Abstracts

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S17-827	Mechanical characterization of Multifold® cardboard angles and the study of the effect of the type of paper, the type of polymer adhesive, and the humidity on their mechanical properties
S17-836	Thermo-acoustic properties of milkweed fiber/polyurethane composite foams

S01-720 New Generation of Extruders with Active Grooved Feed Section and Rotational Barrel Segment

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Since 2017, as part of the Horizon 2020 Program, an international research and training project entitled "Research and development of new generation extruders for processing composite and nanocomposite materials" with the acronym NEWEX has been implemented. As part of the research, a new, activated plasticizing system of the extruder was developed, with an active grooved feed section (AGFS), a rotational barrel segment (RBS) and a special screw (SS) structurally adapted to the changed cylinder geometry. From several designed solutions of each of the above-mentioned vital elements of the extruder, three were selected and their 3D models were made using known incremental methods. Then, using proprietary software, computer simulations of the operation of the obtained plasticizing systems were carried out. On this basis, the optimal plasticizing system was selected and made in metal. The investigations were carried out on: output, melt temperature at die exist (Tmelt), mechanical power consumption (Power), length of screw required for melting (Lmelting), viscous dissipation, the pressure (P), the solids (X/W), the maximum temperature in the solids (Ts max) and the barrel temperature imposed (TBarrel) along the extruder. This paper presents a research methodology leading to a new generation extruder, equipped with several innovative elements that have not been used in such processing machines so far.

New Generation of Extruders with Active Grooved Feed Section and Rotational Barrel Segment

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Abstract. Since 2017, as part of the Horizon 2020 Program, an international research and training project entitled "Research and development of new generation extruders for processing composite and nanocomposite materials" with the acronym NEWEX has been implemented. As part of the research, a new, activated plasticizing system of the extruder was developed, with an active grooved feed section (AGFS), a rotational barrel segment (RBS) and a special screw (SS) structurally adapted to the changed cylinder geometry. From several designed solutions of each of the above-mentioned vital elements of the extruder, three were selected and their 3D models were made using known incremental methods. Then, using proprietary software, computer simulations of the operation of the obtained plasticizing systems were carried out. On this basis, the optimal plasticizing system was selected and made in metal. The investigations were carried out on: output, melt temperature at die exist (*Tmelt*), mechanical power consumption (*Power*), length of screw required for melting (*Lmelting*), viscous dissipation, the pressure (*P*), the solids (*X/W*), the maximum temperature in the solids (*Ts max*) and the barrel temperature imposed (*TBarrel*) along the extruder. This paper presents a research methodology leading to a new generation extruder, equipped with several innovative elements that have not been used in such processing machines so far.

Keywords: Extrusion, Extruder, single screw

PROJECT NEWEX

Lublin University of Technology is implementing a project financed by the European Union, the Research Executive Agency (REA) from the Horizon 2020 program, entitled "Research and development of new generation extruders for processing composite and nanocomposite materials" with the acronym NEWEX. Three companies participate in the project, i.e. SEZ Krompachy a.s. (Slovakia), Dirmeta UAB (Lithuania) and Zamak Mercator Sp. z o.o. (Poland), as well as 3 universities: University of Minho (Portugal), University of Kosice (Slovakia) and Lublin University of Technology, 51 people in total.

The main research goal of the NEWEX project is the construction and testing of a new innovative extruder, in which, thanks to the new concept of its key parts, i.e.:

- Active Grooved Feed Section (AGFS),
- Original Rotational Barrel Segment (ORBS), and
- Special Screw (SS),

a new plasticizing system will be applied. The new design solution will enable the processing of previously difficult-to-process materials for applications in the food, cosmetic and pharmaceutical industries, filled primarily with new types of fillers, facilitating the production of new products with improved properties.

In addition to the research and development goal of the project, it is very important to develop international and intersectoral cooperation between the industrial and scientific sectors. The project mainly includes activities related to the secondment of workers from the industrial sector to the scientific sector and vice versa. A secondment lasts at least 1 month, during which research and development works are carried out and various meetings, trainings, lectures and workshops are organized, primarily aimed at transferring knowledge. These activities are carried out during meetings of the project participants in various places organized by the host institutions (Fig. 1).

Activities in the project are carried out in the field of 4 main Work Packages (WP1-WP4) supported by 3 additional Work Packages (WP5-WP7) - Figure 2, in which 51 people in total participate, including 12 from Lublin University of Technology.

FIGURE 1. Meetings of project participants during secondments.

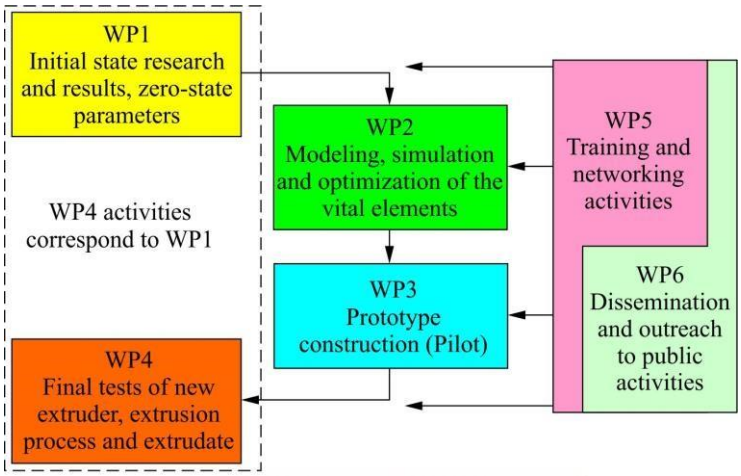

FIGURE 2. Diagram of Work Packages planned in the NEWEX project.

So far, as part of the cooperation and project implementation, 7 workshops and 3 trainings have been organized, an e-learning platform and a project website have been created, and participants have attended 10 international conferences, presenting 24 works. The project inspired the development of 21 patent applications, 14 of which have already obtained a positive decision from the Patent Office in Poland, Slovakia and Portugal. Project participants took part in 3 International Invention Exhibitions in Geneva (Switzerland), Seoul (South Korea) and Nuremberg (Germany). The presented solutions were appreciated by the international Jury, which awarded them a gold medal in Geneva and Nuremberg, and a bronze medal in Seoul - Figure 3. During the project, 25 scientific studies were made, which were also published in high-rated magazines, e.g. in Polymers, Chemical Industry, Facta Universitatis Series: Mechanical Engineering and 3 scientific monographs have been written and published – each year in a different country.

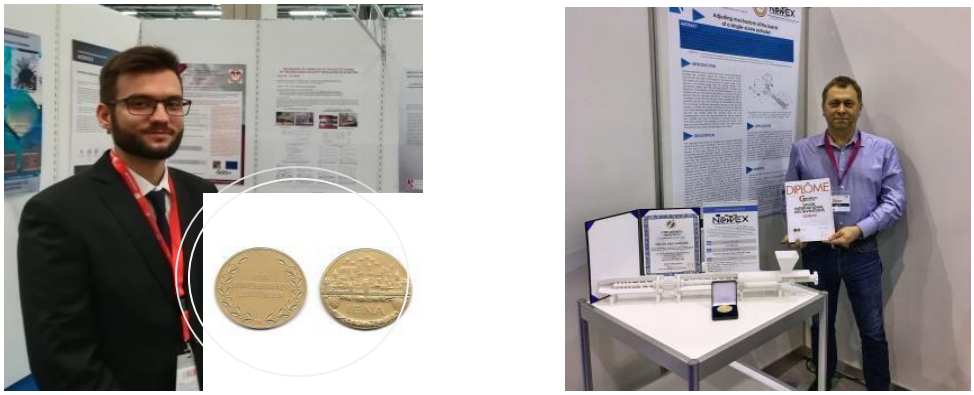

FIGURE 3. Łukasz Majewski, MSc., during the exhibition in Geneva and prof. Janusz Sikora at the exhibition in Nuremberg.

In the field of research and development, tests were first carried out of the classic extruder, the conventional extrusion process and selected properties of the obtained extrudate. A strength, thermal and structural analysis of various solutions of the active grooved section, the rotational barrel segment and the special screw were carried out. This analysis was performed primarily with the finite element method using the ABACUS software and the computer-aided design program SolidEdge. The next step was to perform a computer analysis and simulation of the extrusion process using plasticizing systems obtained with various combinations / connections of the designed: active grooved section, rotational barrel segment and a special screw, using the Ansyss Polyflow software. On this basis, the most favourable solutions were selected, which were printed as 3D models on a real scale (Fig. 4).

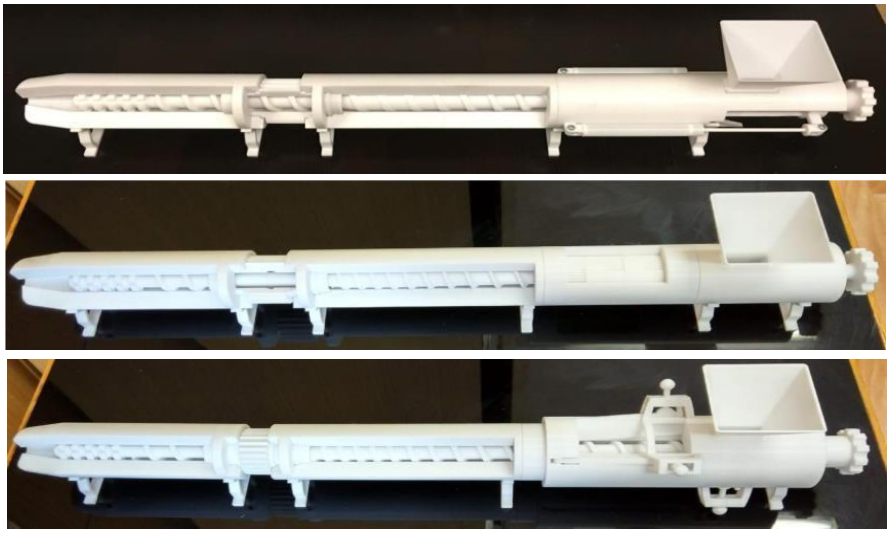

FIGURE 4. 3D models of plasticizing systems with proposed design solutions of an active grooved feed section, a rotational segment and a special screw.

Then, the individual components of the selected model were made in metal by the project Beneficiaries from the industrial sector (Fig. 5), additional equipment was selected in the form of screw drive and rotational segment, pressure and temperature sensors and heaters. All these elements were put together to obtain the extruder prototype, which was equipped with an automatic control and regulation system (Fig. 6).

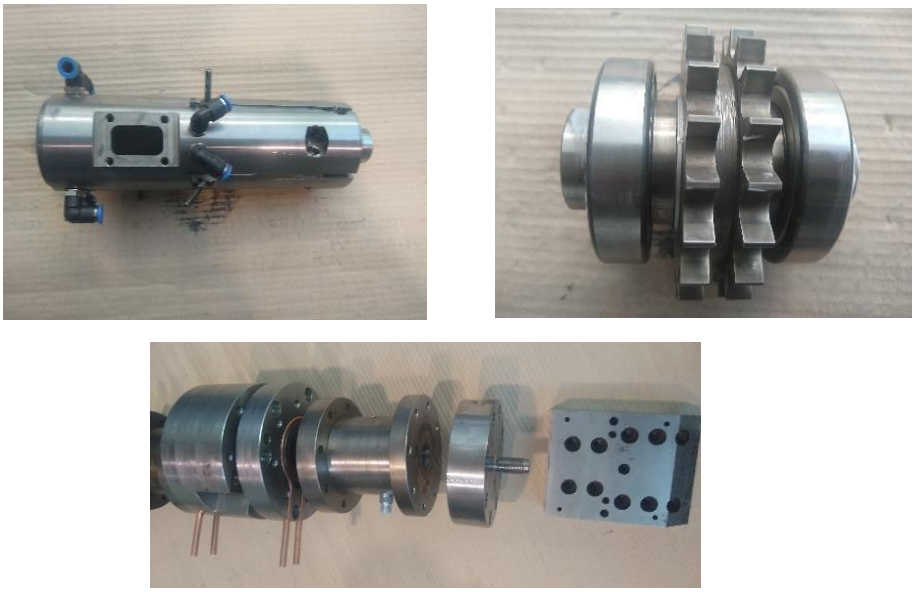

FIGURE 5. Exemplary components of a new extruder.

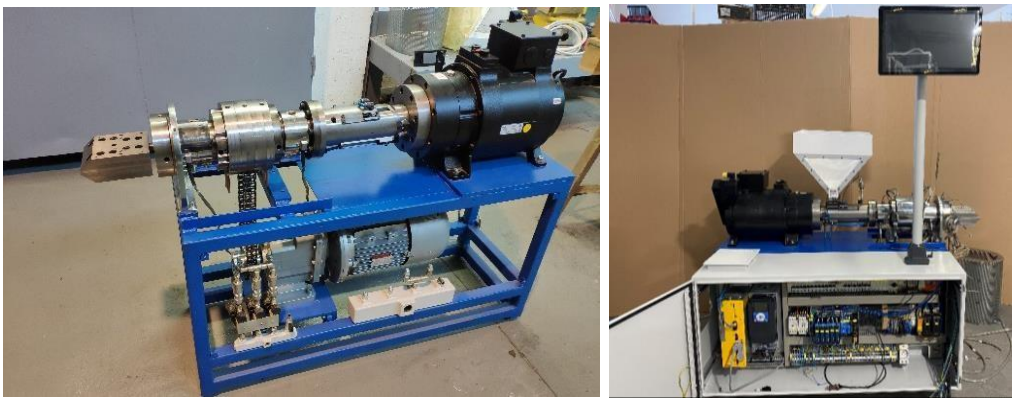

FIGURE 6. Prototype of the extruder developed under the NEWEX project.

In the near future, we intend to research a new extruder and a new extrusion process as well as selected extrudate properties, as well as conduct a comparative analysis between the classic extruder and the new extruder developed under this project.

ACKNOWLEDGMENTS

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