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DEVELOPMENT OF A SCREW EXTRUDER FOR A 3D PRINTER TO PROCESS COMPOSITE MIXTURES INTO FINISHED PRODUCTS

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Abstract.
The report presents the development and implementation of a screw extruder for FDM 3D printing, which significantly improves the processing of fiber-reinforced composite materials.
Keywords: 3D printing, 3D printer, screw extruder, filament, composite mixture, polymer matrix.

3D printing technology using fused deposition modeling (FDM) is one of the most widely used additive technologies. It is based on feeding a polymer filament into an extruder, where the material is heated to a melting state and applied layer by layer through a nozzle to form a product. Standard 3D printers are usually equipped with a filament feed mechanism that ensures a stable supply of material, an extruder with a heating element for melting the polymer, a forming nozzle, a printing platform that allows you to create three-dimensional objects, as well as a control system that coordinates the movement of the print head and the supply of material. However, the use of standard 3D printers for processing composite materials that contain various reinforcing fibers has significant limitations. This is due to the fact that traditional feed systems often do not provide a uniform material flow due to the accumulation of fibers, there are problems with nozzle clogging due to the heterogeneous structure of composites, insufficient mixing of the components of the composite mixture and accelerated wear of extruder parts due to the abrasive action of the fibers.

Composite materials, which consist of a polymer matrix (e.g. ABS, PLA or PETG), reinforced with various types of fibers (natural fibers, carbon fibers or glass fibers), provide significant advantages, such as improved mechanical strength, increased thermal resistance, reduced product weight, as well as better performance characteristics [1–3]. To effectively work with such composites, it was necessary to improve the design of the extruder by introducing a screw feed system (screw extruder). The screw extruder allows for uniform and high-quality mixing of components, stabilizes the material supply, effectively controls the pressure in the extrusion zone, which significantly reduces the likelihood of lumps and nozzle clogging, improves the stability of the printing process and the quality of finished products. The proposed new extruder design was successfully implemented on the Anycubic Mega S 3D printer, which allows this device to be effectively used for working with composite materials (Fig.1).

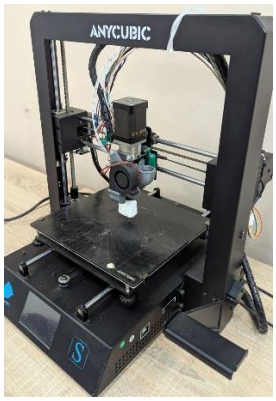

Fig.1-Anycubic Mega S 3D printer equipped with a screw extruder
for printing composite mixtures

As a result of the introduction of the screw extruder, the quality and stability of printing with composite mixtures is significantly improved, which opens up additional prospects for research and applications in various industries.

The general view of the developed screw extruder is shown in Fig.2.

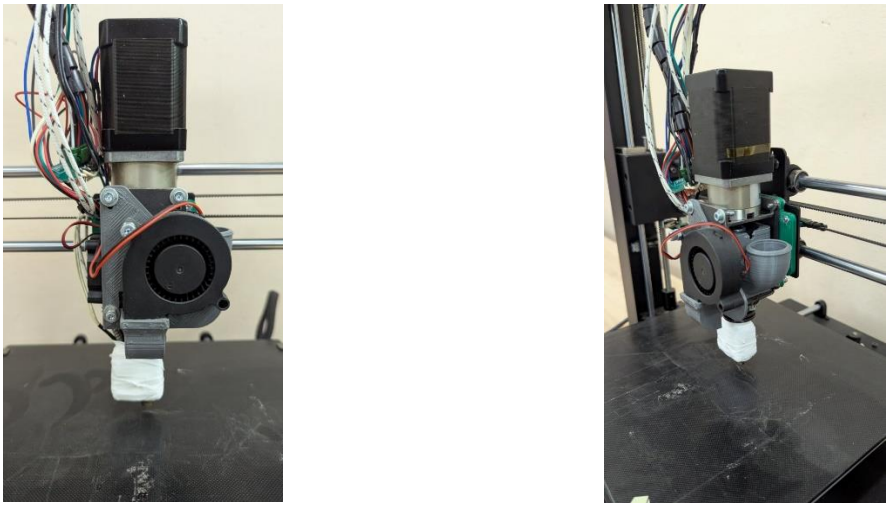

Fig.2-General view of the developed screw extruder

The integration of a screw extruder into the design of a 3D printer significantly increases the efficiency of the printing process with composite materials, by ensuring a uniform and continuous supply of material, stabilizing extrusion parameters, and reducing the risk of clogging in the nozzle area. Such modernization allows to reduce material losses, improve the surface quality of products and achieve greater repeatability of printing results. In addition, the obtained samples are characterized by greater structural uniformity, which creates favorable conditions for further experimental studies to determine their mechanical properties, in particular, the strength limit, stiffness, wear resistance and behavior under operational loads.

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РОЗРОБКА ШНЕКОВОГО ЕКСТРУДЕРА ДЛЯ 3D-ПРИНТЕРА ДЛЯ ПЕРЕРОБКИ КОМПОЗИТНИХ СУМІШЕЙ У ГОТОВІ ВИРОБИ

Анотація.

У доповіді представлено розробку та впровадження шнекового екструдера для 3D-друку FDM, який значно покращує обробку композитних матеріалів, армованих волокнами.

Ключові слова: 3D-друк, 3D-принтер, шнековий екструдер, філамент, композитна суміш, полімерна матриця

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