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ANALYSIS OF THE STRENGTH AND PERFORMANCE PROPERTIES OF PLASTIC PARTS IN TRANSPORT VEHICLES

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Annotatsion: During the development of a new composite polymer material, the influence of the type and amount of fillers on the physical and mechanical properties of local polypropylene was studied, and a sample part was obtained.

Keywords: Polypropylene, polyamides, polyvinyl chloride, Elongation, Izod.

Introduction. When analyzing the research conducted by scientists from leading countries, it becomes evident that within the field of materials science in mechanical engineering, special attention is being paid to the development of scientific studies focused on the targeted use of non-metallic materials—particularly polymer materials. Moreover, ensuring the physical, mechanical, and operational reliability of thermosetting and thermoplastic polymers through the optimization of their compositions remains one of the key scientific and practical challenges awaiting effective solutions in various branches of mechanical engineering.

In Uzbekistan, the production of goods from polymer composite materials has been well established, and measures are being taken to ensure resource efficiency through the use of locally available raw materials. The Action Strategy for the Further Development of the Republic of Uzbekistan for 2017–2021 outlined objectives such as “strengthening macroeconomic stability and maintaining high economic growth rates, increasing the competitiveness of the national economy, reducing energy and resource consumption in production, and expanding the introduction of energy-saving technologies.” Achieving these goals—particularly through the development of high-quality products made from multifunctional composite polymer materials, improving the quality, design, and cost efficiency of molded products in line with international standards, and creating resource-saving technologies using local raw materials—is among the important tasks.

Today, the use of plastic materials and their composites in the manufacture of automotive parts is steadily increasing, primarily to reduce vehicle weight, save metal, and simplify component production. It is well known that there are many types of plastic materials, but the most commonly used in industry are thermoplastic polymers, rubber, and others. Due to their light weight, thermal and chemical resistance, excellent insulating properties, and favorable technological and operational characteristics, plastic materials are used not only as substitutes for metals but also as essential materials in their own right.

Currently, polymer materials play a major role in the automotive industry. The use of polymer materials in vehicle production offers numerous advantages: convenience, low cost, reduced weight, resistance to corrosion and impact, and design flexibility. Because of these benefits, polymers have secured a permanent place in automotive design, and their use in the manufacturing of vehicle components is expected to remain significant in the future.

A modern vehicle contains nearly 30,000 individual parts, about one-third of which are made of plastic. Moreover, over 70% of these plastics consist of just four polymers: polypropylene, polyurethane, polyamides, and polyvinyl chloride.

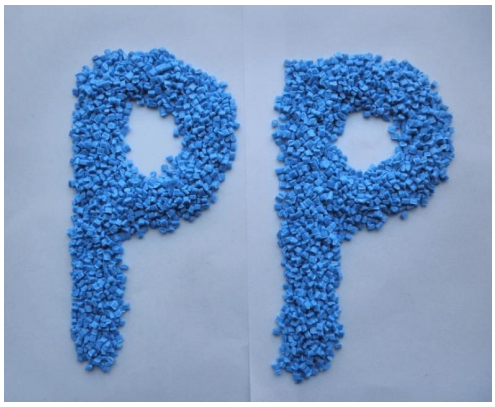
In recent years, plastics have become one of the essential materials for the design, operation, and safety of automobiles. Overall, the consumption of polymers in the automotive industry is expected to continue growing. To date, polymer composite materials based on ethylene and propylene copolymers occupy a leading position among various compounds. They are widely used both in the automotive industry and in the production of household appliances. This is allowed due to their ability to function within a wide temperature range from –60 °C to +135 °C.

The widespread use of these composites is attributed to the fact that polypropylene-based compounds exhibit high impact resistance, rigidity, cold resistance, and enhanced energy absorption capacity, while also being relatively inexpensive due to the cost-effectiveness of the components used. In addition, the use of elastomers, fillers, and other additives in their composition allows for a wide range of modification of these composites' properties [2].

Typically, the introduction of fillers into the compound leads to a decrease in elasticity and an increase in density, or to a reduction in stiffness and an increase in the compound's viscosity. The continuously growing demand for modern polypropylene-based compounds requires manufacturers to search for innovative solutions in material formulation and processing.

Objects and Methods of Research

In this work, polypropylene grade PP J370 with a melt flow index (MFI) of 35 g/10 min, produced by SP LLC "Uz-Kor Gas Chemical," was used. Kaolin produced by the company Angren Kaolin, grade AKT 10, with a particle diameter of 17.8 μm, was used as the filler. Test samples were prepared by injection molding at a temperature of 220–240°C. For the initial stages of the research, only a single filler (one-component) was selected. The amount of the filler is gradually increased step by step. In the process of developing the composition, the number and quantity of fillers are organized in a tabular form. The table is formed after several sample tests have been conducted.



The single-component research test was carried out in the following order. All main and auxiliary components were pre-mixed manually for 15 minutes and then loaded into a twin-screw laboratory extruder. The PP–talc compound, with a weight ratio of 95:5%, was processed into a recomposed raw material by extrusion at a temperature of 210 °C and a screw rotation speed of 100 rpm. Subsequently, test samples were produced using a thermoplastic automatic molding machine (TPA) by the injection molding method under pressure.

Results and Discussion

Laboratory test experiments were conducted on the obtained samples using the following equipment. The results of the tests are shown in Table 1.

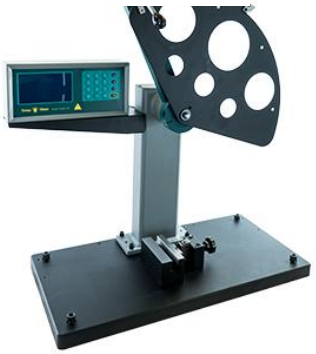


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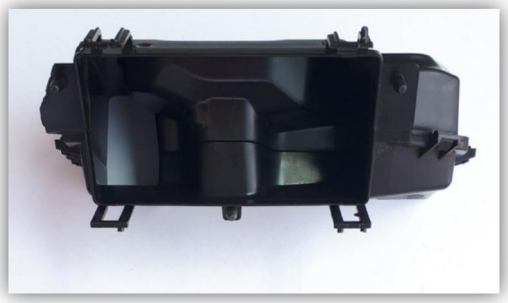
Table 1

Physica nical Properties of Poly with Talc and Kaolin Filler

№	Parameter	Testing Methods	JM-370 (95%) Talk 5%	JM-370 (95%) Kaolin 5%	JM-370 (90%) Talk 10%	JM-370 (90%) Kaolin 10%	JM-370 (85%) Talk 15%	JM-370 (85%) Kaolin 15%
1	Density, g/cm³	ISO 1183	0,955	0,944	1,007	0,989	1,044	1,023
2	Melt Flow Index,	ISO 1133	31,8	30,96	29,6	30,1	28,5	29,44

3	Tensile Modulus (strain rate 1 mm/min), MPa	ISO 527	1930	1866	2042	2020	2280	2256
4	Tensile Strength (strain rate 50 mm/min),	ISO 527	21	26,48	22,6	26,0	23,7	25,1
5	Charpy Impact Strength with Notch (+23°C), kJ/m²	ISO 179	3,6	3,56	3,2	3,41	3,04	3,28
6	Charpy Impact Strength with Notch (-30°C),	ISO 179	1,72	1,68	1,66	1,65	1,60	1,51
7	Heat Deflection Temperature (Load 1.81 MPa), °C	ISO 75-1	52,1	51,02	54,3	52,68	54,8	52,9

Air ducts labeled “DUCT ASM-AIR DISTR FRT” for the car interior ventilation system were manufactured from the obtained polypropylene composite with kaolin filler at “Uz-Koram Co” LLC. The parts were molded without defects.



The physical property tests were conducted as follows: the part was subjected to 168 hours at 95°C ± 3K and 24 hours at -30°C in a temperature-controlled device. The results were positive.

Conclusions

Thus, based on the experimental test results, it was determined that the presented samples fully meet the manufacturer’s requirements in terms of their high physical and mechanical properties as well as the optimal parameters of the production process.

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