Kaunas University of Technology,
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EXPERIENCE IN THE USE OF POLYMER COMPOSITE MATERIALS IN CHEMICAL AND AGRICULTURAL MACHINERY

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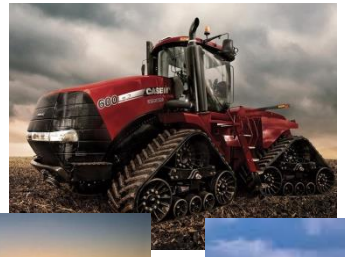
Relevance of the work






<u>THE MAIN PROBLEM</u> is the difficulty in ensuring a high level of reliability and durability in the work of parts and components of modern machines and mechanisms

Ways to solve the problem

Development of new designs of machines with a radically changed principle and mechanism of their operation


Development of new structural materials with a high level of operational properties and new technologies for their production


Physical-mechanical and thermophysical properties of developed PCs

№	Material based on	Property indicators							
		Physical and mechanical			Thermophysical		Tribological (friction without oiling)		
		Density, kg/m^3	Compressive stress at yield σ_y, MPa	Hardness HB, MPa	Softening temperature by Vicat T_{VC}, °C	Temperature resistance, °C	Coefficient of friction f	The intensity of linear wear I_h, ×10^{-9}, m/m	The temperature on the friction surface T, °C
1	Aromatic polyamide	1375-1575	260-280	200-250	290-330	355-380	0,15-0,25	5	65-80
2	Fluoropolymer	1950-2000	20-35	50-67	210-300	465-480	0,12-0,20	2	40-55
3	Phenolic resin	1500-1900	140-180	250-300	-	340-370	0,45-0,65	40	100-140
4	Babita, bronze	7000-9000	50-120	-	300-440 (melt temp.)	-	Rubs ineffectively without lubricant		
5	Carbon steel	7700-7900	210-260	190-250	More 1000	-	Rubs ineffectively without lubricant		

Use of polymer composite materials in chemical machinery

a

b

c

Figure 1 - General view of the anchor stirrer (a) and the (b) friction unit with (c) sealing assembly of its cantilever shaft

Use of polymer composite materials in chemical machinery

To produce technical emulsions, industrial research was done at T CORP GROUP LLC on the introduction of newly developed materials based on fluoropolymers into the friction unit and sealing the cantilever shaft of the anchor stirrer line (fig. 1). According to the findings of industrial research, it was determined that parts made of the developed fluoropolymer-based material operated flawlessly for 22 months in the friction and sealing unit of the cantilever shaft of the anchor stirrer while providing the device with the necessary level of sealing. Because of this, node's total durability was 3.7 times greater than it would have been otherwise.

Use of polymer composite materials in chemical machinery

a

b

Figure 2 - General view of the hydraulic press (a) and the unit for moving the traverse (b)

Use of polymer composite materials in chemical machinery

Khimpostach Dnipro LLC conducted industrial studies on the dependability and durability of the guide bushings in the moving traverse of the hydraulic press for processing polymer materials (Fig. 2). The guide bushings, which are made of bronze, were replaced with developed materials based on aromatic polyamide. This made it possible to abandon the lubrication of these nodes while maintaining the necessary performance.

Use of polymer composite materials in agricultural machinery

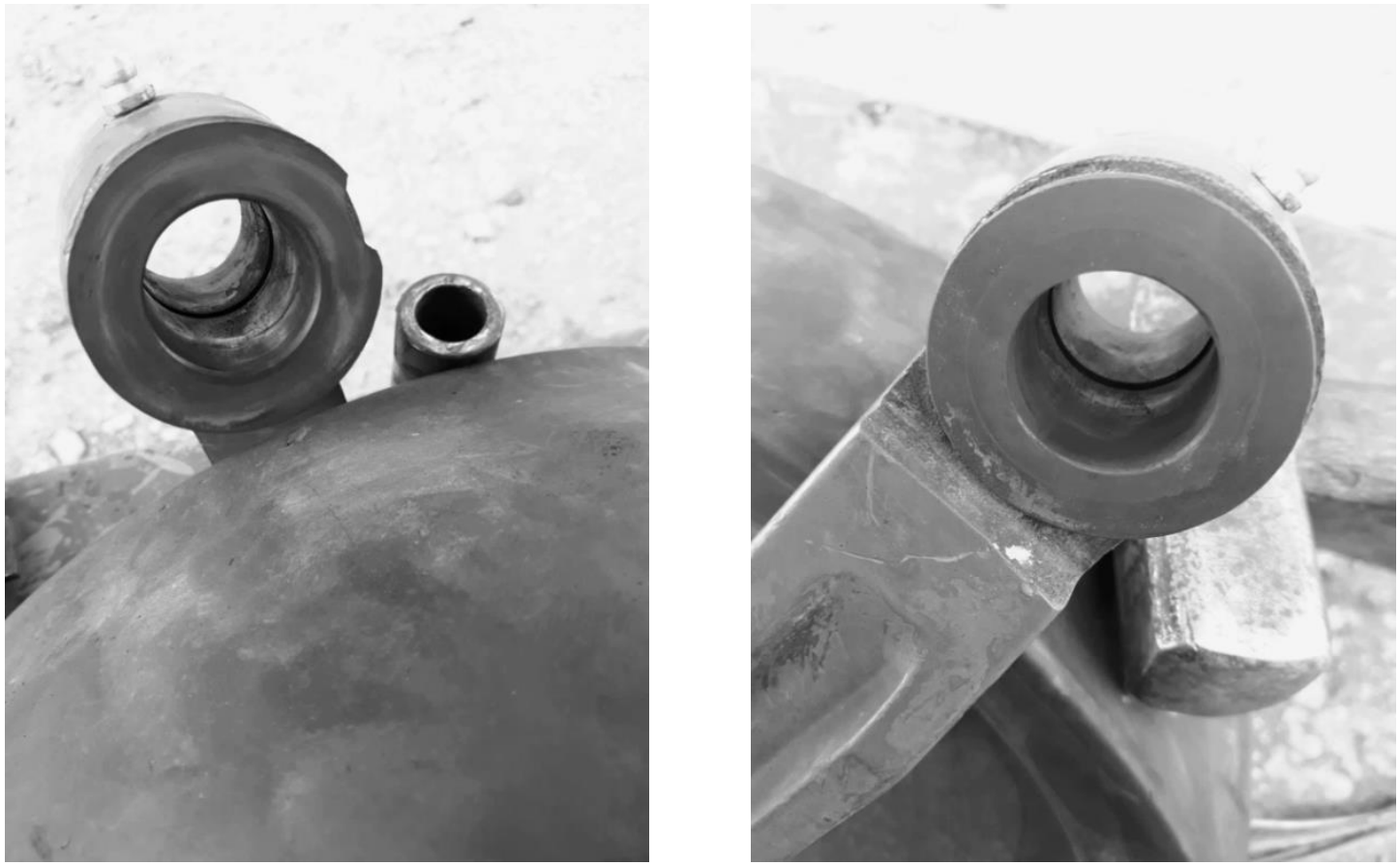
a*

b

Figure 3 - General view of the sowing complex "John Deere 1780“ in work (a) and during downtime (b)

* taken from the source:
https://www.deere.com/en/technology-products/precision-ag-technology/variable-rate-application/section-control/

Use of polymer composite materials in agricultural machinery



a b

Figure 4 - Sliding bearings of the moving nodes of the lever system of the sowing complex "John Deere 1780" after working for 2 years: a - the analogue (PC based on aliphatic polyamide); b - developed PC based on aromatic polyamide

Use of polymer composite materials in agricultural machinery

Tests of PCs parts based on aromatic polyamide in the friction nodes of the "John Deere 1780" seeding complex (Fig. 3 b) were carried out in the conditions of the KODATSKE-AGRO LLC agricultural company. The materials (in the original form of PCs based on aliphatic polyamide) of the bushings of the sliding bearings of the movable units of the lever system of the sowing complex were replaced with those developed by us. They are presented in Figure 4.

According to the studies, it can be seen that after two years of use, standard sliding bear made of aliphatic polyamide material (Fig. 4 a) have significant damage (deep grooves, tears), both on the friction surface and behind it, which indicates emergency or nearly emergency modes of operation of this unit and needs to be replaced.

The sliding bear composed of the polymer composite we created based on aromatic polyamide (Fig. 3 b) does not have these problems, and based on appearance, it functions normally. Further investigation revealed that it is feasible to extend the longevity of the lever system of the "John Deere 1780" sowing complex by 1.5 times by substituting the standard material with the one we created, which greatly lowers the frequency of repairs and downtime over the life cycle of the sowing complex.

Conclusions

1. Developed polymer composite materials based on fluoropolymer, aromatic polyamide and phenolic resin which are filled with materials based on carbon (technical carbon, graphite) and silica (white soot, aerosil, silica gel) of different brands and modifications.

2. It was determined that the introduction of materials based on carbon and silica allows reducing of the coefficient of friction and the intensity of linear wear of these materials by 1.5-1.7 and 5-7 times, respectively, compared to unfilled polymers.

3. It was determined that the level of physical, mechanical and thermophysical properties of the developed polymer composites is 5-10% better than that of the original polymers. It exceeds most non-ferrous metals used in friction assemblies and approaches low-carbon steels.

4. The effectiveness of their employment in friction and sealing units of chemical and agricultural machinery has been demonstrated as a result of industry research on components made of developed polymer composite materials.

THANK YOU FOR ATTENTION!!!