

# Automation in Cement Industries

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**Abstract**— Cement is a bonding substance, used in construction works. Civil infrastructures are a sign of development in the country. The Indian cement industry is one of the oldest industrial sectors in India. Cement industry has introduced many technological changes to meet the demands of Indian population like shifting from wet process technology to dry process technology, the introduction of automation technology in the production line, etc. Automation has improved production, quality and cost factors of cement industries. This paper focused on automation technology for Indian cement industries.

**Keywords:** Indian Cement Industry, Industrial IoT, Automation, Sensors, Cement, DCS, SCADA

## I. INTRODUCTION

India comes to second place in terms of cement production as well as in cement consumption. History of Indian cement industries can be traced to the early 1900s. The Indian cement industry is one of the fast-growing sectors in India and accounted for 1.5% of GDP approximate [1]. Cement sector generated huge revenue for governments. In India, industries. As of 2018, the total production capacity of Indian cement industry was around 455 MTPA, while production was around 297 MTPA [2],[3]. Industries use various technologies for the automation of the process, operation, and management of the supply chain. Whether it is an auto start/stop function of the RO machine or it is complex process control of whole cement plant, it all comes under the single umbrella of automation technology. Automation technology is not a single or new technology; it is the use of various technologies. Automation was started with the use of machinery in an assembly line in “Industrial revolution 1.0”. Now we are in the era of “Industrial 4.0”, where automation includes use of Industrial Internet of Things. “Industrial Internet” term was first coined by “General Electric” in late 2012 [4]. “Industrial Internet of Things” and “Industry 4.0” are synonyms of “Industrial Internet”. According to a report, the industrial automation market is expected to reach USD 153.83 billion by 2022 [5].

## II. AUTOMATION

Automation is a broad concept and its definition depends on its use in a particular application area. According to HCL Company, “Automation is the automatic execution of tasks without periodic interference. It aims to minimize and gradually do away with human intervention” [6]. International Society of Automation defined it as “The creation and application of technology to monitor and control the production and delivery of products and services” [7].

## III. CEMENT MANUFACTURING PROCESS

Cement industries use mainly limestone as a primary raw material. Limestone can be retrieved from open cast mines with the help of drilling and blasting equipment. After

blasting, small chunks of limestone then transported to crushing unit where it can be crushed into required smaller size. After crushing other raw material like clay, sand, coal etc. along with crushed limestone are mixed well with the help of mixing unit. After mixing this mixed raw material is pumped into the kiln, where at a high temperature of around 1500 centigrade, this material burns and forms a clinker compound. To produce OPC cement, gypsum is added to the clinker and to produce PPC cement, pozzolana material like ash etc. are added along with gypsum to clinker in the required ration and fed into grinding mill to produce cement

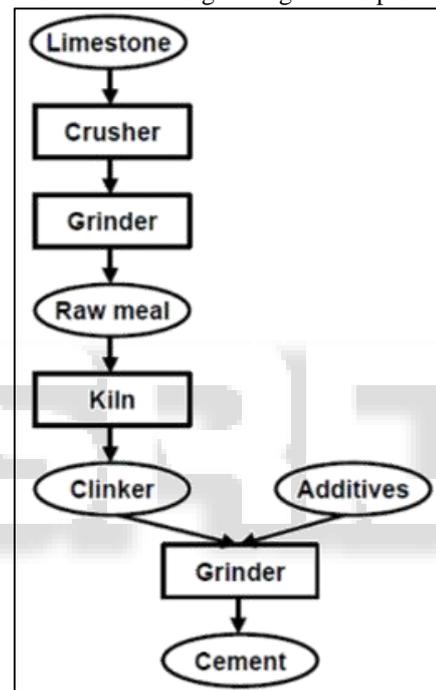


Fig. 1: Simplified process flow of a typical cement manufacturing [8]

## IV. REQUIREMENT OF AUTOMATION

India is a developing country and it needs higher cement production to meet domestic demand which is 210kg per capita, although it is far low than worlds average 580kg per capita [2],[9]. Total Indian cement industry’s production capacity is around 500 MTPA, but it has produced around 300 MT of cement in the year 2018, which shows the underutilization of production capacity [2]. To meet customer requirements, cement industries need technology up-gradation from time to time. Manufacturing of cement has global as well as the local impact on the environment, health and safety, due to which it is a major concern for the cement industry to provide a safe and healthy environment to its employees [8]. Various risks are involved in the cement manufacturing process, from the damage of property to loss of life. Automation technology is required for cost-effective production with minimum risks. Some uses of automation are discussed here.

- 1) To reduce labour cost – Cement industry is a heavy resource consuming industry. If a cement plant is operated manually, it needs a lot of manpower engagement for production and monitoring. Due to the increasing cost of labour and associated expense, automation of cement plants is required. If automation introduced in cement plants, it can improve its capacity, productivity, quality, efficiency etc.
- 2) To reduce worker's fatigue – There are various jobs in cement industries that are repetitive in nature or those required intense work. Humans don't like repetitive jobs and there are always health-related issues in intense work. Automation technology branch, robotics can be helpful in this situation, because of robots or computerized system never tired and can perform their jobs in a harsh environment.
- 3) To increase productivity – Humans can't do work 24X7 without break, but machines can do it. Automation technology can increase the plant's productivity significantly.
- 4) To reduce wastage and damage – Humans can make mistakes, especially if they are tired, but using automation technology, there is less chance of damage and wastage.
- 5) To improve product quality – Automated systems follows strict rules, they will not allow any parameter deviation which can lead to process disturbance in a cement plant, and thus this system can increase the product's quality.
- 6) For workers safety – Automated systems can generate fire alarm, overflow alarm, high-temperature alarm or any other sign according to use of automation system. These types of alarms are important for workers safety. Due to automation, now person need not go to silo tops for checking its levels, automation reduced the working of human in an unsafe environment.
- 7) To reduce maintenance cost – Automation technology can monitor equipment health and can predicate requirement of maintenance, thus reducing further damage and ultimately reduction in maintenance cost. By planned and schedule maintenance equipment can be run longer.
- 8) To increase the morale of employees – Automation creates a safe and secure industrial environment. Employees need not do high-risk jobs as automation technology will take care of these kinds of job. This type of automation increase morale of employees of cement industries.
- 9) For decision making – Automation provided data from most of the equipment of cement plant. Automation technology can also store equipment trends in servers. While making any decision regarding plant operation, managers can view present and previous data with accuracy.
- 10) For easy control and monitoring – Due to automation, now person need not visit each motor or drive or equipment to monitor its condition, with the help of DCS, PLC, SCADA etc. control room operator can easily control and monitor field devices.
- 11) For reducing downtime – Without automation if any drive failed, the maintenance team has to waste their lot

of time to find fault in the drive. But due to automation, sensors can tell the maintenance team, what and where does fault occur in operation.

- 12) To reduce overall production cost – Automation technology reduced manpower engagement, reduced maintenance cost, reduced wastage, reduced damage, thus it reduced overall production cost for cement industries

#### V. AUTOMATION DEVICES AND THEIR USES

Cement plant uses many devices, equipment for its smooth operation. Some of the common and important automation devices are discussed here.

- 1) Sensors – Generally, devices that can sense any physical or chemical condition of machine/system and can share this information with some processing system on demand is known as a sensor. Due to process-oriented and large numbers of devices available in the cement plant, sensors are required to monitor process and devices. To run the process efficiently, some parameters like temperature, pH, pressure, flow, level, etc. need to be observed continuously. This observation can be done with the help of sensors. Some example of sensors is – level transmitter, resistance temperature detector, gas detectors, speed sensors, pH analyzers, proximity sensor, limit switch, positioner, fire, smoke sensors etc.
- 2) PLC – Programmable Logic Controllers are the backbone of industrial automation. This device has own memory, input-output, and processor like a computer has. These are used to control industrial sensor, control valves, etc. Based on the requirement, PLC can be connected to SCADA. PLC works as a mediator between field devices and control station. PLC can also be programmed to act on some specific set of rules. For example, they can control the input flow from a pump if tanks started to overflow.
- 3) HMI – Human Machine Interface is an interface device between human and machine. It is simply a screen on which one can give inputs and can receive output. In cement industries, it is used for interface between operators and PLC/SCADA/DCS/Servers. By connecting HMI with PLC one can load or change a program of it. Mobile HMI and touch screen HMI are some latest enhancement in the HMI field.
- 4) RTU – Remote Terminal Units are similar to PLC device, except they generally come with wireless connectivity and battery or solar power. PLCs are cheaper devices than RTUs. PLCs need continuous AC supply while RTU can work on their battery. PLCs need extra equipment to communicate wirelessly.
- 5) SCADA – Supervisory Control and Data Acquisition is a hardware and software system, which is used to supervise PLCs/RTUs. Normally SCADA is connected with HMI. SCADA systems can record events, communicate with field sensors. With the help of HMI, operator of cement industries can give commands from SCADA to any particular device. SCADA systems are generally equipped with alarm capability and can raise an alarm if any predetermined rule activated. For example, an alarm will generate if the overflow of any

tank takes place or kiln temperature has been raised from a standard value.

- 6) DCS – Distributed Control System is an automated control system for control room operators to control the plant process. SCADA and DCS are quite similar except DCS can control a larger area with high connectivity options. DCS is connected with field controllers by a high-speed communication channel. By simple clicks, on DCS screen a control room operator can operate any drive which is connected with DCS. Like SCADA, DCS also has an alarm system.

#### VI. CHALLENGES RELATED TO AUTOMATION

Although the Indian cement industry has implemented automation technology in their plant, still there is a significant difference between technology used in abroad and in India. Further, there are some challenges, those cement industry is facing while implementing automation technologies in plants. Some of them are discussed here.

- 1) Capital issues – Cement industry is a demand-driven industry and depends on limestone mines availability. If market demand is low or if cement manufacturer not gets any limestone mines, the investment will be reduced which will severely impact the budget for automation.
- 2) Cost – Automation comes at a cost. Cost is a primary concern for any cement industry. Automation device's initial cost, service cost, repairing cost is quite high. Latest technologies are mostly from abroad, which add extra cost burdens.
- 3) Skilled manpower – Automation technology required skilled manpower for installation and maintenance. Skilled manpower also comes at a cost which is again a concern for cement industries.
- 4) Lack of standards/compatibility – Automation devices are normally marketed by various companies. Due to large numbers of vendors, and outdated technology which is still being used in some cement plants, compatibility issues arise. There is also a lack of standards in automation technology; many vendors use their own set of standards, which make compatibility issue with existing technology.
- 5) Resistance – Automation technology is seen as a competitor among workers of cement industries. Many employees think it will replace them with robotics. Many researchers also found that automation abandoned workers from work [10]

#### VII. CONCLUSION

Automation technology has improved cement plants productivity, quality, delivery, safety and cost. But still, there is a significant difference between the automation of Indian cement plants and cement plants abroad. There is a need for government policies; those can reduce taxes on imported technology. The government should encourage Indian automation vendors by reducing the upfront cost. There is also a need for equilibrium between the automation of industry and job of workers. Cement plants should also implement their in house automation ideas to reduce the cost of production. Cement plants should also provide training on automation technology to their employees. India's per capita

cement consumption needs to be improved. India still needs more automation technology to fulfil domestic cement demands. In this paper automation of Indian cement industry discussed with definition, cement manufacturing process, why automation is required, challenges of automation along with some general automation devices for cement plants.

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