Automation of Rubber Injection Moulding Machine

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Abstract: Automation of process is very important in an Industry for the growth of our country. Present work is to design, develop and implement automated operation of Rubber Injection Moulding Machine along with the provision for manual operation. This results in upgrading the technology by reducing manpower in the production process. Initial task is to build-up the control panel as per the designed control circuit by proper selection of components. Control panel for Automation of RIM machine is developed with main objectives of saving at least 10-sets of molding shape settings for RIM with provision of datalogging option. The present work can be extended by implementing SCADA and ANN logic for the automation of RIM process. RIM process involves 4 main operations such as Clamping, Plasticizing, Injection and Ejection. In all these four process both pressure and temperature has to be maintained within the set values. Automated alarming during any calamity condition and pausing the further operation of RIM machine, safety light curtains are installed, which will be used to protect against access into any hazardous areas and points.

Keywords: Delta PLC, Delta PLC, Delta company (Delta.co), Rubber Injection Moulding (RIM), safety curtains.

I. INTRODUCTION

Industrial Revolution with automation can spur the economic growth of India. This will give serious impact on productivity and income levels. In any manufacturing process in industries the users are relied upon observation and control process. Automation with utilization of hardware and software increases the productivity, reliability, safety and profitability. For making Rubber parts repetitively automation of Injection Moulding process is used. In order to keep-up the good quality and stiffness of rubber parts-environmental conditions and different steps involved in the ongoing processes of RIM has to be stable. In this work Delta.co products have been used because of their low cost, long life cycle. As expected input and outputs to and from the PLC being 48 and 44 respectively, it may not be possible to get the module of Delta PLC with so many inputs and outputs. Therefore, a main “CPU DVP28SV11R2 is used along with different DVP-06 XA-S analog module and DVP 16SP digital modules”. The automation of RIM machine helps to increase the productivity by producing parts with high quantity and accuracy in a reduced time span.

II. RELATED WORK

This paper describes an approach for automation with provision of Delta HMI and Delta PLC for automation. Before implementation with programmable logic controller, the RIM machine was operated with embedded system, wherein it is not possible to save sets of data specification for the mould sizes as well as data logging. In this embedded system, all the processes involved in moulding were invisible, where operator cannot see whether product has the strength and the quality with which it is designed for. Maintenance of these systems needs skilled person. Compared to implementation of RIM machine with embedded system PLC operation is less time consuming.

In order to understand the automation in Industrial and to develop program with PLC ladder programming with the provision of HMI graphical user Interface for the ease operation control. This section gives the details of the literature survey carried out.

Few Implementations that have been done on Automatic Injection Moulding by using PLC will be mentioned here. VEERANJANEYULU ITHA et al.[1] has implemented “Low cost Automation(LCA)” technique for “Automatic Injection Moulding By using PLC’s”, Here the author has used asbestos material with high insulating properties for fire and corrosion proof. But in High range application it is health hazardous.

Masao Ogawa and Yutaka Henmi has implemented “Recent Developments on PLC based Control Systems for Beer Brewery Process Automation Applications, Here PC-PLC based operation is implemented along with entire system integration with PLC. PID control loop is used for control and monitoring of PLC.

Chris M. Seaman et al.[3] have presented how PID controller can be used for multiple objective function optimization of a Plastic Injection moulding Process, which includes 1) A prior weighing of objectives is not necessary because of multi-objective function.

2) Feedback is provided that informs the decision maker if the operating point is on the trade of boundary. With simulation results the authors showed the way of using PID tuning for multi-objective optimization.

III. BLOCK DIAGRAM FOR AUTOMATION OF RETROFIT RIM MACHINE

PLC block shown in Fig.1 acts as interface between HMI and RIM machine. Computer block shown in Fig.1 is used for external online programming or for any change of parameters in PLC. Inbuilt USB plugin HMI Delta DOP-B10S615 is chosen, through which Data logging information is taken out. Safety Curtains
Fig. 1. Proposed Block Diagram

The main processes involved in the RIM are as shown in the Fig 2. In clamping, the moving and fixed platens of the RIM machine holds the mould together under pressure. Plasticizing involves the change in mechanical and thermal properties of the rubber polymer. With this plasticization rigidity of the material is maintained at room temperature and strength of the plasticized material will be such that it cannot breakdown with the increase in the elongation. In injection process molten raw material is injected into the mould with the required pressure and temperature to maintain the strength and rigidity of the material. In ejection the moulding. Dwelling is also one of the process stage in RIM wherein, after injection process the pressure is applied to ensure all the mould cavities are being filled.

Different module connection in the panel for automation of retrofit RIM machine is as shown in the Fig.3.

IV. PLC PROGRAMMING AND HMI DEVELOPMENT

To accommodate many analog and digital I/O’s, a main CPU DVP28SU11R2 with analog module DVP-06XAS, digital module DVP16SP and thermocouple cards are used. From all these modules output will be given to the relay. And from the relay these connections have been carried out to the different PLC modules as per requirements.

Step2: Different Memory Allocations: The Main task lies in here, as the programmer needs to assign the exact memory location for different inputs and outputs as the connection of the circuit will do operate as per the memory allocation, not with program logic. Therefore care should be taken while assigning memory locations and while connecting to the control panel. Few memory address allocation given in the PLC program is as shown in the TABLE 2.
Step 3: Programming: In PLC, programming can be written in many ways, but in inbuilt Delta WPL-soft Sequential Flow chart (SFC), Ladder Diagram (LD) mode and Instruction List (IL) mode can be used for programming. The method in which the program is written is being selected first. The signal values from different sensors, transducers are allocated to memories to give outputs as per the allocation list sequence. A few sequence from program is shown in the Fig. 4.

Step 4: Connections As Per The Memory Allocation: As per the given memory allocation list the connection to the components is done. The connections are given as per the allocation list and not considering with respect to the logic.

Step 5: Transfer The Program: The program written the “WPLsoft” software is transferred to the Delta DVP PLC block through RS232 communication channel as shown in the Fig. 1. The inputs and outputs as selected and assigned in allocated memory addresses are taken into PLC processor and the program is executed sequentially.

B. HMI Development:

The list of parameters which are to be displayed is made, and parameter selection entry for different pages of HMI display is prepared and it as shown in the Fig. 5. “Delta DOP” software is used for constructing HMI display. Data logging is provided for this HMI, the parameter entry for the operator is provided on HMI, wherein the operator can select automatic or manual operation of the process. With HMI it is possible to observe the variation in the temperature and pressure values in each and every stage of the RIM process. The quantity of production before and after automation has been increased as compared from the bar charts within less time, which is shown in below Fig. 6.

V. Conclusion

As from the Fig. 6, it is ensured that productivity is increased to 2.5% with automation, high quality with less time consumption. Modern days with the developing technology, improving productivity are the main concern to be in the race. A low cost Automation is very helpful in doing this. Sensors like Pressure Transducer, position transducer, relays, actuators, hydraulic valves are used with connection of electrical panel for automation. Automation helps in increasing the productivity, stability, profitability and also aid in the economical growth of our country.

VI. References


