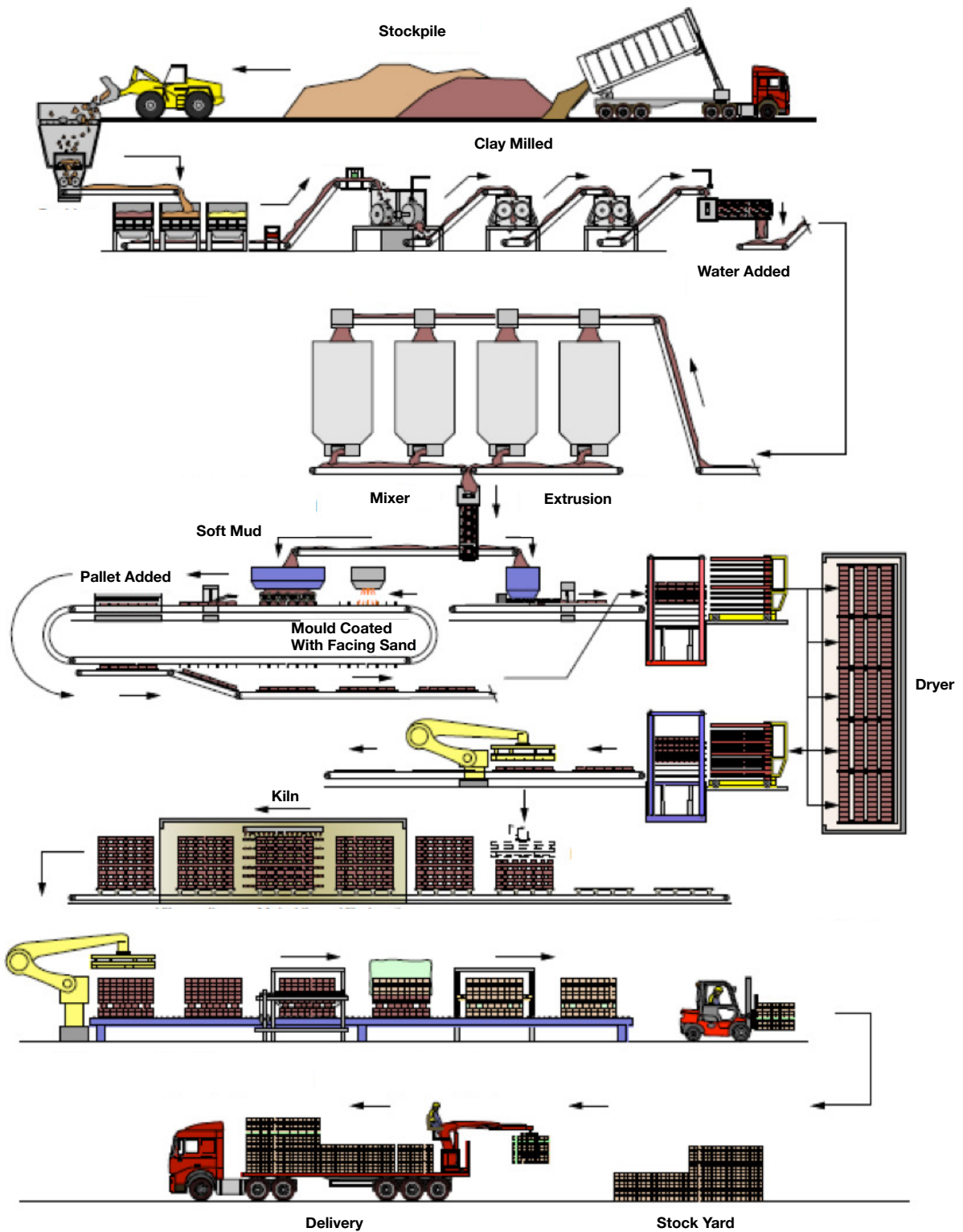
This document has been produced to provide an insight into the various processes and methods employed by the UK Brick Industry in the manufacture of clay bricks.

The manufacturing process can be broken down into various key stages which are shown in the illustration on the next page.



St Pancras

### Brick Making Process Overview



# RAW MATERIALS

The majority of brickworks are located in close proximity to a quarry, although many also source clay variations from other quarries to facilitate the production of a wide range of colours and technical characteristics.



**A Clay Quarry**

The equipment used to extract (or win) clay varies depending on the type of clay being won. Hydraulic excavators are the machines most commonly used and are generally operated in combination with dump trucks.

Clay is then taken to a stockpile where it is tipped and leveled with a bulldozer. It is usual practice to layer a stockpile with different types of clay won from different parts of the quarry to ensure consistency.



**Layered Stockpile**

It is also possible to add materials from alternative recycled and secondary sources.

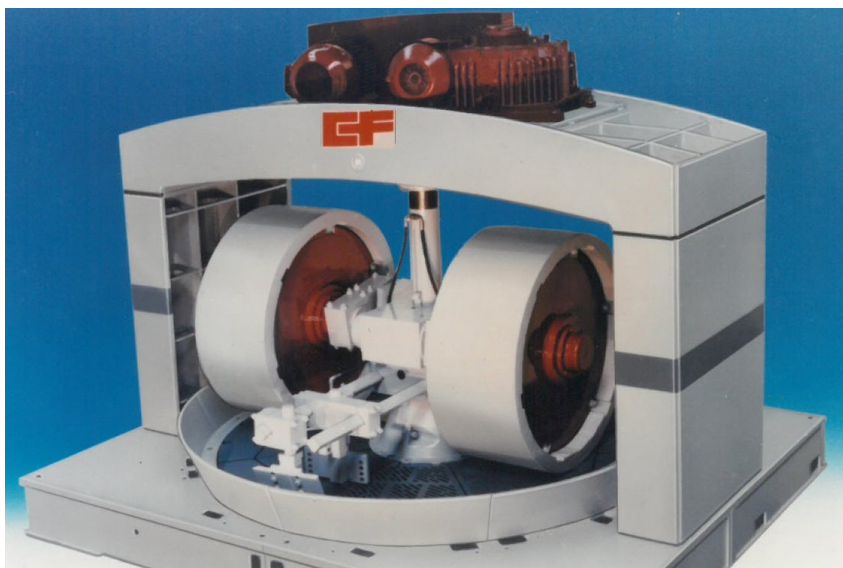
There are a wide variety of clay deposits in the UK, which contribute to the extensive range of brick types and colours seen across the British Isles. Clays used for brickmaking typically contain clay mineral, fillers and fluxes.

The same clays will almost certainly contain high levels of impurities such as carbonaceous matter, iron compounds, carbonates and sulphates.

## CLAY PREPARATION

In order to achieve the correct consistency for the brick forming process, appropriate preparation of the clay is essential. The raw material must be transformed from what can be a very hard unyielding state, into a plastic mouldable material. There are different methods for achieving this workable level.

A primary crusher such as a rotary crusher will initially break down large lumps of rock into a manageable size, (100-200mm). These are fed into a secondary crusher such as a pan mill, which further reduces the size of the clay pieces. At this point, with sizes ranging between 5-15mm, water can be added in what is known as 'wet pan'. Alternatively, if a dry pan is being used then the clay is reduced to between 5mm and dust, with water added later.



Pan Mill

Further crushing takes place through pairs of high-speed rolls, which break the clay particles down to about 1-2mm.

Various additives can be added during the clay preparation stage, usually before or at the pan, to assist the manufacturing process (such as giving additional dry strength or to assist firing). Other materials are also added to influence aesthetic qualities of the brick, primarily colour.

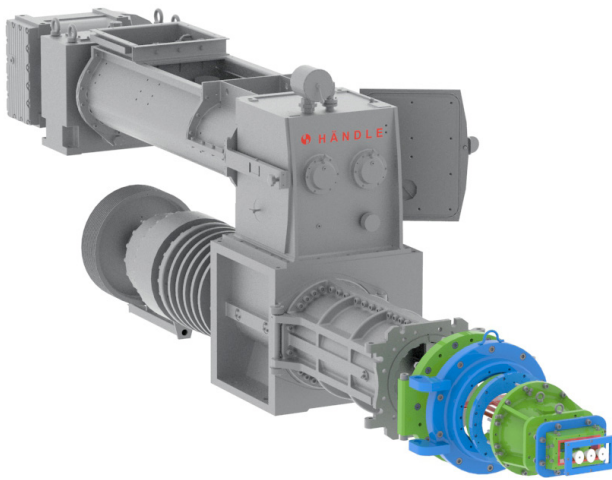
The clay is fed into a mixer in which final quantities of water are added and thoroughly mixed. Most modern mixers comprise a double shaft with attached blades or paddles, which are set at specific angles, to both mix and convey clay along a large trough.

# FORMING METHODS

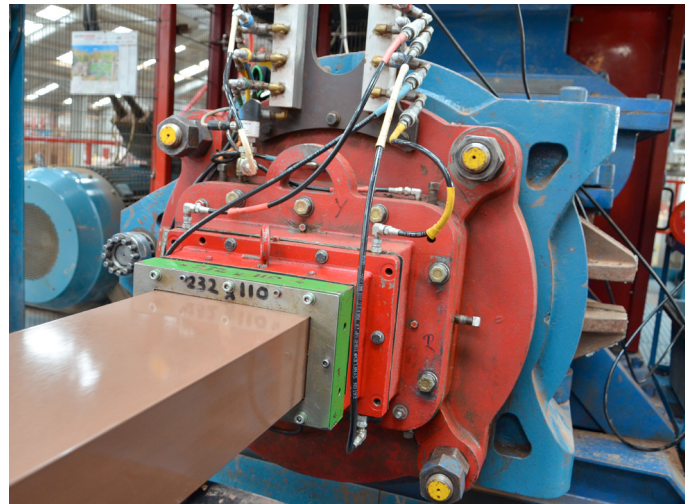
There are several methods of forming clay bricks, all of which produce a product with unique characteristics. These are described below.

## Extrusion

The clay is fed from the mixer into a vacuum chamber through which air is removed from the clay. The clay is then forced via a corkscrew shaped auger through a mouthpiece and extrusion die. The extruder is usually fitted with perforation bars, which produce the characteristic perforations seen in extruded bricks.



Extruder



Clay being extruded

The extruded column can be subjected to different processes in order to achieve the desired finish. More can be read on this subject under the 'Colours & Textures' section of this document.

Once the finishes have been applied, the column is then cut into bricks using a set of wires as shown below.

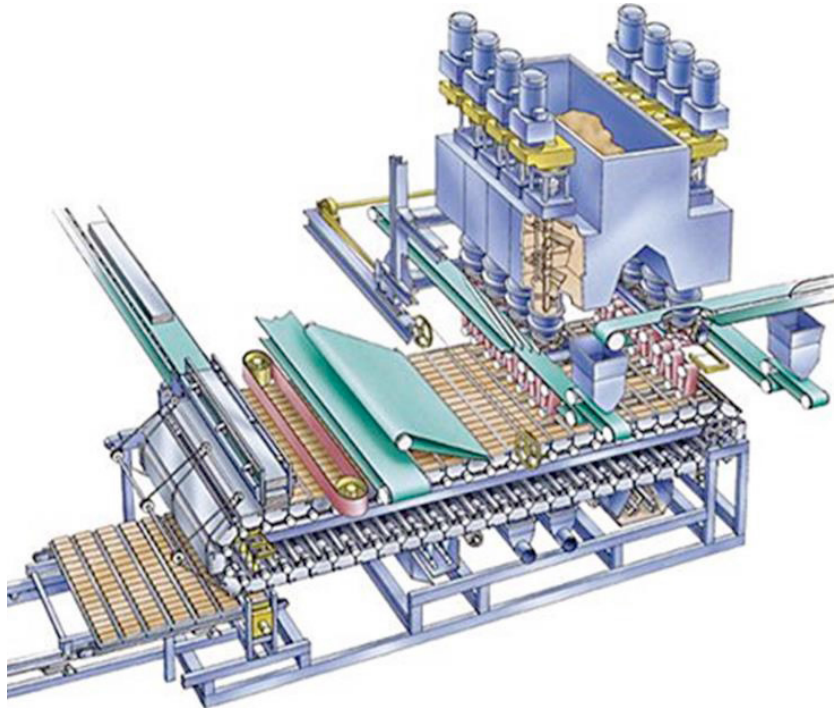


Brick Cutter

Once cut, the bricks are usually placed onto steel rails or pallets before being sent to the dryer. Some brickworks extrude a very firm column of clay which allows wet bricks to be set straight onto kiln cars before drying the entire car.

### Soft Mud

Soft mud bricks are produced with very soft clay with a high percentage of water, typically 25-30%. The clay is either 'pressed' into a sanded mould box or 'thrown' by vertically extruding small pre-sanded clots of clay, which are then accelerated downwards into the mould. Any excess material is automatically trimmed and re-used.



Hubert Brick Throwing Machine

Modern soft mud machines are capable of manufacturing in excess of 40,000 bricks per hour.



Petersen Waterstruck Press

### Waterstruck

Waterstruck bricks are made using the same principal process as soft mud. However, the releasing agent is water rather than sand, which gives a unique, traditional-looking finish.

### Semi-Dry Pressing

The semi-dry pressed method is used to produce the 'Fletton Brick', with the traditional deep square frog.

Clay is prepared using the dry pan method and fed directly into a press mould box. Here it is pressed into an initial brick shape, and re-pressed into the final shape and size.



Fletton Brick Press





Hand Moulding

## Hand Moulding

Handmaking is the oldest method of forming a brick. From the earliest times a lump of wet clay has been thrown by hand into a brick shaped mould and then turned onto a plank or pallet for drying. Clay is 'rolled' in sand before being thrown, which adds colour and texture as well as easing the release of the brick from the mould.

The process of forming and throwing the clay so that it properly fills the mould demands a high degree of accuracy. The ability to repeat this many hundreds of times a day requires endurance.

Handmade bricks maintain their place in the modern market due to their individual character and the ability to match a wide variety of sizes and shapes to complement historic brickwork.



## COLOURS & TEXTURES

The combination of different colours and textures results in a broad range of brick types. The UK brick industry produces products with varied surface textures and a rich diversity of colours, which both facilitates the creation of new innovative structures and allows credible brick-matching when working with existing builds.

The body colour is largely dependent on the clay type, however, variation can also be achieved through methods such as body staining, surface sanding, staining or altering firing conditions.

Extruded products can be left with their initially smooth finish, but may also be modified, for example, by removing a sliver from the top and sides using a taught wire to produce a 'wire-drag' effect.

Extruded and semi-dry pressed bricks can also be textured by placing textured rollers around the brick column to create a rusticated or patterned effect when impressed into the clay.

Machine made soft mud bricks have a sanded face, which as a result of the clay being dropped into the moulds, can also have a creased effect. The sand which is used as a releasing agent also greatly affects the aesthetic of the brick.

Waterstruck bricks - as a result of the use of water as the release medium - have a relatively smooth, sand free texture, which is unlike bricks made through alternate methods.

Handmade bricks have subtle creases and other natural irregularities that contribute to their individual appearance and charm.

Further possible modification of fired products includes rumbling, whereby bricks are turned over in a machine similar to a large tumble dryer. The resulting attrition removes the sharp edges by chipping and rubbing.

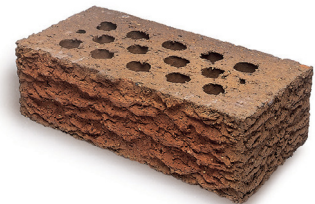
In some cases a blend of different brick types and finishes are used in the same construction in order to create a unique appearance.



**Smooth**



**Wire Drag**



**Rusticated**



**Soft Mud**



**Waterstruck**



**Handmade**

## DRYING

All clay bricks when formed contain water, this is what makes the clay plastic enough to shape. This can range from 12% for extruded bricks, to above 25% in soft mud application.

This water must be removed before the bricks can be fired. This process must be carefully controlled so as not to stress the product, which could lead to distortion and cracking.

The rate at which a brick dries is controlled by adjusting temperature, humidity and air movement. A typical drying cycle starts with low temperature (around 30°C) and high humidity and ends with high temperature (up to 120°C) and low humidity. The movement of air, controlled by fans, is used to help evenly distribute the air around the product and remove saturated air.

There are various types of dryer used by UK brick manufacturers and the type chosen is influenced by clay type, making method, product type and process flow.

The chamber dryer is gradually filled with pallets of wet bricks which are supported on frames or stillages. When at capacity, the door is closed and the drying cycle begins. It usually takes between 24 and 48 hours to dry the bricks.



Tunnel Dryers differ in that the bricks are transported through the dryer on trucks or frames, the dryer is designed to create a drying profile along its length, cool at the entrance end, hot and dry towards the exit. The bricks are 'pushed' through the tunnel to the exit at the far end.



In some cases, where wet bricks are made very stiff with relatively low shrinkage and water content, the product can be set directly onto kiln cars before drying. This reduces handling.

## KILNS & FIRING

The purpose of firing is to transform the relatively weak dried clay into strong, durable bricks.

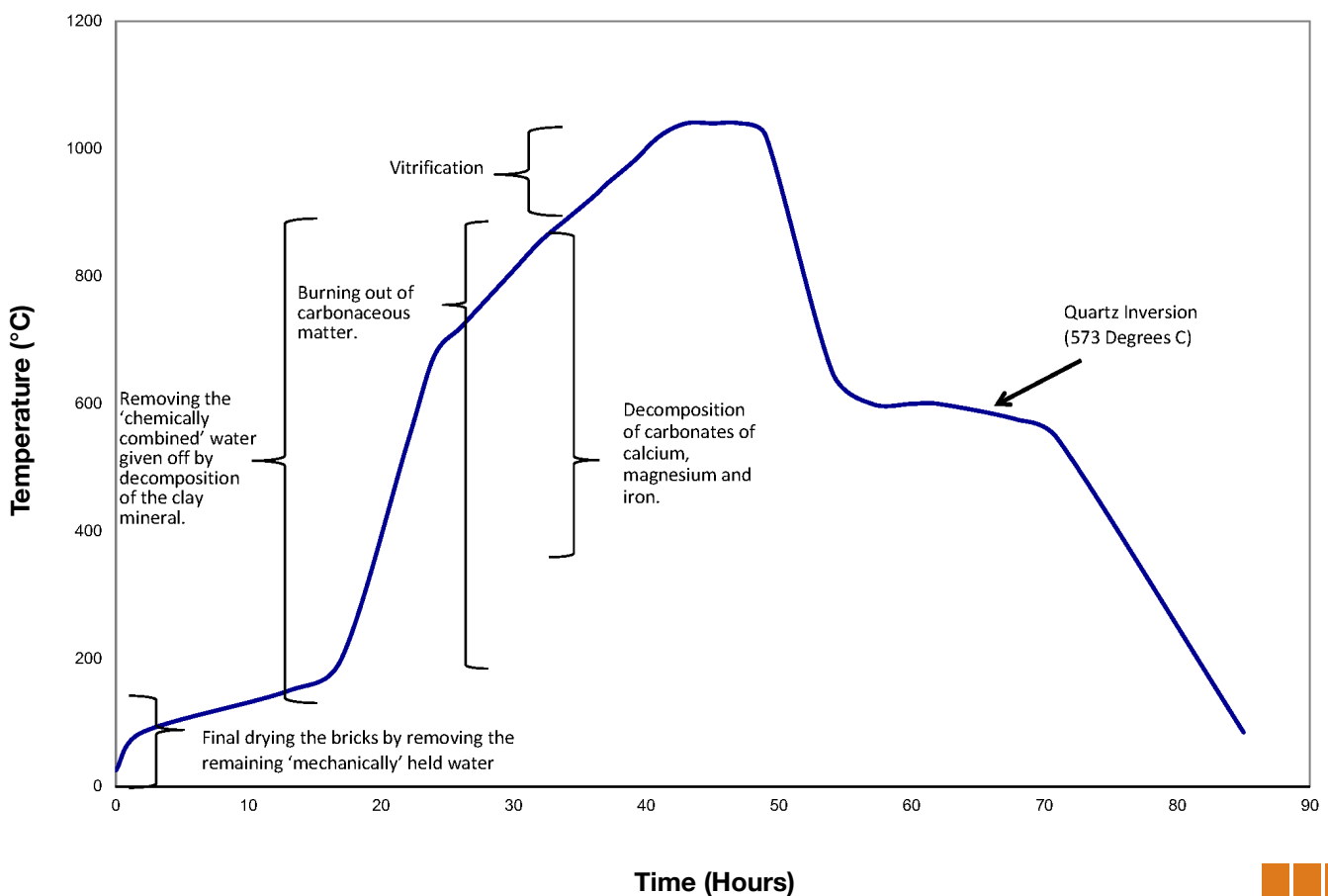
The firing of bricks is a complex subject, because of the large difference in the types of clay used, in the methods of manufacture, in the types of kiln used and in the types of products.

During the firing process reactions occur within the clay body, some of which transform the unfired body and develop the fired properties. The effects of firing on a clay body include shrinkage, weight loss, increased strength and a change in colour.

Clays differ in composition and behaviour when fired and the material's reaction is also influenced by the kiln's atmosphere.

In order to produce well-fired bricks the firing schedule, that is the time of firing and the rate at which temperature rises, must be regulated so that certain reactions have time to take place under the correct conditions at the appropriate temperatures:

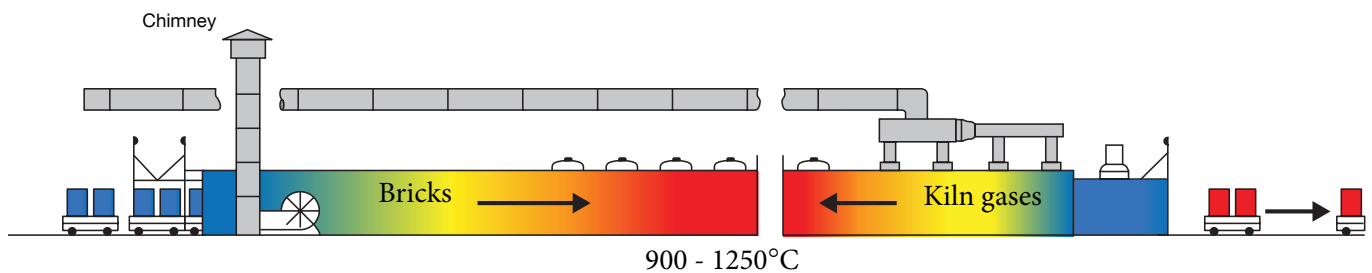
### Idealised Time-Temperature Profile (Firing Curve)



Kilns are normally fuelled with natural gas, however, it is also possible to fire brick kilns with liquefied petroleum gas (LPG), coal, and oil.

## Tunnel Kilns

Most bricks produced in the UK are fired through a tunnel kiln. In this process, the bricks are pushed into the kiln on “kiln cars” at one end and come out fired at the other. The majority of tunnel kilns are 100-200m long and are up to 3m high.



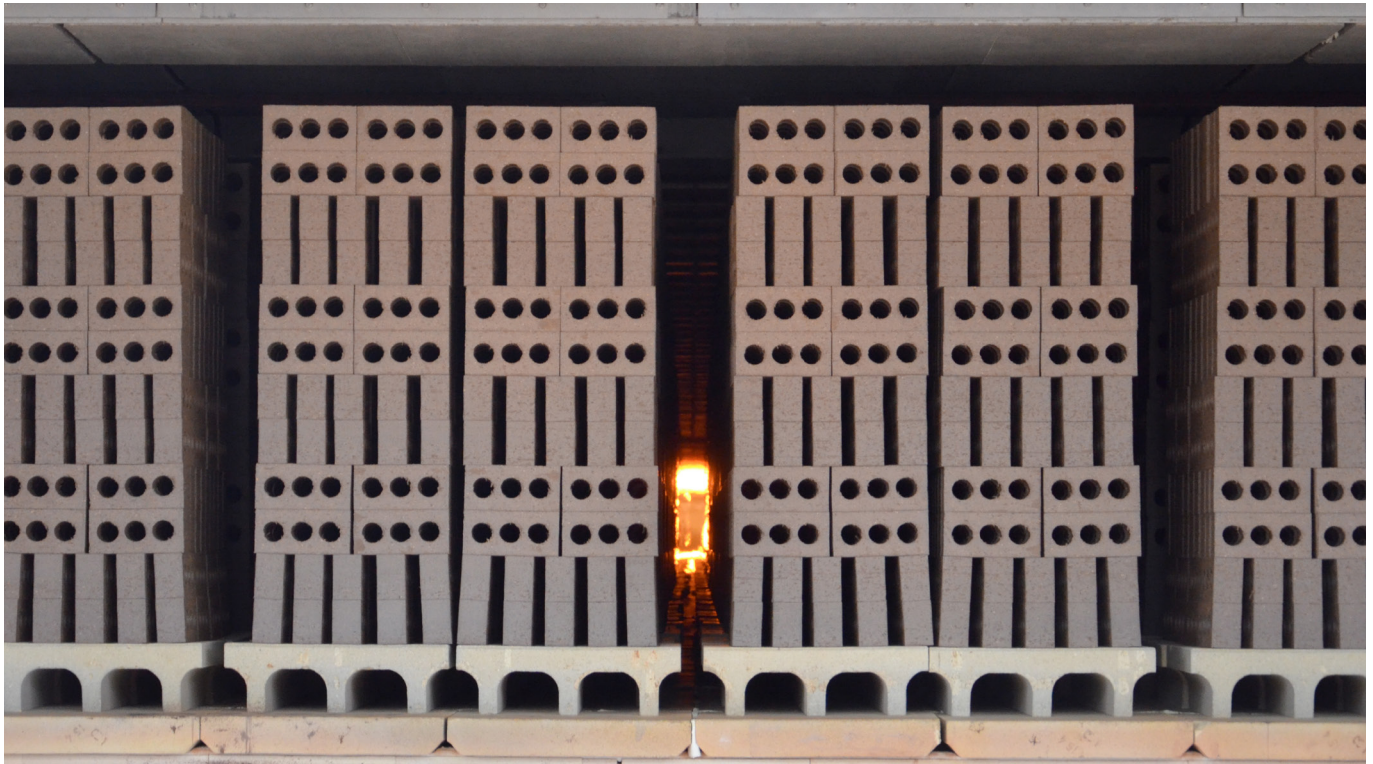
Tunnel Kiln Illustration

As the bricks progress through the kiln, they pass through zones of increasing temperature, until they reach the desired soak temperature. Hot air is pulled towards the front of the kiln which heats the bricks in the earlier stages. The bricks are then cooled with the waste heat taken from the cooling zone and fed to the driers. This makes this type of kiln highly efficient in high volume production.

Modern brick factories reuse as much energy as possible. The steel ducting pictured in the image below, takes waste hot air and recycles it to provide heat for the driers.



Top of Tunnel Kiln



Bricks Exiting Tunnel Kiln

### Intermittent Kilns

Intermittent kilns are fired on a cyclical basis, typically over a 3-5 day period. The bricks can be set onto special ceramic pallets, kiln cars, or directly onto a fixed hearth. There are various kiln designs, but essentially the kiln is sealed, usually with a door, and the burners are lit.

The firing profile, although to a different time-scale, is generally similar to that of the tunnel kiln. When the kiln has finished firing, waste heat can be ducted to supply the brick dryers with warm air.



Intermittent Kiln

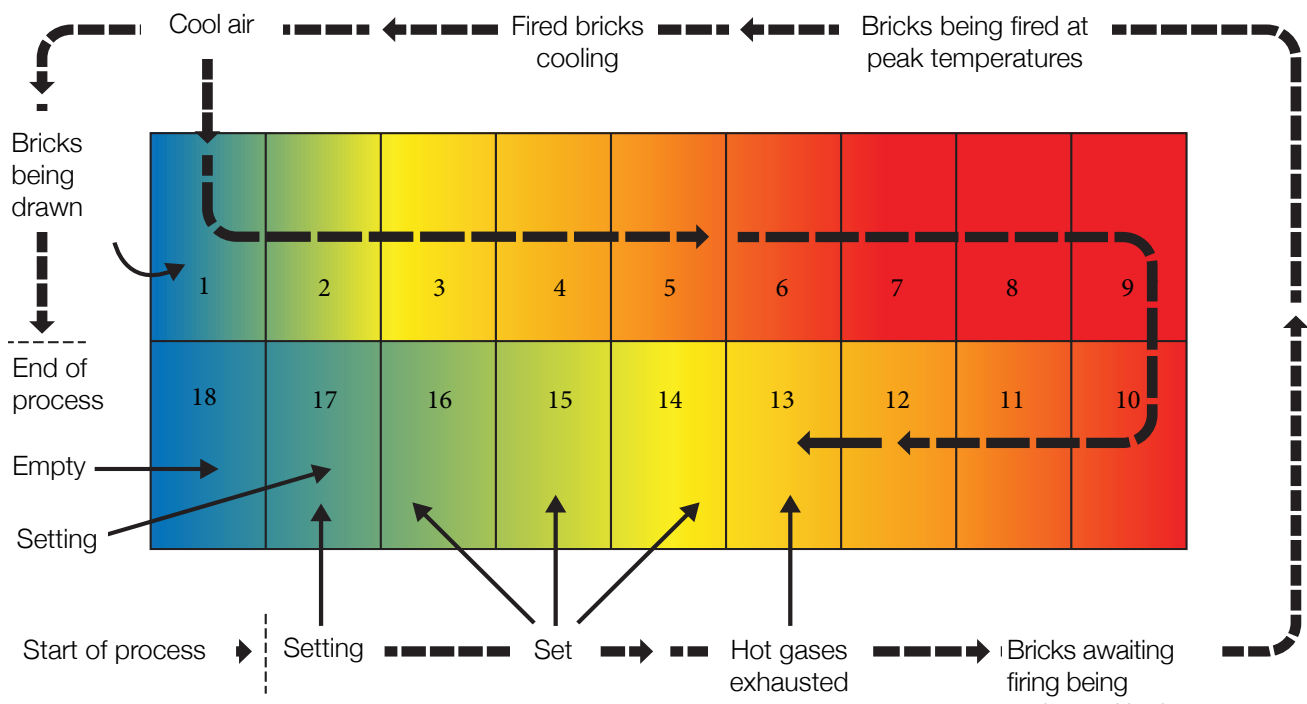
### Hoffman Kilns

The kiln comprises multiple individual chambers around which the fire travels (as shown in the diagram below). This design of kiln allows the bricks to be dried and fired within the same chamber.

The Hoffman kiln was traditionally coal fired, however, modern environmental legislation means that most Hoffman kilns in the UK are now gas fired.



Hoffman Kiln



Hoffman Kiln Process

The openings for setting and firing are known as wickets. These are generally temporary fired brick walls or prefabricated doors of lightweight concrete, insulaton, etc.

Bricks awaiting firing being preheated by hot gases from firing chambers (7, 8, 9)

## Clamp

Clamps are a traditional form of firing bricks. Unlike kilns they do not have any permanent structure. They are carefully built up of dry bricks on an earth/sand base. Coal is added to the brick clay which allows the bricks to fire fully.

Traditional clamps use a layer of solid fuel at the base and modern clamps use natural gas to assist in the start of firing. The advantages of clamps are that they do not require large, expensive kiln structures or the buildings in which to house them, and, they are capable of producing a very rich and varied coloured product that complements traditional brickwork.



Clamp Firing



# PACKAGING & DISTRIBUTION

## Sorting

The majority of bricks produced today are handled by machines (known as de-hackers) or robots, at rates of up to 200,000 bricks per shift. These machines gradually remove bricks from kiln cars and reconfigure them into packs of bricks that can be handled by forklift.



Robotic De - Hacking

During this process, sorting operatives manually inspect and remove any substandard products, usually on sorting conveyors. Different quality products are banded and packaged. Manufacturers have names for the different grade types, but as a general rule, bricks are categorised into best quality and lesser grades.

Some brickworks are configured to employ manual packers to sort the bricks, allowing for a greater degree of flexibility in product mix. These packers usually handle between seven and twenty thousand bricks per day, depending on the weight of the product being handled.

## Packing

Pack sizes and types are dependent on the brick factory, but generally range between 300-500 bricks per pack, and weigh between 1-1.5 tonnes. They are commonly stacked and strapped in a self-supporting manner and designed with forklift holes to enable transportation. They can also be palletised, shrink-wrapped, or bagged, sometimes as standard, and in some cases on request.

The brick industry uses a minimum amount of packaging on its products, and fulfils its legal obligations to recover and recycle their packaging materials.

## Distribution

Bricks are stored in the stockyard to facilitate stock rotation.



Delivery Vehicle

On being despatched from the factory, the bricks are usually loaded onto crane-equipped lorries for delivery to customers. Destinations often include builders merchants' yards, from which further deliveries take place, which could include direct delivery to housing development or commercial project sites.

Brick is a natural product, which means that colour variation is inevitable. For this reason, it is imperative that before being laid, bricks are mixed from three different packs.

# PRODUCT QUALITY & COMPLIANCE

All UK brickworks operate their own factory process control system, often supported by the ISO 9001 Quality Management System.

Quality checks are carried out at every stage of the manufacturing process, from clay winning through to despatch.

All bricks are manufactured and supplied to Clay Masonry Products standard EN771-1. This defines the specifications and technical requirements for clay bricks.

## CE Marking



Since 2013, it has been a legal requirement to CE-mark clay bricks in the UK. The CE mark should accompany all clay bricks when they are despatched, and is usually found on the product packaging, or on the delivery documentation.

CE Marking implies the existence of a Declaration of Performance related to the product. It is usual practice for manufacturers to provide the aforementioned Declaration on their websites.





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