Effect of Temperature on Drying Rate of Various Types of Bricks

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Abstract - ***This research article gives the introduction to the manufacturing process of clay bricks. Drying is one of the important steps in manufacturing of clay bricks. Drying rate is the amount of moisture removed per unit time. Value of drying rate will affect the quality of bricks, time required for drying of bricks, and amount of energy required for drying of bricks. From the actual experimentation one can observe the various factors affecting the drying rate of clay bricks. Some of them are Moisture content of the bricks, temperature of drying air and humidity of drying air. Article gives the actual experimental work carried out to find out the effect of all these factors on drying rate of various standard sizes of the bricks.***

Key Words: *Clay Bricks, Drying, Drying rate, Drying temperature, Moisture content*

1. Introduction

Bricks are one of the important building materials. Which classified based on the material used for manufacturing. Further all types of bricks can be classified depending upon the sizes of the bricks. Drying plays an important role in clay brick manufacturing process. Drying is the process which removes free moisture present in the brick. During high temperature firing of the clay bricks free moisture present in the system may cause manufacturing defects. Drying plays an important role in clay bricks manufacturing[1].

Time required for drying of Clay brick depending upon the temperature of the air and free moisture content. Thus the productivity of the brick manufacturing industry can be increased with increasing the drying temperature. Manufacturing of clay bricks includes the clay formation, molding, Drying, Firing and storage of bricks. India has per capita brick consumption nearly about 215 which is second largest in the Asia. India has higher number of brick production units than china because less productivity of the brick manufacturing units. Study and improvements in the bricks drying can help to improve the productivity of the brick manufacturing units.

2. Manufacturing Process

According to Indian standards clay bricks can be manufactured, manually (for small scale industries), Semi-mechanized or fully automated (for large scale industries). Irrespective of manufacturing type basic manufacturing process remains the same. These basic steps are explained below briefly.

Site Selection:

Site selection must follow some town planning guidelines placed by local authority. Actual consumption sites and raw material suppliers must within the economically possible transport distance.

Clay Selection:

IS 1727: 1967 will give the guidelines for the selection of clay for the manufacturing of the various types of bricks. The total lime (CaO) and magnesia (MgO) (see IS 1727: 1967) in the case of alluvial soil will be not more than one percent and in other cases shall not preferably be more than 15 percent.

Selection of Additives

Depending upon the availability and necessity various types of additives can be added in the clay. Fly ash, paddy husk, silica are some of the examples of such type of additives.

Preparation of clay

Preparation of clay contains the following three stps as Weathering, Tempering and Mixing.

Moulding

Hand-made bricks may be either ground moulded or table-moulded. A level, firm surface of ground, will be used in the former case. Typical specifications for accessories for table moulding are given in Indian standards.

Drying

Drying is the procedure of removal of free moisture present in the bricks. Free moisture present in bricks can cause manufacturing defect during the firing of the bricks. Drying may take time from one day (artificial drying) few weeks (Natural drying).

Firing

It is the high temperature procedure of moisture removal from the bricks. It provides the actual strength to bricks. Various types of firing kilns are available for the firing of the bricks. Vertical shaft brick kilns are the most efficient and eco-friendly options used now a days in the brick industry.

3 Experimental Setup

Data logger is used for temperature measurements at various points inside the drying chamber. One of temperature sensor is covered with the wet cloth to give the wet bulb temperature. 500 W heating coil is used to heat the drying chamber at require temperature.

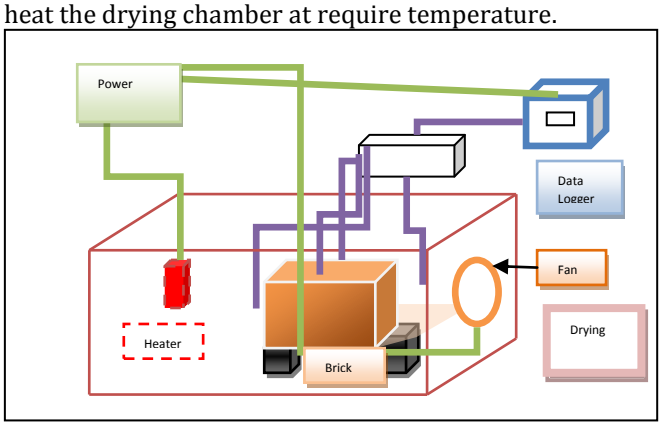


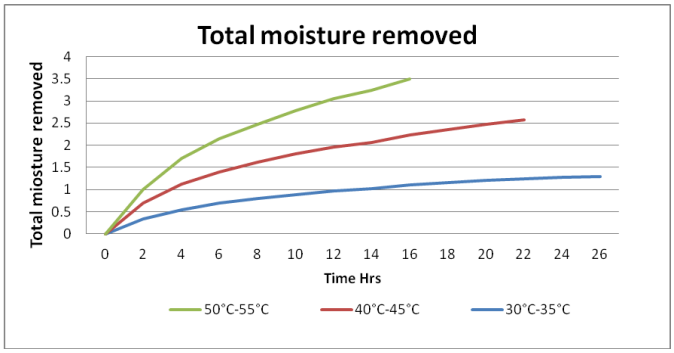
Fig. 1. Praposed Drawing of experimental setup and instrumentation

Fig. 2. Actual photograph of experimental setup and instrumentation

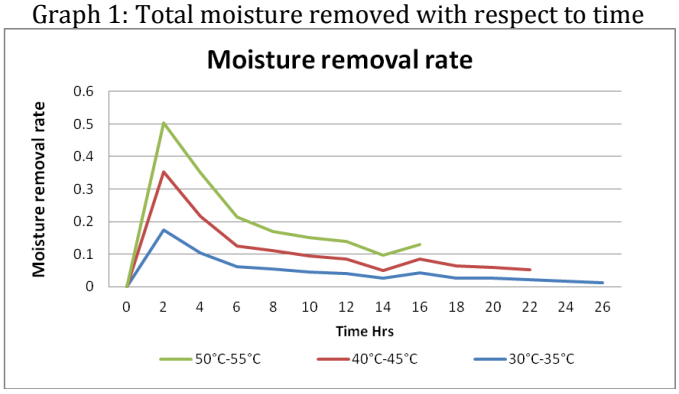
Test setups:
Experiments are carried out at three different temperature levels. At each setup proposed readings has been taken to study the drying characteristics of the brick. This three test conditions are.
Test setup 1: Temperature is maintained at 30°C -35°C
Test setup 2: Temperature is maintained at 40°C -45°C
Test setup 3: Temperature is maintained at 50°C -55°C

4 Results of the Experimentation

Graphical representation of results shows the comparison of the moisture removal rate for various drying temperature, the drying rate of the sample. This graph shows that as drying temperature increases total moisture removed within certain period will be increased. This reduces the total time required to remove the same amount of moisture content. Drying rate will increase as drying temperature increases. But for same drying temperature drying rate reduces as the time passes. This reduction is caused due reduced moisture content of the sample. These results also give the total moisture content and the percentage moisture content with respect to time. As time passes total and percentage moisture content reduces. This causes to reduce the moisture removal rate for sample. After some period the moisture content is nearly constant this point shows the time when Drying rate is very negligible.



Graph 1: Total moisture removed with respect to time



Graph 2: Moisture removal rate with respect to time at various temperatures

5. Calculation of constant drying rate[4]:

$$R_C = \frac{W_D}{A}\left[\frac{X_1 - X_2}{t_c}\right]$$

R_C = Constant drying rate
A = Area exposed to hot air
W_D = Weight of the dry solid
X_1, X_2= Initial and final moisture content kg/kg of dry basis
T_c = Time taken to dry from X_1 to X_2

For the bricks under consideration for the Study
A = 0.13 m^2

Constant drying rate for this type of bricks:

at temperature 30- 35°C

$$R_C = \frac{3.5}{0.13}\left[\frac{0.92 - 0.50}{26}\right]$$

$$R_C = 0.43\ kg/hm^2$$

at temperature 40- 45°C

$$R_C = \frac{3.5}{0.00065}\left[\frac{0.92 - 0.50}{22}\right]$$

$$R_C = 0.51\ kg/hm^2$$

at temperature 50- 55°C

$$R_C = \frac{3.5}{0.00065}\left[\frac{0.92 - 0.50}{16}\right]$$

$$R_C = 0.70\ kg/hm^2$$

From this drying time for clay bricks of various types can be calculated this is given the following table.

Table 1: Moisture Removal time for various types of bricks at various temperatures

Type of Brick	Initial Moisture content	Final Moisture content	Moisture to be removed kg	Drying Area	Drying time required (Hours)		
					35 °C	45 °C	55° C
Mod-A	0.45	0.15	1.76	0.0846	48	40	29
Mod-B	0.45	0.15	0.75	0.0756	23	19	14
NM- A	0.45	0.15	1.98	0.0982	46	39	28
NM- B	0.45	0.15	0.85	0.071	27	23	17

6. Conclusion

Low temperature drying must be carried out temperature range of 40°C - 60°C. For standard size of clay brick constant drying rate at temperatures 35°C, 45°C and 55°C are 0.54 kg/m^2-hr, 0.64 kg/m^2-hr and 0.89 kg/m^2-hr. Thus if one able to place wet bricks at 60 °C they can be dried and used for firing within 20 hours.

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