A Statistical Analysis of Automatic AAC Block Manufacturing Plant Using Siemens PLC S7-300

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Abstract—The main idea behind this project is to control and monitor the AAC block plant via a PLC based technology for industry process. AAC stand for Autoclaved Aerated Concrete. It is light weighted block having eco friendly material which possess a great acoustic and fire resistive properties. It is now gaining significance in the construction field by omitting the conventional process. AAC block consist of base ingredients like fly ash, water, cements, Aluminium powder and other items (silica).

The paper deals with a manufacturing stages of AAC blocks and Siemens PLC S7-300 which comprise of processor CPU 315-2PN/DP, adaption circuit, power circuit and RS 232 interface and sensors like proximity sensors, position sensors, limiting switches, water level indicators for the manufacturing of AAC blocks.

Index Terms—PLC- S7 300, AAC Block manufacturing proccess, Ladder Logic Diagram, OPC, Fly Ash, Aluminum Powder.

I. INTRODUCTION

In the present era, mostly all the industries are automated by using PLC. So it has become a vital part of industry. PLC required continues monitoring and controlling due to large production. PLC is a special type microprocessor based controller to control out the many type of function and operation. It is device which is connected to the equipment in the industry, which transfers the data to PC via long cable and a person sitting on the PC can monitor and control the industry. [7]

Developing countries like India which are not been automated fully yet, hence involve huge man-power and energy for manufacturing brick. Automation in the AAC block preparation plant improves the quality of product plus reduces the man power and energy consumption and also increases the production of block. Automation helps in enhancing the safety operation and deduction in the cost of block.

AAC is not the new invention, it has been around 80 year. Invented by the Swedish architect and inventor Dr. Johan Axel Eriksson. It has been extensively used in the countries of Europe and Asia. It include around 40 percent of all advancement in the United kingdom and 60 percent in Germany and 16 percent in India. [5]

II. DETAIL STUDY

PLC is a logic-controlled devices which is used for automation process in manufacturing. PLC needs to programmed to operate. It is programmed with the PLC languages i.e. Ladder program, Functional blocks and Structured programmed. PLC has both analog and digital input which makes it easily accessible to interface with the machine to perform dedicated task. This accessibility made it to make place in automation industry. [7]

Autoclaved aerated concrete is an adaptable light weighted construction material which is widely used as blocks. Compare to other concrete, AAC blocks has low density, with brilliant insulation properties. Because of the development of air voids to produce cellular structure, hence low density is achieved.[3]. AAC block is prepared by mixing fly ash, water, OPC, gypsum and aluminium powder.

III. PROPOSED METHODOLOGY

The complete proposed AAC block plant is controlled by modern automation system planned by dint of Siemens S7 300 programmed controlled system using standard components which available worldwide. User friendly interfacing provides easy and understandable logical operation of block manufacturing process.

The AAC block process involves 5 stage for production.[2] The proposed model focus on 4 stages of production i.e. batching process(slurry preparation), pouring of the slurry in the mould, pre-curing and needle test and last but least cutting of AAC block(vertical and horizontal) since these stages are very much prone to automation. The automation is done with help of sensors (like limit switch, proximity sensors, position sensors, water level indicators) which are connected with analog and digital inputs of a PLC.
IV. BLOCK DIAGRAM

The block diagram is a diagram of system which represent the important process and shows the relation between them with the help of connection lines. Figure 1 is the Block Diagram Of Automatic AAC Block.

![Block Diagram of Automatic AAC Block manufacturing Plant.](image)

V. AAC BLOCK MANUFACTURING USING PLC

For manufacturing of AAC block fly ash is required along with other raw materials like cement, lime, sand, gypsum, Aluminium powder and water. The Aluminium powder combines with the calcium hydroxide and water to produce hydrogen. The hydrogen gas foams and enhances the capacity of the raw material. [5] And thus form the AAC block.

\[ 2\text{Al} + \text{Ca(OH)}_2 + \text{H}_2 \rightarrow \text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O} + 3\text{H}_2 \]

The AAC block manufacturing has 4 stages which are as follows:

- Slurry preparation.
- Pouring of slurry in Mould
- Static curing and Performing the Needle Test
- Horizontal and Vertical Cutting of AAC block

A. Slurry Preparation

In this process the raw material are mixed. [6] The raw material required in the preparation are shown in fig 2 and fig 3:

Fly ash: The waste fly ash is combined with the liquid (water) to prepare Ash Slurry. Then the cement, Lime gypsum in added to it along with the expansion agent. Fly ash is supplied by the thermal plant. It is very cheap since it is a waste product of industry.

Cement: It is an 53 grade Ordinary Portland Cement(OPC) which is used in construction of building and houses. It is supplied by the cement manufacturing plant.

Water: It is the portable water which is used in the manufacturing of AAC block.

Quick Lime: Lime powder is obtained by crushing the limestone into the fine particles with the help of ball mill and then added to the slurry.
Aluminium powder: It is an expansion agent. It reacts with the calcium hydroxide and water to produce hydrogen. This hydrogen gas double the volume of material. In the end the hydrogen gas escape in the atmosphere and leave the air molecules in it. That is the reason for having light weight of AAC block.

After raw material is prepared, the proceeding step of ACC block manufacturing process is mixing and dosing. The process of mixing and dosing unit is used to form the correct mix to produce AAC blocks. Maintaining the ratio of all materials as [2]: FLY ASH: LIME: CEMENT:GYPSUM= 69:20:8:3, Aluminium is about 0.08 percent of total dry materials in the mix., Water ratio=0.60-0.65 The cycle of mixing and pouring is around 5.5 minutes.
B. Pouring the slurry into Mould

In this process the prepared slurry is poured in the mould as shown in Fig 4. It is filled 3/4th of the mould height and signal in send back to PLC to close valve as shown in fig 5.
C. Static Curing and Needle Test

In this process the mould which filled with the fly ash slurry is moved to the static curing area with the help of motor roller, where it is kept for 3-4 hr for static curing [2] and after then a needle test us done for checking hardness of slab for cutting into blocks as shown in fig 6.

![Fig. 6. Moving mould for static curing and Needle Test.](image)

D. Horizontal and Vertical Cutting of AAC Block

In this process the pre cured casted mould is lifted by the lift crane for de-moulding and tilted it to 90 degree. Then the developed AAC slab is wired cut into block in required size. The horizontal and vertical wired cutting machine has proximity sensor which helps slab not to moved away from the cutting sensor.

After the cutting it is send to Autoclaved which has high pressure and temperature, typically a range of pressure is from 800kPa to 1200kPa and a maintained temperature is 180 degree. It is cured for 10 -12 hr. [2] The finished product is dispatched as shown in fig 7.
VI. EXPERIMENTAL SETUP

In this section, an AAC block manufacture plant is setup on Fig. 8. Demonstration Of Automatic AAC plant On Siemens S7 300 PLC the control panel. The complete process is explained with help of DC indicators, push button, and selector switch as shown in Fig 8. The DC indicators used here for representing the process output. The push buttons and selector switches are used for starting and ending the process and also used as sensor input for the particular process.

VII. CONCLUSION

Automation in AAC block plant helps in increase the production , quality, and enhances the safety for operation and reduce the manpower and capital. Automation is possible with the help of PLC. PLC can be programmed to sense , triggered and control the industrial instrument and device and ,therefore incorporates a number of I/O points, which allow electrical signal to be interfaced. Input and output point of equipment are connected to the PLC, PLC also control the analog and digital inputs and outputs. PLC monitors the inputs and activates the outputs according to the control program. Automation helps in preparing the slurry, mixing of raw material for slurry, to maintain the temperature and pressure of autoclaved moving the moulds plate and many more.

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