



# A Review on Control of Plastic Extrusion Process

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**ABSTRACT:** The plastic extrusion process is the well-known process for the plastic industries but is also well accepted by the pharmaceutical industries. With the use of plastic extrusion process, we can increase solubility and bioavailability. It has also proven to be a robust method. It also investigates about the application of genetic algorithm in the design and implementation of Fuzzy logic controller. FLC use membership function generated by human operators. This research develops a system that may help users to determine the membership function of FLC using the GA optimization for the fastest processing in completing the problems.

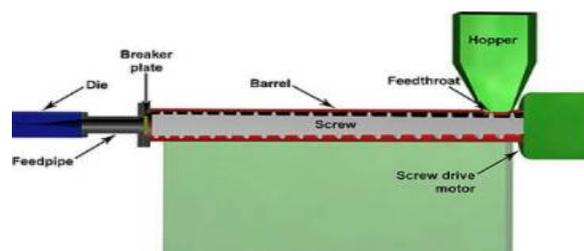
**KEYWORDS:** Extrusion, Fuzzy Logic Controller, Genetic algorithm, Membership function.

## I. INTRODUCTION

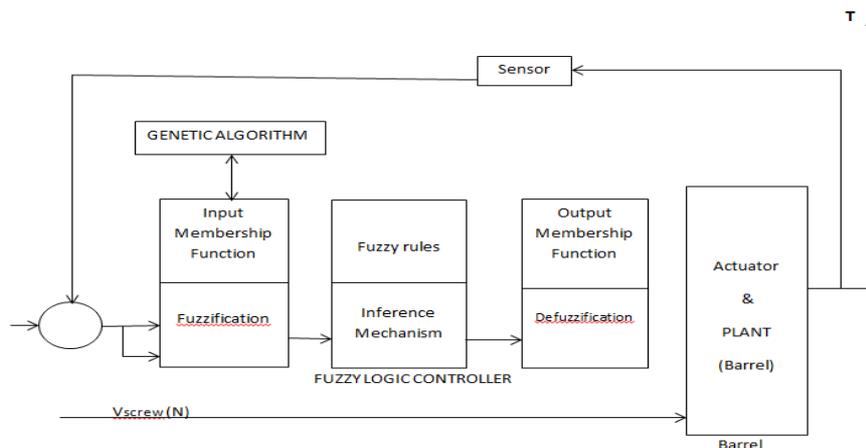
Plastic extrusion has been a challenging process for many manufacturers and researchers to produce products meeting requirements at the lowest cost. The complexity of extrusion process and the enormous amount of process parameters involved make it difficult to keep the process under control. Extrusion is a well-established technique widely used in different industries like aluminium, sheet and plastic. The extruder typically consists of large barrel divided into several constant temperature zones, with a hopper at one end and die at another end. The extrusion process control system had to be based upon the use of timers, counters, individual temperature controllers and speed controllers. Less satisfactory performance has been achieved by such systems due to the dependence of human operators for the combination of the individual controllers. Here we propose the temperature control of plastic extruder using the fuzzy genetic algorithm. The aim of the article to review is to review the research for the determination of process parameters and the design for plastic extrusion, research is based on various logic, genetic algorithm (GA).

## II. PLASTIC EXTRUSION

Plastic extrusion is a process for converting plastic material from solid to liquid states and reconstituting them as finished components. There are numerous hardware considerations that can influence the quality of extrusion, for example, screw geometry, screw rotation speed and barrel heater temperature must be calibrated to suit the specific type of plastic being fabricated



The temperature control in industry is a crucial process. Temperature control decides the nature and rigidity of the material. The temperature control is a tedious process which involves monitoring and quick response from the controller. Extrusion can be defined as the process of forming a new material, the extruder by forcing a material through a die under controlled conditions. The raw materials are pumped through the die by a rotating screw under elevated temperatures, see Figure. Extruders provide extensive mixing and agitation that causes de-aggregation of the suspended particles in the molten polymer resulting in a uniform dispersion. Most extruders consist of three parts: a conveying system for material transport and mixing, a dying system that forms the extruder and downstream supplementary equipment such as cooling, cutting or collecting the products.



### III.FUZZY LOGIC CONTROLLER

Fuzzy logic process (fuzzy inferences) provides a formal methodology for representing, manipulating, and implementing a human’s heuristic knowledge about how to control a system. The Fuzzy controller is composed of four following elements:

1. Fuzzy rules (a set of IF-Then rules), which contains a Fuzzy logic quantification of the expert’s linguistic description of how to achieve good control.
2. An inference mechanism(also called inference engine fuzzy inference module), which emulates the experts decision making in interpreting and applying knowledge about how is the best to control the plant.
3. A fuzzification interface, which converts inputs into information that the inference mechanism can easily use to activate and apply rules.
4. A defuzzification interface, which converts the conclusions of the inference mechanism into actual inputs for the process.

### IV.GENETIC ALGORITHM

The genetic algorithm is determined as the optimal die gap programming of extrusion blow moulding processes using soft computing techniques. The GA searching efficiency was enhanced using the introduction of a fuzzy inference of the engineering knowledge .Each individual in the population is called a “chromosome”, representing a solution to the problem at hand. For three variable problems hence, chromosomes will arrange three genes. The chromosomes evolve through successive iterations, called generations.

During each generation, the chromosomes are evaluated, using some measures of fitness. To create the next generation, new chromosomes, called offspring, are formed by either:

- Merging two chromosomes from current generation using a crossover operator
- Modifying a chromosome using a mutation operator.

A new generation is formed by:

- Selecting, according to the fitness values, some of the parents and offspring



- Rejecting others so as to keep the population size constant.

## V. PREVIOUS WORK

Ware.E[1], explained the extrusion of molten plastic on the wire and other metal shapes requires very close control of numerous variables to ensure consistent product quality at maximum production rates. The advent of the programmable controller afforded the opportunity to accomplish a higher degree of coordination and extruder performance by integrating the variety of individual controls into a single system. A key element of the control integration was the performance of closed loop temperature control by the program of the programmable controller.

Mohd Sali Saad[2], investigated the implementation of PID controller tuning using two model heuristic techniques which are Differential Evolution(DE) and Genetic Algorithm(GA).The optimal PID control parameters were applied for high order system, the system with delay and non-minimum phase system. The performance of these techniques is evaluated by setting their objective functions as Mean Square Error(MSE) and Integral Absolute Error(IAE).The reliability between DE and GA in consistently maintaining minimum MSE is studied. The performance of the PID control system tuned using GA and DE method are compared with Zeigler Nicholas method.

Seema Nara, Pooja Khatri and Jatin Garg[3], said that any temperature control system like an oven, take the certain time to heat up initial. But with the help of genetic algorithm, this time, taken to heat up can be reduced. And the oven can be made to start instantly without wasting time. It was very difficult to achieve an optimal gain like this as up to the present time the gain of the controller has to be manually tuned by hit and trial. Thus, the paper described the Genetic algorithm approach that would certainly reduce manual effort and give an accurate result.

S.Ravi, P.A.Balakrishnan[4], developed and tested GA-based Fuzzy logic controller for temperature control in a plastic extrusion through simulation. The system was designed with two different control techniques to control a temperature at different set point changes and as well as to control sudden input disturbances. The method was robust against changes in the system parameters and superior to the Fuzzy controller.

A.K.Kochar[5], presented the alternative methods for determining plastics extrusion process models, suitable for high-level control are examined. The importance of time series techniques for feed forward control is demonstrated. The results of extrusion process dynamic model identification experiments, carried out on a single screw extruder used for processing polyethylene are described. Some results of exploratory control strategy simulations were included.

C.C.Tasi and C.H.Lu[6], described the design of single loop fuzzy supervisory predictive PID controllers for a plastic extruder barrel. A fuzzy supervisory shell is proposed to improve the set point tracking performance of the proposed PID method by appropriate adjustment of the weighting term for the control effort.

Ismail Yusuf, Nur Iksan, Nanna Suryana Herman[7], investigated an application of Genetic Algorithm in the design and implementation of Fuzzy logic controllers. This idea was used in a real case application called extrusion of plastic. The comparison of various parameters showed that GA is helpful in improving the performance of FLC. The research developed a system that may help users to determine membership function of FLC using the GA optimization for fastest processing in completing the problems.

Huailin Shu and Hugo Pi[8], analysed the characteristics of the temperature control systems in the industry which have long delayed time, large time constants and strong couple effects. Then introduced a proportional, integral, derivative neural network(PINN) is a multivariable controller. The result proved that the PID neural network has perfect decoupling and self-learning control performances in the coupled temperature system.

Hongfu Zhou[9], introduced a linear control design method for the temperature control in injected mould machine. The temperature control systems was a time delay system, which was described in the first order system on the transfer function. The temperature control fuzzy model had two inputs and one output and using trapezoidal membership function for fuzzification. Simulink in Matlab was used to simulate fuzzy control and best fuzzy parameter.



Jaswinder Singh and Aman Ganesh [10], investigated that the Adaptive Neural Controller(ANC) is used since because it causes flow disturbances and sensor noise is common in chemical and metallurgical industries. In order to maintain optimal performance, the controlling system has to adapt continuously to these changes. Using a neural network controller, ANC modifies network parameters through the genetic algorithm. Along with fuzzy logic controller is also implemented for the online tuning of PID controller even in the presence of noise. The simulation results showed that identified GA-based adaptive neuro-controller along with PID controller was able to adapt the process changes.

Leehter Yao and Chin-Chin Lin [11], presented the adaptive fuzzy PID controller with gain scheduling is proposed in the paper. The structure of the proposed gain scheduled fuzzy PID (GS\_FPID) controller consist of both fuzzy PI-like controller and fuzzy PD-like controller. Both of fuzzy PI-like controller and PD-like controller are weighted through adaptive gain scheduling which is determined by fuzzy logic. A modified Genetic Algorithm called accumulated genetic algorithm was designed to learn the parameters of fuzzy inference system.

Sheros Khan, Salami Femi Abdulazeez, Lawal Wahab Adetunji, AHM Zahir Alam[12], investigated all control systems suffer from problems related undesirable overshoot, longer settling times and vibrations while going from one state to another state. This was based on a software approach which was focusing on an algorithmic approach to programming a PIC16F877A microcontroller for eliminating parametric dependence issues while adding the benefits of easier modification to suit a given control system to changing operational conditions.

Ali Riza Mehrabian.Y and Morteza Mohamed Zaheri[13], presented a systematic approach for the design of temperature controller using GA for the thermal power plant subsystems and investigates the robustness of the designed control law. The proposed approach employs GA search for determination of the optimal PI controller parameters for a previously identified non-linear de-super heater of a 4X 325 MW thermal power plant. Results indicate proposed algorithm significantly improves the performance of the thermal power plant subsystem.

Chi Huang Lu and Ching-Chih Tsis[14], presented an adaptive decoupling temperature control for an extrusion barrel in a plastic injection molding process. After establishing a stochastic polynomial matrix model of the system, a corresponding decoupling system representation was then developed. Results proposed that proposed method has been shown to a powerful under set point changes, load disturbances and significant plant uncertainties.

Prabhat Kumar Mahto, Rajendra Murmu[15], developed an ANFIS controller design method for temperature control in plastic extrusion system at different set point changes as well as sudden input disturbances controlled with different control techniques. The temperature of the plastic extrusion system had a wide range of variation subject to various disturbances. All the PI, PID, FUZZY,ANFIS control method was simulated using Matlab/Simulink. It has been concluded that ANFIS controller gives better performance than three other controllers.

## **VI. RESULT AND CONCLUSION**

GA has been successfully applied to solve many optimization problems. In this research, genetic algorithms are implemented to a system (programming language) for determining the membership function of FLC.This research developed a system that helps users to determine the membership function of FLC using the GA optimization for the fastest processing in completing the problems. The data collection is based on the simulation results and the results refer to the maximum overshoot. Plastic extrusion proved to be a robust method and, therefore, it is useful in all type of industries enlarging the scope to include a range of polymers that can be processed with or without plasticizers.

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