Review in Controlling Analysis of Injection Molding Machine

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Abstract- An Injection molding machine, also known as an injection press, is a machine for manufacturing plastic products by the injection molding process. Injection molding is a method to obtain molded products by injecting plastic materials molten by heat into a mold and then cooling and solidifying them. The method is suitable for the mass production of products with complicated shapes, and takes a large part in the area of plastic processing. Review process involving 2 stage approaches has been undertaken for 20 research papers which were published in the period of year 2001 to year 2013. After an exhaustive review process, four key issues were found "Controlling Process of Injection Molding Machine, Trouble Shooting, Production & Stock Management and Controlling Process of Hot Runner Type Injection Molding Machine" which is mostly need to enhance of Industrial Automation aspects to get better solution approach. The outcome of the review was in the form of various findings, found under various key issues. The findings included algorithms and methodologies used to solve particular research problem, along with their strengths and weaknesses and the scope for the future work in the area.

Key words: IMM , PIDNN , MRAC , MRAS

I. INTRODUCTION

Injection molding is a method to obtain molded products by injecting plastic materials molten by heat into a mold and then cooling and solidifying them. The process of injection molding is divided into 6 major steps as shown below:

Clamping

Injection

Dwelling

Cooling

Mold opening

Removal of products

Injection molding machine is divided into 2 units i.e. a clamping unit and an injection unit. The functions of the clamping unit are opening and closing a die, and the ejection of products. There are 2 types of clamping methods, namely the toggle type shown in the figure below and the straight-hydraulic type in which a mold is directly opened and closed with a hydraulic cylinder. The functions of the injection unit are to melt plastic by heat and then to inject molten plastic into a mold. The screw is rotated to melt plastic introduced from the hopper and to accumulate molten plastic in front of the screw (to be called metering). After the required amount of molten plastic is accumulated, injection process is stared. While molten plastic is flowing in a mold, the machine controls the moving speed of the screw, or injection speed. On the other hand, it controls dwell pressure after molten plastic fills out cavities. The position of change from speed control to pressure control is set at the point where either screws position or injection pressure reaches a certain fixed value.

II. REVIEW PROCESS ADOPTED

A literature review is necessary to know about the research area and what problem in that area has been solved and need to be solved in future. This review process approach was divided into five stages in order to make the process simple and adaptable. The stages were:-

Stage 0: Get a "feel"
This stage provides the details to be checked while starting literature survey with a broader domain and classifying them according to requirements.

Stage 1: Get the "big picture"
The groups of research papers are prepared according to common issues & application sub areas. It is necessary to find out the answers to certain questions by reading the Title, Abstract, introduction, conclusion and section and sub section headings.

Stage 2: Get the "details"
Stage 2 deals with going in depth of each research paper and understand the details of methodology used to justify the problem, justification to significance & novelty of the solution approach, precise question addressed, major contribution, scope & limitations of the work presented.
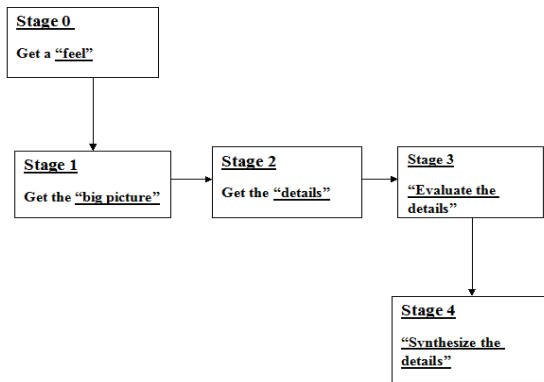
Fig: 2.1 Review Process Adopted

Stage 3: "Evaluate the details"

This stage evaluates the details in relation to significance of the problem, Novelty of the problem, significance of the solution, novelty in approach, validity of claims etc.

Stage 3+: "Synthesize the detail"

Stage 3+ deals with evaluation of the details presented and generalization to some extent. This stage deals with synthesis of the data, concept & the results presented by the authors.

III. VARIOUS ISSUES IN THE AREA

After reviewing 20 research papers on Controlling Analysis of Injection Molding Machine we have found following issues, which has to be addressed, while the designing and implementation of the Injection Molding Machine these issues are:

1) Controlling Process of Injection Molding Machine
2) Trouble Shooting
3) Production & Stock Management
4) Controlling Process of Hot Runner   Type Injection Molding Machine

IV. ISSUE WISE DISCUSSION

Issue1:- Controlling Process of Injection Molding Machine

Controlling Process of Injection Molding Machine is one of the issue, some approaches are used for this issue which is adaptive intelligent control algorithm based on Multi-CPU,Back-propagation algorithm of the PIDNN , PID neural network forward algorithm. Injection molding machine controlling process very hard with relay logic, so embedded system controlling process (logic) used for injection molding machine, this process is better than the relay logic & it provides an effective & easy way to control the hydraulic system. PIDNN, in which proportional (P) neuron, integral (I) neuron and derivative (D) neuron is defined. Every neuron has an input u and an output x. The

properties of a neuron are decided by the input-output function. The P-neuron, I-neuron and D-neuron are different from each other because of the proportional (P) function, the integral (I) function and the derivative (D) function. A basic PIDNN had 2 inputs and 1 output and three layers which were input layer, hidden layer and output layer. The input layer has two neurons and the output layer has one and their neurons are P-neurons. The hidden layer has three neurons and they are P-neuron, I-neuron and D-neuron respectively.

Issue 2:- Trouble Shooting

Trouble shooting is second issue, some approaches are used for this issue which is object-oriented technology & case based reasoning technology. Object-oriented technology, case based reasoning technology and Rule-based expert system have been suggested to model the injection molding process reduces the dependency on human expertise needed for decision-making. Case based and rule-based reasoning to form a model for solving trouble-shooting problems in molding processes.

Issue 3:- Production & Stock Management

Production & Stock Management is third issue , some approaches are used for this issue which is Model Reference Adaptive Control (MRAC) scheme. Mold cavity pressure in injection molding machine plays an important role in determining the quality of molded products. The Model Reference Adaptive Control (MRAC) is an important adaptive controller, in which the desired performance is expressed in terms of reference model, which give the desired response to a command signal. In the MRAC the desired behaviour of the system is specified by a model and the parameters of the controllers are adjusted based on the error, which is the difference between the output of the system and the output of the reference model. The mechanism for adjusting the parameters in a MRAS could obtain in two ways: by using a gradient method (MIT Rule) or by applying stability (Lyapunov) theory.

Issue 4:- Controlling Process of Hot Runner Type Injection Molding Machine

Controlling Process of Hot Runner Type Injection Molding Machine is fourth issue, some approaches are used for this issue which is special purpose controller & a human machine interface for hot runner type micro injection molding module. The performance of this hot runner type micro injection molding module is tested with a reciprocating injection molding machine. The test results showed that the metering precision of using this module is at least as good as a two stage reciprocating screw. A hot runner type micro injection molding module is successfully developed.

V. ISSUE WISE SOLUTION APPROACHES USED

The solution approaches under the various issues have been shown in the Table 6.1 to 6.4, which includes additional information like hardware,software,variable/parameters used along with results obtained. The same table also describes the Comparative analysis between various solution approaches.

VI. ISSUE WISE DISCUSSION ON RESULTS

Issue1:- Controlling Process of Injection Molding Machine

S. No.	Solution Approach	Results
1	Artificial Intelligent Technology	It can improve the control capability, decrease the preparation time, reduce the default rate, enhance the safety performance of the system.
2	Plastic Rheological Approach	This approach is suitable for setting up the injection parameters automatically when installing new mold on injection molding machine.
3	PID Neural Network Forward Algorithm ,ARM technology	Increase processing speed, quality of product & ARM technology achieve better temperature control effect.
4	Adaptive Algorithm	Improve the overall performance of Injection molding machine.
5	High Order Reaction Force Observer & Reaction Force Observer based on two Inertia Resonant Model	Improve the accuracy in the screw back-pressure process & holding process also improved by adding a periodical signal to the force command.
6	Back Propagation Algorithm	By using this algorithm it can give small overshoot value & zero steady state error every kind of inputs.
7	Adaptive Intelligent Control Algorithm	By using this algorithm it can improve the processing speed of system & reduces the cost of controller hardware.

Table 6.1 Issue wise Solution Approaches & Result

Issue2:- TroubleShooting

S. No.	Solution Approach	Results
8	Component & Object Oriented technology	Improve the response speed & provides a plate form for further research in terms of intelligent control of molding processes.
9	Dynamic Model Turning Minimum Variance Method	This method is used to control the whole process & control the product quality.

Table 6.2 Issue wise Solution Approaches & Result

Issue 3:- Production & Stock Management

S. No.	Solution Approach	Results
10	MS Visual Web Developer 2005 Express & MySQL Database tools	It can reduce time & cost for the organization.

Table 6.3 Issue wise Solution Approaches & Result

Issue 4:- Controlling Process of Hot Runner Type Injection Molding Machine

S. No.	Solution Approach	Results
11	Reciprocating screw & Plunger type mechanism & Control Algorithm are used	The performance of precisely metering is as good as the Sodick Plustech Tuparl TR30EH. (Machine Name)
12	Adaptive Algorithm	Improve the overall performance of IMM.

Table 6.4 Issue wise Solution Approaches & Result

VII. COMMON FINDINGS

Issue 1:- Controlling Process of Injection Molding Machine

- Adaptive intelligent control algorithm is used for the temperature control.
- Adaptive intelligent control algorithm based on Multi-CPU.
- Back-propagation & PIDNN control system control temperature of Plastic Injecting-molding Machine
- ARM-based distributed intelligent control system of the injection molding machine could improve the control capability, the management level by optimizing the process parameters, dynamically tracking, controlling the molding process, establishing and updating the processing knowledge base. Dual ARM processor control system is better approach to provide a reference for the control system software design on different models of injection molding machine.
- PID neural network control algorithm combined with the ARM technology could achieve better temperature control effect

Issue 2:- Trouble Shooting

- Proposed object-oriented technology & case based reasoning technology.
- Case based and rule-based reasoning to form a model for solving trouble-shooting problems in molding processes.
- Reduce the dependency on human expertise needed for decision-making.

Issue 3:- Production & Stock   Management

- Proposed Model Reference Adaptive Control (MRAC) scheme.

- The mechanism for adjusting the parameters in a MRAS could obtain in two ways: by using a gradient method (MIT Rule) or by applying stability (Lyapunov) theory.
- Proposed control scheme is prospective to implement in the real system.

Issue 4:- Controlling Process of Hot   Runner Type Injection Molding Machine

- Proposed a special purpose controller & a human machine interface for hot runner type micro injection molding module.
- Hot runner type micro injection molding module is tested with a reciprocating injection molding machine & find out the test results showed that the etering precision of using this module is at least as good as a two stage reciprocating screw.

VIII. SCOPE FOR THE WORK IN AREA

- Further work can be done on Injection Molding Machine for controlling process like that Mold close , Mold open , Unit return , Unit forward etc.

- In Future we can use the Multi CPU process technology than increases the product quality & consumption time.
- Further work can be done on Injection Molding Machine for controlling process with the help of Servo Motor.

IX. CONCLUSION

We have elaborated review of 20 research papers ranging from 2001 to 2013 based on controlling analysis of Injection Molding Machine. The review process consists of 3 stage analysis. Basically we found four main issues in the field of Controlling parameters of Injection Molding Machine viz. Controlling Process of IMM ,Trouble shooting problem , Production & Stock Management , Problem of IMM, Controlling process of Hot Runner Type IMM. Here after finding the solution approaches we concluded that controlling parameters of   Injection Molding Machine is the main area into which the future work can be done. We found different Solution approaches out of which Case based reasoning, Control Algorithm , Control Algorithm MS Visual Web Developer 2005 Express Model , Predictive Control Methodology , Temperature Control by training & self learning process, Multilayer group method of data handling algorithm.

The exhaustive review could finally lead to extract findings in the area of Controlling analysis of Injection Molding Machine, strengths and weaknesses and scope of work during M. Tech II semester Research work.

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