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DESIGN OF THE FEEDBACK CONTROL SYSTEM TO CONTROL THE EXTRUSION PROCESS

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Introduction

A rapid prototyping method makes it possible to produce complicated parts based on computer 3D model. Most of the rapid prototyping methods can assemble models from a variety of widespread and special materials. The modern additive technology for most of 3D-printers requires ABS-filaments or PLA-filaments, respectively, from ABS (Acrylonitrile butadiene styrene) polymer or PLA (Polylactic acid) polymer, with a diameter of 1.75 mm or 2.85 mm, which are used as a consumable material in 3D printing technology.

Filament is obtained from plastic granules, which in case of ABS, are the products of oil and gas industry. Accordingly, the price of granules is much cheaper than the price of the finished product, even taking into account the cost of electricity consumed in transformation of the granulate in the filament.

In this article, factors affecting the diameter of plastic filaments are investigated, the problem of improving the quality of the filament plastic in the extrusion process is considered.

Statement of the problem

A great deal of the research has been conducted at universities and research institutions to expand the applications of FDM technology and to improve the FDM process. The work has also been in progress in some organizations to develop new metallic or ceramic materials for rapid fabrication of functional components by FDM with higher mechanical properties [2, 3].

In operations of the 3D-printer, the basic parameter affecting the quality of the finished product and fidelity digital models is the diameter of

the plastic filament. Therefore, to improve the production of plastic filaments, it is necessary to investigate and correct the plastic filament control loop diameter.

In order to stabilize the diameter of the plastic filament, we must consider the dependence on other parameters such as temperature in the heated zone of the screw, the screw speed, the pressure in each zone of the screw and others. Changing any of these parameters leads to change in the diameter of filament.

The most important parameter that have a permanent effect on the change in the diameter of the plastic filament is heating temperature and screw speed. On the base of this parameter, an experiment has been conducted with a real object.

Figures 1 and 2 show the graphs of the experiment conducted with an extrusion installation showing the temperature and speed of the screw dependence of the diameter.

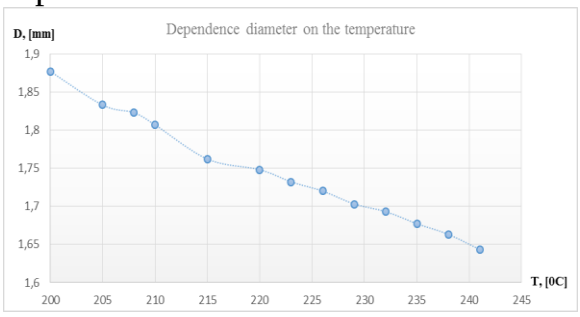

Figure 1.

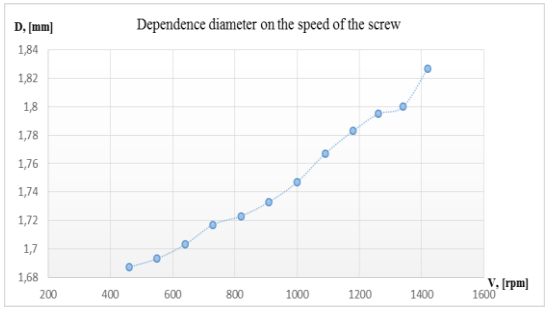

Figure 2.

From the graph in Fig.1 it can be concluded that the higher the temperature, the smaller the diameter.

Analyzing the resulting graph in Fig. 2, we can conclude that increase in the drive speed increases the diameter of the filament in the plastic extruder.

For a simple model of the extruder, the control parameters such as drive speed and the heating temperature are changed manually. The influence of external factors is not taken into account in the system. Consequently, the system is not able to respond to external perturbations in the form of changes in ambient temperature, changes in the composition of raw materials, etc., thereby increasing the range of variation of the filament diameter.

The arguments above lead to the need for a system of automatic control of the loop diameter to provide the required accuracy and speed in the production process. The developed algorithm of adaptive digital PID control can solve the tasks. Figure 3 shows a functional line diagram of an extruder feedback

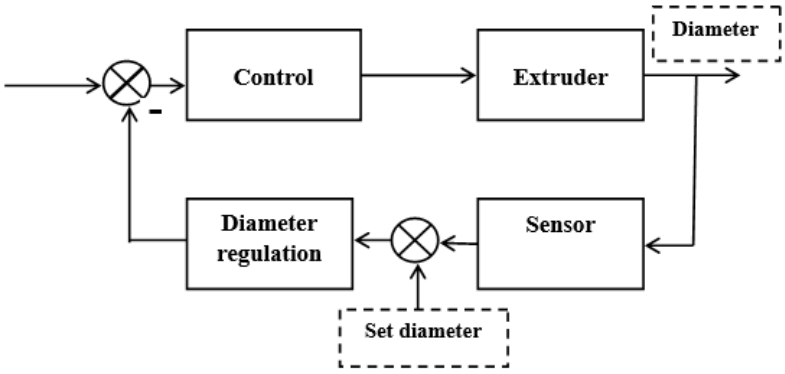

Fig.3. Functional diagram of the extruder line with feedback

This diagram shows the connection of the probe diameter and electric installation, temperature sensor, and others. The controller is designed to form the control signal for diameter regulation when a signal comes from the sensor.

Conclusion

In this paper, the conducted a study of factors affecting the diameter of the plastic threads are studied, and the problem of improving the quality of the plastic thread in the extrusion process is considered. The theoretical rationale for developing a feedback system for extrusion plant to improve the quality of the product, to reduce the number of rejects and to ensure continuous operation for a long period is provided.

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