

A Review on Foundry Automation by using PLC

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Abstract—Automation or automatic control, is the use of various control systems for operating equipment with minimal or reduced human intervention, with some processes have been completely automated. By automating routine tasks and systems within the foundry, various benefits can be achieved. Automation helps in improving the production and casting output. Modern process control systems are used in industrial automation for flexibility, modularity and reliability. From last decade the industrial automation is important in all production industries for the sustainable growth. Particularly foundry industry includes the different processes. It demands for safe and careful handling of molten metal and prepared moulds. For small to medium scale industries it is advantageous to introduce automation within present plant layout or with smaller change, by taking assistance of PLC (Programmable Logic Controller). In this paper a review is done on the Industrial Automation encountered with the use of PLC. Use of automation systems in foundries has proved to be highly economical than other means. The main benefit of using automation systems in foundries lies in their flexibility that is their ability to undertake a variety of other tasks and functions.

IndexTerms—DCS (Distributed Control System), PLC (Programmable Logic Controller), RTU (Remote Terminal Unit), SCADA (Supervisory Control And Data Acquisition).

I. INTRODUCTION

For foundries doing flask moulding with no any automation or with automation for selected processes like sand preparation, automatic mould making etc. it is not feasible to replace whole system and put fully automatic system. These fully automatic systems are often using flask less moulding. So, for the foundries with flask moulding, automation can be done for particular process by making no any or small changes in existing system.

PLC (Programmable Logic Controller) based automation interacts with the real world input and output. This enables the automation to be implied for particular process. Automation with PLC can be done economically and it will yield well with numerous of its advantages.

By giving the output of the PLC to the instruments and drives, corresponding processes like metal pouring, mould handling etc. can be brought under automation. PLC replaced relay control systems. PLC executes a list of instructions in sequence.

II. LITERATURE REVIEW

A. Fedoryszyn [1] has made their paper on assessment of systems of casting production. In this paper they studied that an increase of productivity requires a wide-scale mechanization or automation. They described modern design of moulding lines including moulding machines and related equipment. In domestic foundries mechanical stands, posts and lines of casting fabrication (moulding lines) are used and they are equipped with modern casting machines. According to them for greater flexibility holding areas are preferred by foundrymen instead of closed loop available on trolley conveyor. In holding area transport system consists of foundry conveyors, railway track, trolleys for moulds and transfer table. PLC programmer is used for operation of conveyors in an automatic cycle.

Pravinkshirsagaret al. [2] have given a detailed summary about the role of PLC in foundry. PLC is an intelligent system of modules for replacing relay based logic. PLCs are often programmed in ladder logic which is the wiring up of relay contacts and coils on screen. Some of relay contacts are tied up with inputs and some are with outputs from real world. The program incorporates timers, counters and arithmetic operations which couldn't (easy) with just relays. The working of PLC is also mentioned by author. Along with the PLC, SCADA database is used for graphical view of process monitoring from operator station in the central control room. The history of automation from manual control, with logic gates, electrical control with logic gates up to PLC is given by author. PLC eliminates the physical wiring of the control devices. The advantages of PLCs are enlisted by author like reduced space, energy saving, modular replacement, easy trouble shooting, error diagnostic programmer, economical, greater life and reliability. A SCADA system used to gather data from sensors and instruments and transmit data at a central site for control or monitoring. The collected data is viewed on one or more SCADA host computers. The implementation of PLC and SCADA system is described by authors. The authors concluded with the statement that remote and safe operation and monitoring, flexibility, scalability and power modular structure can be provided by PLC.

RichaNetto, Aditya Bagri [3] have worked on Programmable Logic Controllers. In this paper they highlight the concepts, working, advantages and practical applications of Programmable Logic Controllers. Also they have made comparison of PLC with other control systems. The term Programmable Logic Controller defined by the National Electrical Manufacturers Association (NEMA) such as "A digitally operating electronic apparatus which uses a programmable memory for the internal stage of instructions for implementing specific functions such as logic, sequencing, timing, counting etc. through digital or analog input/output modules, various types of machines or processes". They mentioned that there are six basic components of PLC such as

I/O modules, processor, power supply, memory unit, network interface and programming units. The authors have mentioned about the programming and working of PLC. Also they have made the comparison of PLCs with other control systems. The results from comparison made by them are as shown in below table.

| Parameters | Relays | Solid-State Controls | Microprocessor | Mimicomputer | Digital Logic | PLCs |
|-------------------------------------|---------------|---------------------------------------|----------------|--------------|---|-------------------------------|
| Hardware cost | Low | Equal | Low | High | Average (can be high in small quantities) | Depends on number of controls |
| Versatility | Low | Low | Yes | Yes | | Yes |
| Troubleshooting and maintainability | Poor | Poor | Poor | Poor | Poor if IC's are soldered | Good |
| Computer compatible | No | No | Yes | Yes | Yes | Yes |
| Arithmetic capability | No | No | Yes | Yes | Yes | Yes |
| Programming cost | (Wiring) High | (Wiring) High | High | High | Low | Low |
| Reusable | No | No | Yes | Yes | | Yes |
| Space required | Largest | Large | Small | Ok | Fairly compact | Small |
| Operating speed | Slow | Faster than electro-mechanical relays | Fairly fast | Fairly fast | Fairly fast | Fast |

According to author PLC can carry out complex functions, PLC is highly economical and disadvantage is that system stops if power fails. They introduced some applications where the PLC used. E.g. Beverage industry, Bottle filling systems, etc.

Avvaru Ravi Kiran et al. [4] have made their paper on principle of PLC (Programmable Logic Controller) and its role in automation. This paper discusses topics of PLC and role of PLC in automation engineering, which is a cross-sectional discipline that requires proportional knowledge in hardware and software development and their applications. According to them the purpose of PLC is to directly replace electromechanical relays as logic elements. The main difference from other computers is that PLC are armoured for server conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output arrangement. These connect the PLC to sensors and actuators. PLC is good example of an industrial control system. PLCs are specialized computers which are often used to synchronize the flow of inputs from sensors and events with the flow of output to actuator and events.

Thomas Bangemann et al. [5] have described the present situation and trends in automation. Architecture of production system is described by author and accordingly the data flow within automation systems. According to author production management applications would operate on the data from production output. This information is built by PLC or DCS. For the supervision, the data is used by SCADA which again includes Human Machine Interface (HMI), computer, RTUs, PLCs and a communication infrastructure. SCADA offers good communication service and improved device interoperability for process monitoring and automation without the need of high cost of integration. The use of data within the process control architecture is described and in the production management as well. Authors have given the details for integration of devices using Gateway and mediator. The look of the instrument through the 'window' of its digital communication link can be seen using an Electronic Device Description (EDD). Field Device Tool (FDT) concept defines interfaces between device-specific software components (DTM—Device Type Manager) supplied by device manufacturers, and engineering systems supplied by control system manufacturers which have been mentioned by authors. The conclusion is made by authors that within the plant hierarchy, PLC, SCADA and DCS systems are the basis for monitoring and controlling industrial applications at lower levels.

AmoghTayade et al. [6] have implemented PLC based Hydraulic Auto Ladle system for casting department of Victory Precision Private Limited, Chakan, Pune. For the automation process authors have taken the aid of PLC. A pallet is designed by authors for smooth pouring of molten aluminum. The PLC is used to control the flow of hydraulic oil to actuator for controlling the tilting of ladle. The reasons behind selecting hydraulic control system are enlisted by authors. Control panel consist of the electronic components namely single pole MCB (Miniature Circuit Breaker), double pole MCB, relay board, SMPS (Switched Mode Power Supply). Double plate MCB protects the whole circuit from sudden changes in incoming power. SMPS is used to attain the power supply as per requirement of component from the supply available. Single pole MCB is used to supply DC power to the PLC. PLC used is Messung XMP8.11. Digital inputs and outputs have been used. Relay board drive the output of PLC. Relay provides power to solenoid valve for controlling the flow of the hydraulic fluid. Limit switches provides feedback to the PLC. According to authors the system is very precise and inexpensive.

Akhil Dixit et al. [7] have made their paper on PLC and its applications in automation plants. In this paper they carried out basic task of filling up of water bottles using Programmable Logic Controllers (PLC). In this paper, they given information about the basic parts of PLC such as i) CPU (Processor), ii) Memory, iii) Input devices, iv) Output devices, v) Programming unit, vi) Power supply. They used the PLC for performing the filling operation because they are flexible, easy to program and space efficient. In this project they have placed bottles on the conveyor belt one at a time and then they get filled. The entire system can be controlled using PLC; SCADA (Supervisory Control And Data Acquisition) was used for visual representation of the bottling plant. They

concluded that the purpose of their project is to create a PLC based automatic bottle filling plant based on given description. During their project they got the knowledge about various processes directly utilised in industries such as automation system. They mentioned specifically about PLC and SCADA. The result made by them is that this technique of bottle filling is very accurate, cost saving and time saving.

Jaswandi G. Joshi, Prof. D. D. Ahire [8] have made their paper on survey of programmable logic controller and its versatile applications using the SCADA (Super Visionary Control And Data Acquisition) system. According to authors general survey was first performed to chronicle past research efforts in developing the PLC based system using SCADA technology. The number of automated electromechanical design is done through use of small computers called as PLC. This system obtains a real time data of industrial parameters and displays it in various forms. It is automatic control system which is usually practiced in number of industries. The advantage of automation is that it saves labour, however it is also used to save energy, materials and it improves quality, precision and accuracy. The SCADA and PLC communication system make it possible to integrate protection control and monitoring specific parameter together for maximum benefit. The system is highly efficient and cost effective, as only one interfaced digital system along with a PLC can control many subsequent valves.

Ephrem Ryan Alphonsus, Mohammad Omar Abdullah [9] have made their paper on applications of Programmable Logic Controllers (PLCs). According to them as the need of automation, a control system needs to be easily programmable, flexible, reliable and robust, cost effective. In this paper the authors have discussed about applications of PLC in our current market. In this paper the author enlisted PLC hardware, PLC programming, other programmable devices and the PLC applications. As they have mentioned, PLC is capable of controlling many types of industrial equipment and entire automated system. The list of PLC manufacturers in global market is also provided in this paper. The authors given the most common way to program a PLC is to design the desired control circuit in the form of relay logic ladder diagram and then enter this ladder diagram into programming terminal. They have listed out some other programmable devices such as relay, pushbutton, selector switch, limit switch, proximity switches etc. The author has described some applications of PLC like water and waste water management control, energy research, research-training and education, manufacturing, control and monitoring of plants and other applications. Also authors have provided the schematic diagrams for each application. The result made by the author is that, researchers will tend to use PLCs as their main controller for any field of research even though there are other controllers out there in the market. This paper concludes that PLCs can be applied to any system, whether it is a simple or complicated control system.

D.Kanakaraja et al. [10] have made their paper on the fabrication of semi-automatic molten metal pouring system. In this paper they focused on transferring the molten metal pouring system in casting industry. In this paper according to authors in current global competitive environment there is need for casting units and foundries to develop components in short lead time. In any casting industry the leading problem is taking place in mould shifting from electrical furnace to the die casting. According to authors the system was tested for carrying the metal which reduces the manual work for mould shifting. The results are compared with manual working which improves the quality, productivity and defects free product. To transferring the molten metal by manual is also hazardous for workers for carrying molten metal nearer to them. Automation also effects on the quality and performance.

BhagyashreeNagarkar [11] worked on industrial drives and automation using PLC. She stated that automation of the electromechanical processes on factory assembly lines, amusement rides, all lightning fixtures are carried out by PLC which is a digital computer. Also PLC is designed for multiple inputs and outputs arrangement, extended temperature ranges, resistance to vibration and impact. Within the bonded time PLC gives output results in response to input conditions. In this paper author mainly focused on the control unit i.e. PLC, RTU (Remote Terminal Unit), SCADA etc. She has given features of PLC, development in PLC, programming in PLC and architecture of PLC. The feedback control loop passes through the RTU or PLC while the SCADA system monitors the overall performance of the loop.

III. CONCLUSION

After going through the literature, we have found many issues in industries which can be solved by automation. The biggest benefit of automation is that it saves labors, save energy, materials and improves quality and accuracy. The requirement for higher quality and reliability and control techniques have backup from constant demand for better and more efficient process, machinery in control techniques. The intent of this paper is to create PLC based foundry automation. Semiautomatic foundries can be made automatic by using PLC automation. PLC plays an important role in foundry automation.

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