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Quality Control of an Automated Brick Manufacturing Plant

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ABSTRACT:A brick is a block made of clay burnt in a kiln. Brick manufacturing is carried out since time immemorial and used as filler materials for framework structures as well as to construct load bearing structures. It has 9 batch processes like stockpiling, transporting to plant, Grinding Section, Mixing section, Extrusion, Drying, Firing and Cooling. After completion of all these stages the final product Bricks will be Dehacked and transported to Stockyard. The software used to develop the ladder logic is Zelio soft 2 4.5.0. Actually these processes in Countries like India though have been mechanized but have not been automated fully yet and hence involves huge manpower in carrying out it manually. Additionally quality Control of the bricks can be carried out and hence at minimum investment better quality would be produced.

KEYWORDS:PLC, Ladder Logic Diagram, Zelio Soft 2 4.5.0 Software.

I. INTRODUCTION

Automation of manufacturing operations helps in increasing the production, improving the product quality, enhancing the safety of the operator, decreasing the cost of production. A Programmable Logic Controller (PLC) is nowadays key component for Industrial Automation. PLC helps in making the automation more flexible. SCADA systems became popular to arise the efficient monitoring and control of distributed remote equipment. Brick plants are one of the largest consumers of energy. The large crushing and mixing machines and oven, kilns and motors used in the production process consume a major part of electrical energy.

Based on different nature of raw materials variations in the proportions of ingredients and water added, a temperature and humidity control of kilns and ovens, timed operation of each section is required for the main areas to control and achieve efficient finished product and operation. Also the speed control of driving machines, conveyors and rollers etc., are prerequisite in modern brick plants.

The PLC is a programmable device, continuously monitors the status of input devices, processes the input data as programmed, makes decisions and modifies the outputs accordingly. Many factories use PLCs in automation processes to diminish production cost and to increase quality and reliability. PLC continuously monitors the inputs and activates the outputs according to the control program.

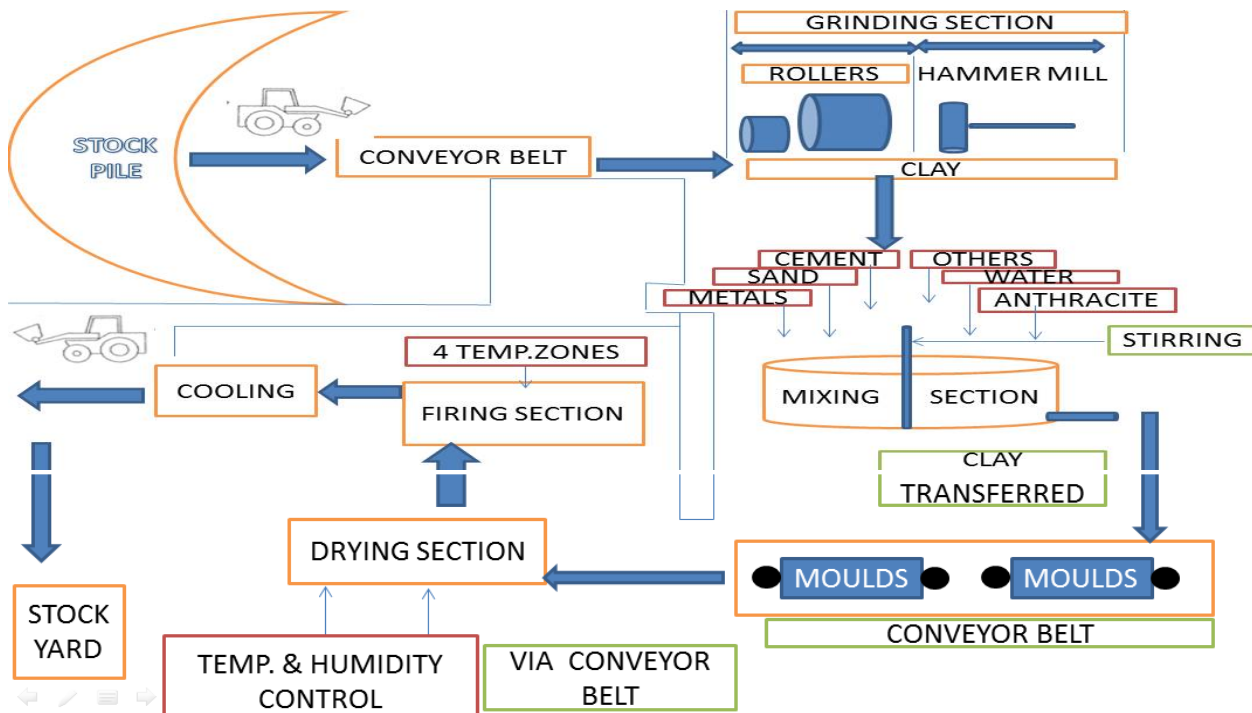
SCADA systems include operator level software applications for viewing, supervising and troubleshooting local machines and process activities.

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II. BLOCK DIAGRAM REPRESENTATION OF THE PROCESS



III. BRICKS MANUFACTURING USING PLC:

Since for production of brick, huge clay is required, which is generally brought from different areas. Hence from experience we can classify clay in terms of the duration and degree of temperature and cooling, texture of clay particles (relative hardness of particles) etc. Here in order to simulate the process we take two types of clay materials namely 'A' and 'B'. Suppose type 'A' is having small particle size hence requires less grinding and type 'B' is having relatively large particle size hence requires large grinding. Also the amount of additives and water required for each type of material is different and hence duration of treating them also varies. In drying section, the treatment of the types of clay is different based on the relative humidity of the clay and hence separate control units of the two types of clay is being designed. In Firing section, duration of each step varies depending on the type of clay.

STAGE 1

STOCKPILING:

The clay is extracted from the clay pit and stored in an open area, which is nearer to the Brick Plant. Here clay is brought from different areas and hence can be accordingly categorized in accordance with the properties. If the stocking of clay is around the periphery of a circular plot, it would ease in transporting to the factory using PLC.

STAGE 2 :

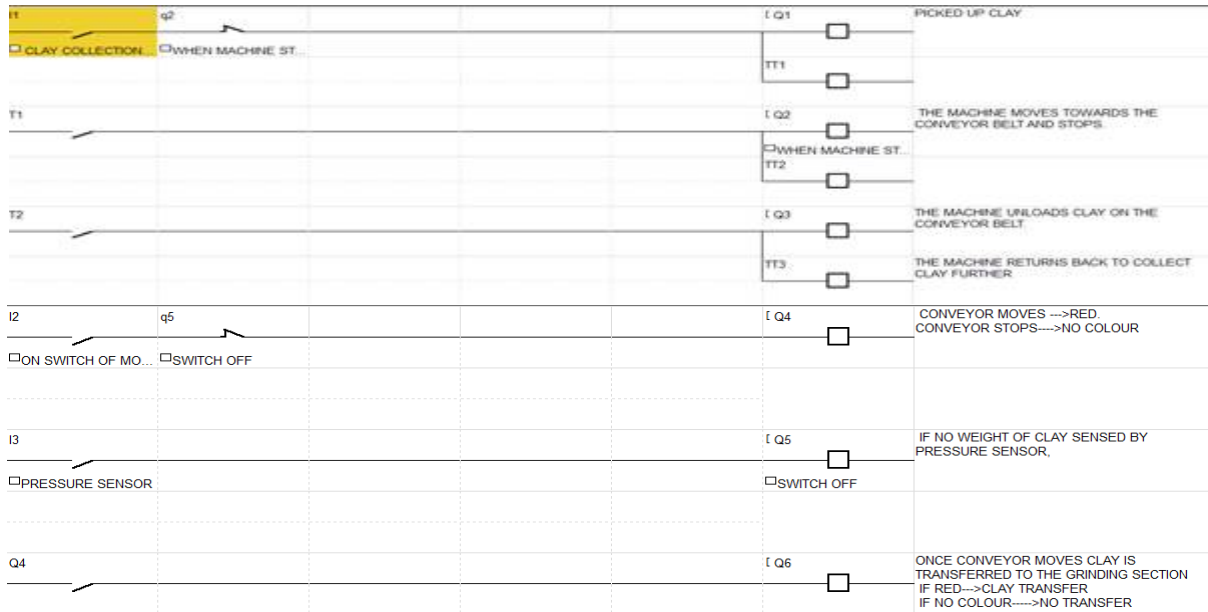
TRANSPORT TO THE FACTORY:

The clay of particular type is chosen and taken out by the vehicle and then placed on a moving conveyor belt. This conveyor belt straightly opens up inside the Grinding Section of the factory. The conveyor belt transfers the clay to the grinding section by centrifugal force.

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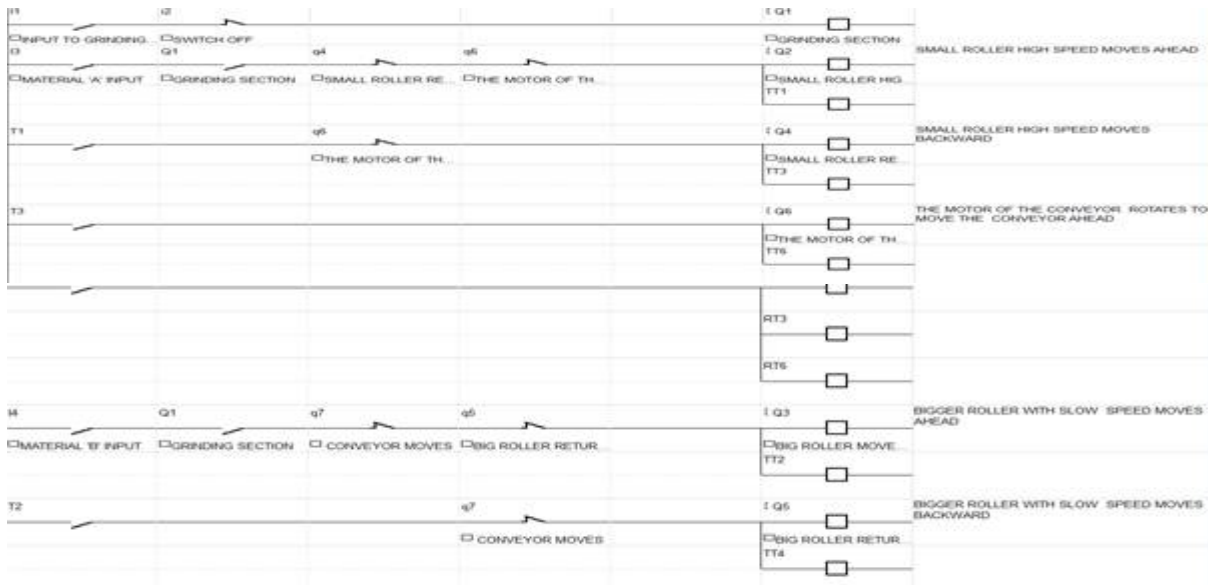
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STAGE 3 : GRINDING SECTION:

Let there be two rollers, one with heavy mass or big size with slow speed and the other one with small size and medium speed. These two types of rollers are meant for grinding clay particles to as small as 1-2 mm in size. Suppose the material 'A' requires the bigger one, while the material 'B' requires the smaller one for grinding. Thus to minimize expenditure for grinding we can use either of the grinder as per requirement.

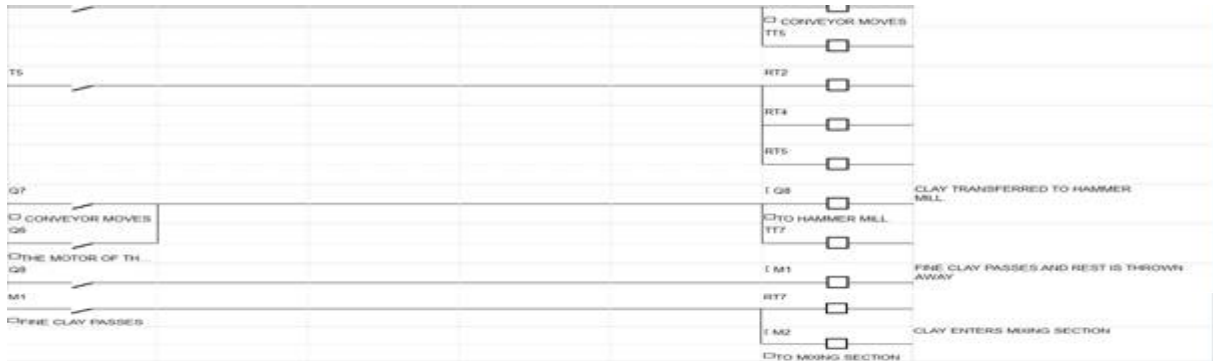


This grinded clay is then transferred to the hammer mill, where this clay is hammered till it passes through the porous wire meshes of 1-2 mm in size. The oversized particles are then thrown away.

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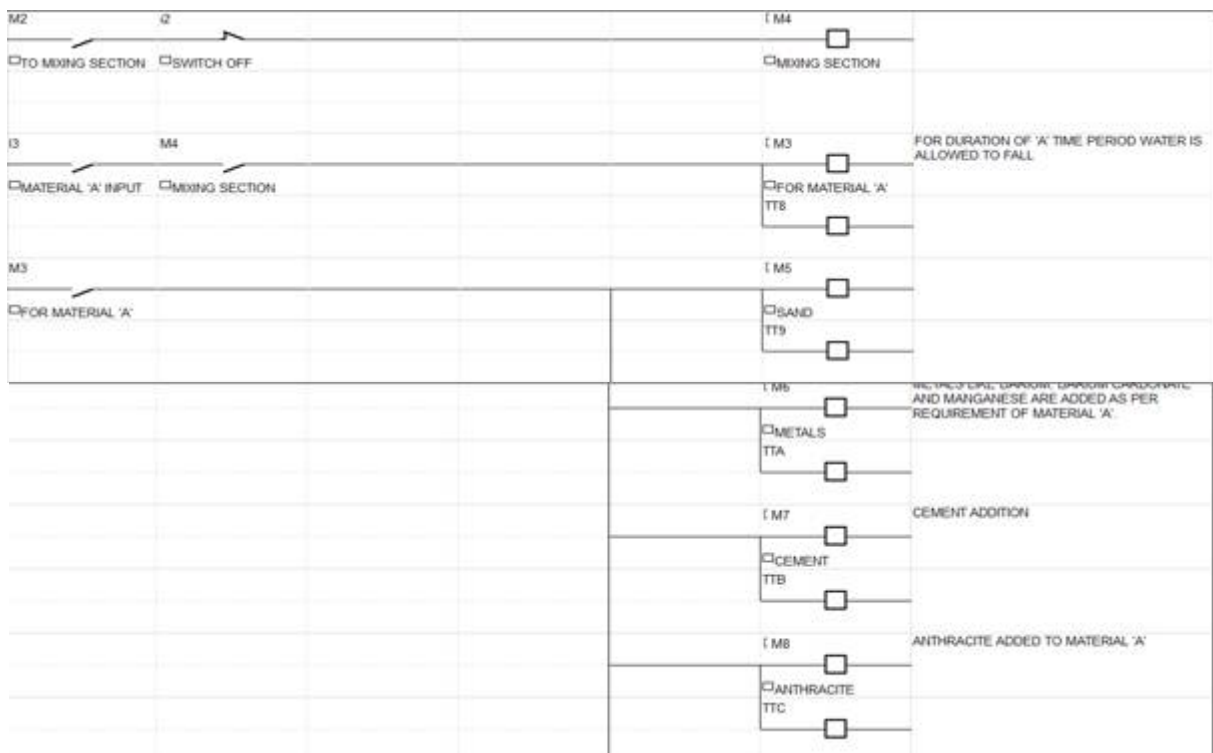
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**STAGE 4 :
MIXING SECTION:**

In this section, water is added to clay soil for transforming the clay rock into plastic mouldable material. This process is called Tampering. Along with this, other additives are added to make the clay soil homogeneous and smooth. Elements like SAND, which prevents sticking the brick to the mould, ANTHRACITE, which aids in firing. Cement, a bonding agent, Natural clay minerals like kaolin and shale, make up the main body of brick, METALS (like manganese and barium) blended with the clay to produce different shades and barium carbonate is used to improve brick's chemical resistance to the elements. Also flocculent (which cause particles to form loose clusters) and deflocculents (which disperse such clusters) are needed to be added in correct proportions as per the nature of the clay materials.

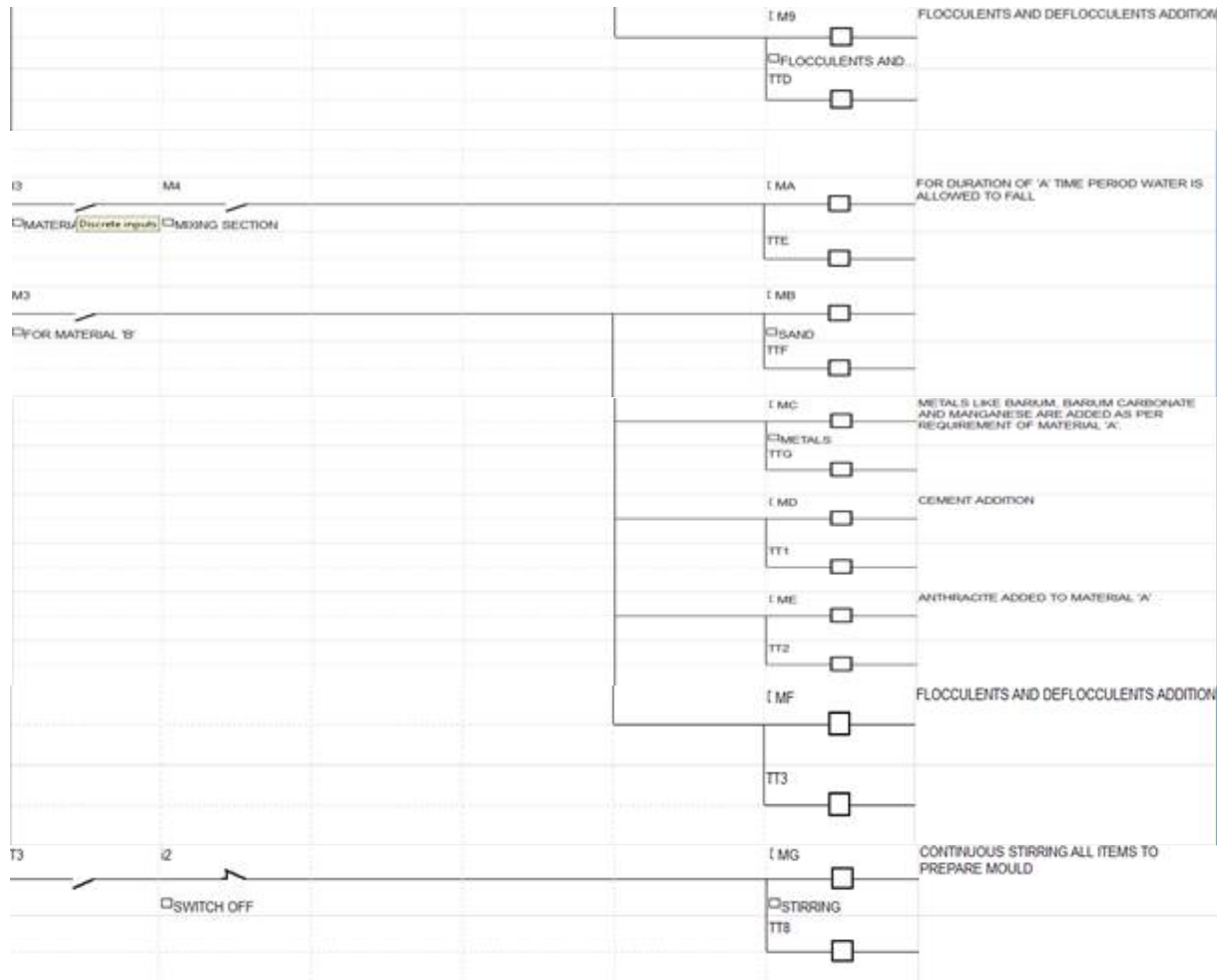
Using PLC automated production, we can allow the amount of additives and water to mix for a fixed timing with the clay. From experience we can set the timed period. Suppose for material 'A', time 't1', t2, t3 etc... and for material 'B' 't4', 't5', 't6' etc., are required for sand, anthracite and metals etc., to mix with the raw material. Since all these are user defined hence can be changed when required.



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STAGE 5 : EXTRUSION:

Once the soft clay is prepared, it is then needs to be moulded .The moulds arefirst clamped at the bases and to avoid sticking of clay to the mould, sand is sprayed .Soft clay is then thrown into a mould, whose top surface is open.A steel plunger set, at a desired pressure,is lowered and compacts the material and then it moves up and the conveyor proceeds a step to make space for the next mould to be compressed. An excess of soft clay is struck off from the top to make the surface smoother.

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With the help of hinge of the mould and hook, the mould is allowed to taken out and then washed under running water and then again placed in the row of moulds to be filled again. The shaped bricks are then transferred via conveyor belt and are stored .This storing of the bricks continue for some time and then this enters drying section.

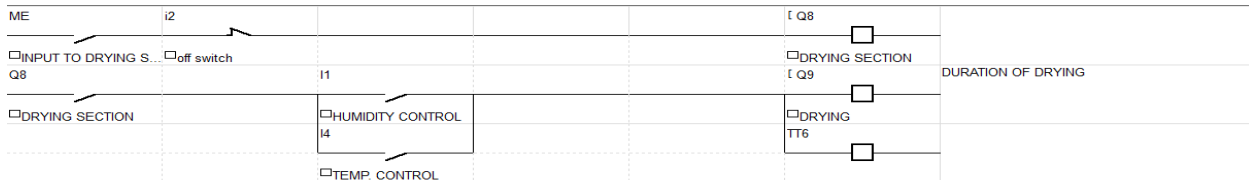
STAGE 6 : DRYING SECTION:

This stage needs to be monitored very closely to reduce surface cracking. Here removing excess moisture is the aim otherwise water will burn off too quickly causing cracking. Tunnel dryers use cars to move bricks through humidity-controlled zones that prevent cracking .The atmosphere is very humid keeping the exterior of the brick as moist as possible. The extent of drying time, which varies with different clays, usually is between 24 to 48 hours. The dryers are kept at temperatures of about 80 –120 degrees centigrade.

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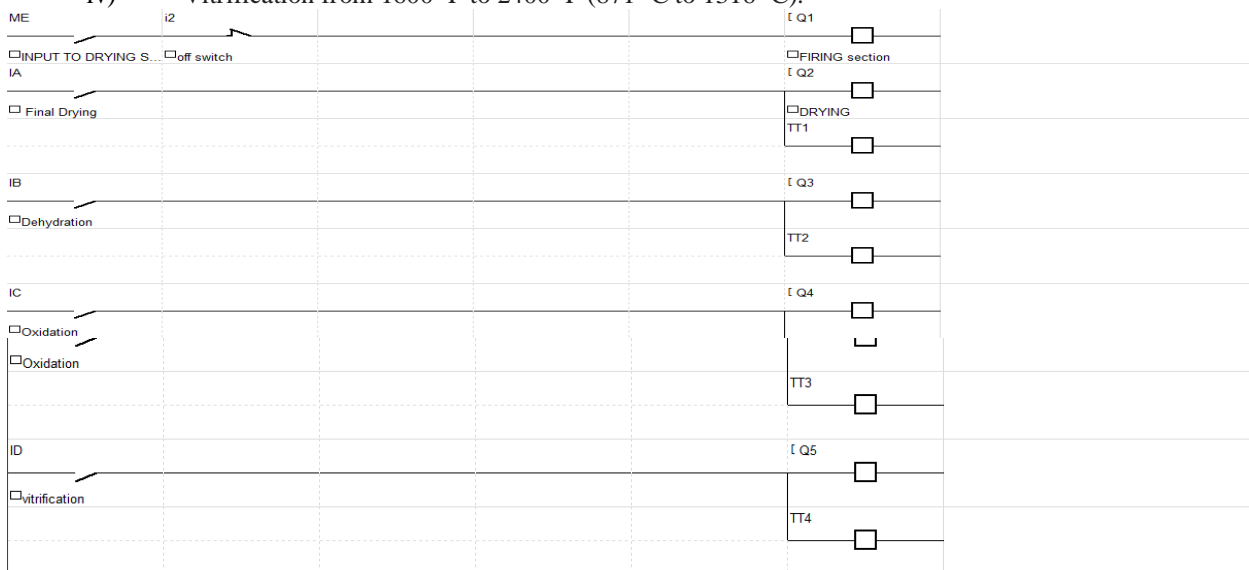


STAGE 7 :

FIRING SECTION:

The aim of firing is to harden and strengthen the bricks. These are pushed continuously through maintained temperature zones, at a specific rate that depends on the material, called tunnel kilns. Brick are fired between 10 and 40 hours approximately. Generally firing is divided into four general stages of heating:

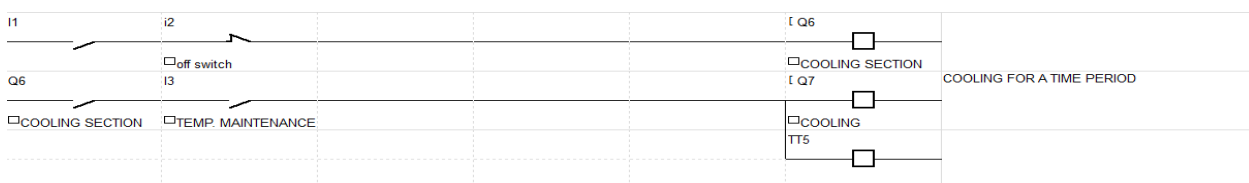
- i) Final drying (evaporating free water)-- up to about 400 °F(204 °C)
- ii) Dehydration (300 °F to 1800 °F (149 °C to 982 °C)
- iii) Oxidation from 1000 °F to 1800 °F (538 °C to 982 °C)
- iv) Vitrification from 1600 °F to 2400 °F (871 °C to 1316 °C).



STAGE 8:

COOLING SECTION:

The rate of cooling has a direct effect on color. It rarely exceeds 10 hours for tunnel kilns. Also the rate of cooling should be uniform.



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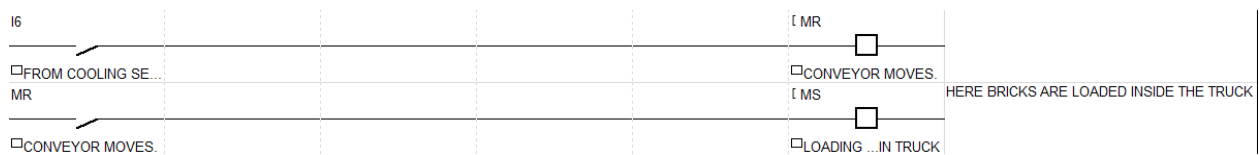
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STAGE 9 :

DEHACKING AND TRANSPORTATION:

De-hacking is the process of unloading a kiln or kiln car after the bricks have cooled

When the temperature of the bricks come down to normal temperature, it is loaded in a car and taken to stockyard. Here through a conveyor belt it straightly leads inside the truck.



III. CONCLUSION

PLC can be programmed to sense, activate, and control industrial equipment and, therefore, incorporates a number of I/O points, which allow electrical signals to be interfaced. Input devices and output devices of the process are connected to the PLC and the control program is entered into the PLC memory. PLC controls analog and digital inputs and outputs for varying types of clay materials. PLC continuously monitors the inputs and activates the outputs according to the control program. The key for quality control of the bricks is the maintenance of appropriate temperature at each step especially at drying, firing and cooling section because excess temperature during firing leads to cracking and faster rate of cooling leads to different colours or shades. Even improper size of clay particles may lead of rough surface and poor quality of bricks. Irregularities in shape, size, and appearance of bricks occur due to improper firing and rough handling. All such factors should be taken into consideration for all types of clay and at the same time keeping production level constant at minimum expenditure, PLC based brick manufacturing plant is inevitable.

REFERENCES

1. <http://www.madehow.com/Volume-1/Brick.html#ixzz3MgyP9sFV>
2. www.ibstock.com
3. Ecobrick
4. Howtopedia – English
5. www.gobrick.com