Technical science and innovation

Volume 2022 | Issue 1 Article 10

4-15-2022

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13. N.F. Yefremov, T.V. Lemeshko, A.V. Churkin. “*Construction and design of containers and packaging”*. **2004**.
14. L.G. Varepo. “*Production of packaging from paper, cardboard and corrugated cardboard”*. **2002**. 200.
15. A. Karpov *“Production of packaging and containers: situation, equipment, technologies”*. **2001**. 35.
16. L.G. Varepo, I.V. Nagornova. “Manufacture of packaging from paper and cardboard with printed image: problems of ecology and recycling”. *“Polygraphs in modern Russia: materials intern. scientific. conference”*. **2001**.
17. I.V. Marchenko, O.P. Starchenko. “*Technology of tare and packaging*”. **2014**. 110.

PROSPECTS FOR USING METAL-POLYMER COMPOSITE STRUCTURES IN THE GEAR MANUFACTURING

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Abstract: *In this paper, some thermoplastic polymer composites and filler composites for the production of metal-polymer gear transmissions are presented. Efforts have been made to expand the raw material base and identify ways to increase the durability of gears through technological and design measures.*

Keywords: *polymer, composite material, gear, automated design system, basalt roving.*

INTRODUCTION. Wide range utilization of composite polymeric materials in various fields of technology is expanding. The main factors in this situation are the rapid development of chemistry, chemical technology and automated design systems. At the same time, it should be noted that a number of modern ideas in the field of "Mechanical Engineering and Machine Parts" have been formed and their effective application in design and construction is the basis for further increasing the durability, reliability and resource efficiency of various machines and mechanisms.

Currently, there are automated design systems such as ProEngineer, Unigraphics, Solid Edge, CATIA, EUKLID and others for the design and construction at the disposal of scientists, engineers, designers in the development of details of machines and various aggregates. Each of them includes special modules for calculating and building different types of gears and gear models. Gear transmissions and gears made from metals, despite their high load capacity, wide selection of a constant number of transmissions, high kinematic accuracy, the creation of their production base, a number of shortcomings include their large mass, low wear resistance, large resource and labor capacity, operation with noise at high speeds, resistance to shock loads, susceptibility to corrosion, requiring tolerances for each size, and so on. The use of composite-polymeric materials in the manufacture of gears reduces their mass, slightly reduces their delay, increases corrosion resistance, advanced and efficient, economical and ultra-precise injection molding technology, the use of precision methods, gear opens up prospects for expanding the material base for wheels. In practice, the use of combined gears made of metal with a flange and the rest of the mirrors, for example, fiberglass. These wheels have the advantages of both metal and all-plastic wheels. Their areas of application include the design of military and special equipment, technological equipment, driving mechanisms, and more.

However, despite some successes, the effective implementation of the proposed solutions is hampered by the lack of a single method for calculating the performance of the interconnected parts of the wheel. In addition, the diversity of polymer-composite materials used, as well as the diversity of chemical, physical and mechanical properties, place great demands on the level of scientific research. The joints between the metal gear flange, the polymer-composite filler and the wheel hub must be reliable (Figure 1).

It should be noted that plastic gears can be used in combination with metal gears to reduce noise, self-lubricate or provide chemical resistance at low load transmissions.

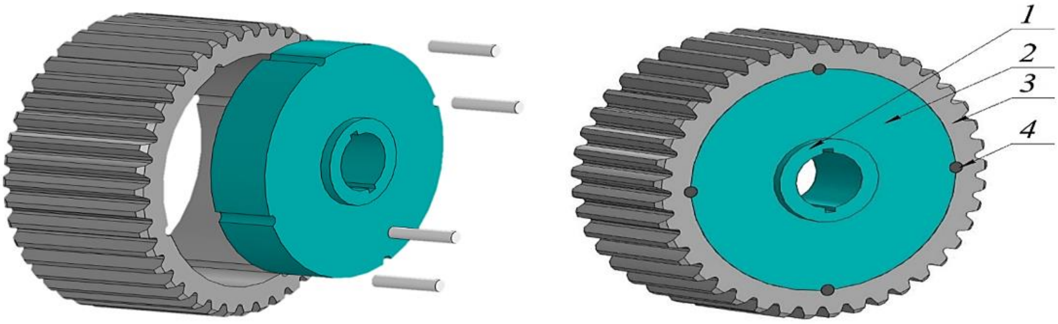

Fig. 1. Combined gears: 1-metal clutch; 2-Polymer filler; 3-toothed metal flange; 4- fastening pins.

They are not used in heavy-duty and percussive gear transmissions, as fiberglass-resistant plastics contain slippery particles that cause teeth to erode more quickly. Therefore, the metal pairs of plastic wheels must have sufficient rigidity.

MATERIAL AND METHODS. Many factors depend on the formation of strong joints on the joints of metal gears and blades with the polymer-composite filler. These include the choice of fillers for the wheels, their complex properties, technological rhythms, wheel dimensions, loading condition of the finished wheel, and more. Dense joints are formed at the joints, and the bending and rotational moments, the force on the axis, are observed separately or together. When a tight joint is affected by an axial force (Fig. 2, a), its strength condition can be expressed as follows:

$$F_a < \pi d l \rho f, \quad (1)$$

Where: F_a – axial force; d and l – diameter and length of cylindrical surface; f – coefficient of friction. (1) If the coefficient of gravity reserve K_t is included in the expression, it is possible to determine the required pressure at the connection surface:

$$p = \frac{K_t F_a}{\pi d l f}. \quad (2)$$

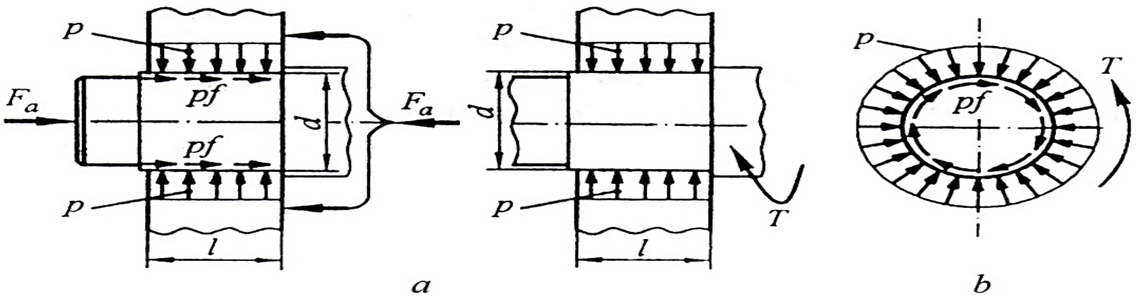

Fig. 2. The power to read the union F_a (a) and torque T (b)

RESULTS AND DISCUSSION. The required pressure value that ensures the integrity of the joint when F_a and T act together on gears with a combined design: where $F_t = 2T/d$. When the proposed F_a wheel is loaded together with the axial force F_a, torque T and bending moments M, the required pressure is greater than whichever is greater than the pressure determined by expressions (5) and (6). is evaluated according to.

Table 1

Thermoplastic polymer composite materials: "SABIC Innovation Plasties"

№	Base polymer	Kompozitning savdo belgisi	Komponent tarkibi	Improvement of properties
1	Polycarbonate (PC)	Labriloy D	PC	Impact viscosity, dimensional stability
2	Polycarbonate (PC)	Labriloy D-FR ECO	PC	Dimensional stability
3	Polyamide (PA)	Labriloy R	PA 66	Chemical tolerance, small noise
4	Polyoxymethylene (POM) based composite	Labricomp KL-4040	POM + PTFE	High friction resistance
5	(PC) Polycarbonate based composite	Labricomp DFL-4036	PC + SHT + PTFE	High strength, dimensional stability
6	Polybutylene terephthalate (PBT) based composite	Labricomp WFL-4036	PBT + SHT + PTFE	High durability
7	Polyamide (PA) based composite	Labricomp RFL-4036	PA66 + SHT + PTFE	---------------------
8	Polyphenylene sulfide based composite (PFS)	Labricomp OFL-4036	PFS + SHT + PTFE	High strength, temperature stability
9	Polyesterimide (PEU) based composite	Labricom EFL-4036	PEI + SHT + PTFE	Temperature and size stability
10	Polyphthalamide (PFTA) based composite	Labricomp UFL-4036	PFTA + SHT + PTFE	Temperature stability, propensity to specific pressure velocity factor
11	Polyester refractory (PEEK) based composite	Labricomp LCL-4033	PEEK + SHT + PTFE	Temperature stability, high strength
12	Polyamide (PA) based composite	Verton RF700-10FM	PA66 + M + ShT	High strength

The required specific pressure depends on the relaxation time of the composite material after pressing the gear flange (or thermoplastic casting) on the surface on which the density is formed. As mentioned above, it is important to choose thermoplastic polymers and their fillers for metal-polymer composite gears. Additional improvements in the composition and properties of some of the structural thermoplastics used in the manufacture of gears are given in Table 1. Thermoplastic fillers for the production of gears are given in Table 2.

Table 2

Appendix: SHT – full bottle; PTFE – polytetrafluoroethylene, M-oil.
Filler for thermoplastics for gears [2]

№	Fillers	Name	Composition %	Grounds for use	Limiting factors
1	Powder	Materials (mica, talc, technical carbon, glass	5…40	CC, P3, TC, EC	ISZ, SUV, ISK
			C1	UTS, TS	– // –
2	Amplifiers	Glass fiber	5…40+	TS, SI	ITL, ISZ, IO
		Carbon fiber	10…40+	TS	VS, ITK, IO
		Aramid fibers	5…40	TS, PP, SI, ST	VS, ITP
3	Lubricant	Polytetrafluoroethylene	1…20	ST, SI	VS, UL, SP
			< 1	ST, SI, UTS	VS
		Silicone	1…4	ST, SI	UL
		Graphite	5…10	ST, SI	SP, SUV
		Molibden disulfide	2…5	SI	– // –
4	Impact viscosity modifiers	Thermoplastic polyurethane	5…20	UV	SP
5	Others	Painters	< 2	– // –	SP, ITP, VS
		Technological additions	– // –	UL	SI, VS
		Moderators	– // –	– // –	VS
		Flame retardants	– // –	– // –	VS, UL, IO, ITP, SP, SUV

Notes: CC- cost reduction; PK- dimensional stability; ES- electrical properties; TS- heat tolerance; UTS- improvement of technological properties; SI- reduction in wear; PP- increase in robustness; ST- reduction of friction; PV- increase in impact viscosity; UL- casting conditions; ITP- changes in the casting process; ISZ- wear of the contact ring; SUV- decrease in impact viscosity; IO- wear of technological equipment; VS- high cost; SP- decrease in strength

CONCLUSION. According to the data in Table 1, it can be seen that "SABIC" has proposed a number of polymer composite materials for the manufacture of gears. This PKM is filled with solid oils and fiberglass, the complex physical and mechanical performance of which satisfies a total of 5 criteria: high accuracy of geometric dimensions, low noise, high corrosion resistance, operating temperature above 80 ° C and Strength up to 43 Mpa. Table 2 provides sufficient data on the effect of recommended fillers and their materials on service properties for cast thermoplastic gears regulated by AGMA regulatory documents. The data in Tables 1 and 2 can be used to construct gears intended to be made of metal-polymer materials. The agenda includes improving the service properties of polymer-metal composite materials, expanding and localizing their material base as much as possible, further reducing the cost, adequate analysis of machines and units that can use gears with such a design and recommendations. important issues such as development should be addressed. In Table 3, we found it necessary to describe the quality characteristics of the basalt ravine, which can be used as an adjunct to the hardening of plastics used in various conditions (especially for thermoplastics). Their introduction into production will improve and expand the material base for the production of metal-polymer gears.

Table 3

Basalt quality indicators

№	Index name	Norm according to TU24373711-001:2018	Test results	Conclusion
1	Elements rope diameter, mkm	9-22	15	Compatible
			17	– // –
			17	– // –
2	Linear density, tekc	2160-2640	2412	Compatible
		1080-1320	1275	– // –
		4320-5280	4829	– // –
3	Relative interrupt loading, MH/tekc	600	689,8	Compatible
			674,2	– // –
			645,7	– // –
4	Humidity, %	2,0%	0,1	Compatible
			0,09	– // –
			0,09	– // –
5	Loss of refining mass, %	0,4%	5,65	Compatible
			487	– // –
			479	– // –
6	Relative elongation at break	2,-4,5	3,3	Compatible
			3,8	– // –
			3,9	– // –
7	Guaranteed shelf life	1 year from the date of manufacture		

References:

1. AGMA 920-A01. Materials for plastic Gears. "*AGMA Information Sheet*". **2000**. 40.
2. "*Sabic,Electronic resource*". URL:https://www. Sabic.com/en, https:/sfs:sabic.eu/.
3. V.E. Starzhinsky, A.I. Sviridenok, A.T. Kudinov, S.V. Shilko. Metal-polymer gears and transmissions in Belarus: design, technology for assessing properties. "Metal-polymer gears and transmissions in Belarusians: design, technology for assessing properties". **2000**.
4. A.N. Fedyaeva, S.Y. Matyushkov, G.V. Rogovtsev, A.N. Tarasov. Traction electric drive control at the limit of wheel-rail adhesion and suppression of frictional auto-oscillations. "*Publishing house of VNU*". **2011**. 31.
5. R. Schreiber. "*Optimization of the adhesion coefficient of an electric locomotive of the 12x series*". **2000**. 29.
6. S.V. Kikichev. Increasing the efficiency of adhesion activators by improving their adhesion characteristics. "*Abstract of the thesis".* **2009**.
7. B. Engel. Traction control with high use of adhesion forces. "*World railways*". **1999**. 39.
8. D.K. Minov. *"Improvement of traction properties of electric locomotives and diesel locomotives with electric transmission*". **1965**. 267.

9. E.M. Frenkel. To the question of wheel-rail adhesion. "*Trans Holder Publishing*". **1953**.
10. H. Zhua, M. Salyani, R.D. Fox. A portable scanning system for evaluation of spray deposit distribution. "Journal of computers and electronics in agriculture". **2011**. 38.
11. M. Salyani, M., R.D. Fox. "Evaluation of spray quality by oil and water-sensitive papers". **2011**. 37.
12. K.M. Sundaram, P.D. Groot, A. Sundaram. "*Permethrin deposits and airborne concentrations downwind from a single swath application using a back pack mist blower*". **1987**. 171.
13. G. Heidarinejad, M. Bozorgmehr. Modelling of indirect evaporative air coolers. "*International journal of heat and mass transfer*". **1993**. 17.
14. G.Q. Qiu, S.B. Riffat. Novel design and modelling of an evaporative cooling system for buildings. "*International journal of energy research*". **2006**. 985.
15. L.A. Andrienko, B.A. Baikov, I.K Ganulich. Under the editorship of O.A. Rykhovsky Machine parts [Detail of machines]: Proc. for universities. "*Publishing house of MSTU*". **2002**. 544.

ANALYSIS OF FRONT PERFORMANCE DEVICE BASED ON SYSTEMS THINKING

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Abstract*: In this article, a multi-stage system analysis of a processing device using IR to Cocoon through systems thinking was carried out, analysing the elements of the hierarchical structure of the device and the processes that take place in each element. The elements of the IR device go deep into the device from top to bottom, and the input and output parameters are selected starting from the internal positions of the device. If we consider the biochemical processes occurring in the material at the lower levels of the hierarchy, the changes in the material to be processed, the heat and mass transfer processes in the elements at the top of the hierarchy, the resulting changes, are analysed by means of a multi-step structural analysis. Based on the results of the system analysis, mathematical equations are generated for each process from the links between input and output parameters from the lower stage to the upper stage, and on their basis mathematical models are formed to determine the optimum process conditions. On the basis of the mathematical models constructed, the optimum use of the treatment device through IR to the stage is selected.*

Keywords: *systematic consumption, drying, dehydration, irradiation, storage, cocoon, dome, mass, machines, hierarchical structure*

INTRODUCTION. The development of lightweight silk technology and technology on a global scale remains an important economic challenge. The practical application of improved high-performance design devices solves a number of scientific and technical