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EFFICIENT MATERIALS FOR TRUCK COMPONENTS

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Abstract
The carried out model studies with varying the design of elements and their dimensional parameters made it possible to substantiate the possibility of using construction materials based on thermoplastics of the polyamide class for their manufacture. Due to this, not only the required operational parameters of the brake chamber are provided, but also its resource increases, due to an increase in corrosion resistance with an increase in manufacturability and assembly. The use of structural composites for the manufacture of rod and disc elements allows optimizing the design solution of this element of the brake chamber, which largely determines its resource and the safety of vehicle operation.

Keywords: Thermoplastic polymers, aliphatic polyamide, corrosion, membrane brake chambers, stress-strain state.

Introduction

In the republic large-scale work is being carried out on the structural adaptation of products made of polymer materials on the influence of the operational parameters of metal-polymer tribosystems and the development of technologies for their production, and certain results have been achieved in this regard. In the action strategy for the further development of the Republic of Uzbekistan in 2017-2021, in particular, the need for "mastering fundamentally new types of products and technologies ...". In the implementation of these tasks, in particular, the creation of new effective materials for machine-building parts of truck aggregates and the development of technologies for their production is of great importance.

This study, to a certain extent, serves to implement the tasks defined in the decree of the President of the Republic of Uzbekistan No. UP-4749 dated February 7, 2017 "On the strategy of actions for the further development of the Republic of Uzbekistan", in the decree of the President of the Republic of Uzbekistan No. PP-3012 dated May 26, 2017 “On the Program of Measures for the Further Development of Renewable Energy, Improving Energy Efficiency in the Sectors

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of the Economy and the Social Sphere for 2017–2021," also in other regulatory legal acts in this area. [1]

The purpose of this work is to develop new effective materials for machine-building parts of truck aggregates with increased operational parameters and technologies for their production.

Objects and methods of research.

Composite materials based on industrial thermoplastics of the class of polyamides, polyolefins, polytetrafluoroethylene were selected as objects of research. To assess the parameters of the stress-strain state of elements of automotive units, multifunctional software SolidWorks (Simulation), Pro / Engineer (Pro / Mechanica), Ls-Dyna were used. [2].

Results and its discussion

A experimental-industrial test of the effectiveness of the use of the developed composite materials based on thermoplastic polymers of industrial production and technologies for their manufacture and processing into products of metal-polymer systems of various functional purposes was carried out at the enterprises of the operation of trucks of the Republic of Uzbekistan and Belarus in accordance with the agreement on scientific and technical cooperation for the period of 2015 -2025. Coatings based on aliphatic polyamides (PA 6, PA 6.6) are effective for elements of brake chambers of various designs for vehicles used in the domestic economic complex.

It is advisable to form functional coatings (protective and tribotechnical) by the method of precipitation from a fluidized bed of active powder components obtained using cryogenic grinding units for granular semi-finished products. The coatings formed using the installations of the State Scientific Institution "Institute of Mechanics of Metal-Polymer Systems named after V. A. Bely of the National Academy of Sciences of Belarus" from the developed composite materials based on polyamide 6 are not inferior to analogues (PA 11, Rilsan), but have significantly lower cost parameters. The coatings are effective in the repair and maintenance of vehicles of domestic and foreign production. [3-4].

Brake chambers used to drive the service brakes of cars, road vehicles, agricultural machinery, trailers differ in design and materials used.

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Diaphragm brake chambers, brake chambers with a spring energy accumulator, modernized chambers with a spring energy accumulator, and brake chambers with an energy accumulator with connected cavities are used.

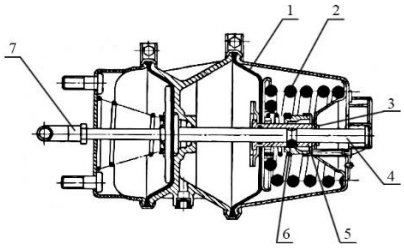

FIGURE 1. General diagram of a brake chamber with a spring brake and a quick-release device (QRD)

1 - diaphragm; 2 - the spring of the power accumulator; 3 - a key for releasing the brake; 4 - the rod of the power accumulator; 5 - bushing; 6 - balls; 7 - power section rod

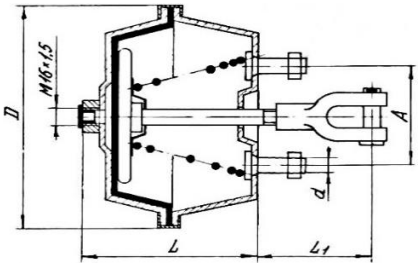

FIGURE 2. General diagram of a brake chamber without a spring brake

A - the center distance between the fastening bolts; L - overall size of the chamber assembly; L - stem overhang; d is the diameter of the fastening bolt; M16x1,5 - designation of the boss thread; D - outer diameter of the chamber

A general diagram of a brake chamber without a spring brake is shown in Fig. 1, a brake chamber with a spring brake - in Fig. 2. With various designs, these units use characteristic functional elements - a body, a spring, a diaphragm, a support disk with a stem.

The presence of similar typical structural elements and problems arising in chambers sets the main directions of design activity and allows the introduction of positive results of work in almost all types of chambers.

The specificity of the work of the brake chamber lies in the fact that, firstly, being a very important element of any vehicle, it must meet the increased requirements

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for durability and trouble-free operation; secondly, it is located in places of significant contamination (near the wheels of a vehicle), therefore, all its parts must have increased corrosion resistance, and the assembly itself must be particularly tight; thirdly, the mode of operation of the camera is dynamic, which presupposes the presence of fast braking, which makes high demands on the strength and reliability of its functional elements. [5-7].

To select the directions for the development of functional materials to increase the service life, an analysis of the main types of rejects and failures of brake chambers was carried out. As a basis for the analysis, we used the production facilities of OJSC “Belcard”, which specialize in the production of auto components for various purposes and designs, to meet the needs of the automotive industry, road equipment manufactured in Belarus and the CIS countries. [8.9].

Analysis of the data obtained indicates that the most common causes of assembly defects and failures during operation are the discrepancy between the supplied elements - diaphragm, power spring and housing with the requirements of regulatory technical documentation and operating conditions.

Elements of brake chambers made of carbon steels are exposed to intense corrosion during operation. Corrosion of elastic elements leads to a decrease in their resource due to the formation of defects, which are a source of destruction under alternating loads (Fig. 3, a).

a) b) c)

FIGURE 3. Corrosion damage to structural elements of the brake chamber a) - spring; b) - membrane assembly; c) - disc with stem

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a) b)

FIGURE 4. Destruction of the brake chamber disc
a) - with energy storage; b) - without energy storage

Corrosion damage to the surface layer of the membrane assembly (Fig. 3, b) reduces the service life of the membrane due to the local effect of microroughnesses on its surface layer.

Defects of the rod with the disc, formed as a result of the corrosive effect of the operating environment (Fig. 3), reduce the parameters of its deformation and strength characteristics during high-cycle exposure. As a result, during the operation of the brake chamber, the disc can be destroyed by the rod (Fig. 4) and the discontinuity of the membrane (Fig. 5) can occur, which leads to a loss of functional characteristics and the creation of an emergency situation.

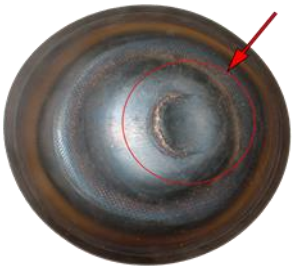

FIGURE 5. Destruction of the brake chamber membrane

Analysis of the characteristic defects of brake chambers during their assembly and operation (Fig. 3-4) made it possible to determine the main directions of optimization of structural, materials science and technological solutions to increase their service life and reduce the likelihood of emergencies when vehicles are moving.

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Using the Pro / Engineer and LS-DYNA software products, the brake chamber (Fig. 6 and 7) and its main structural elements - the spring (Fig. 8) and the stem with the disc (Fig. 9) were simulated.

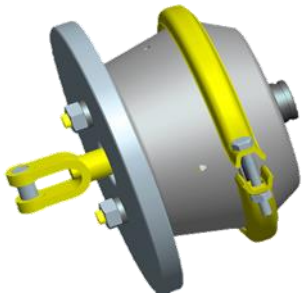

FIGURE 6. Model of the brake chamber assembly

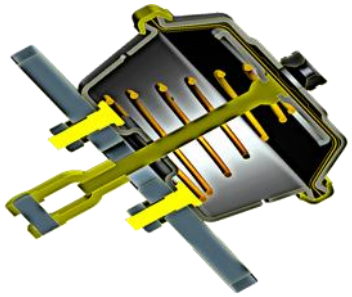

FIGURE 7. Section of the model brake chamber

Modeling the stress-strain state of the main element of the brake chamber - the power spring - made it possible to identify characteristic sections with maximum stresses caused by violation of geometric parameters during manufacture, installation and operation. The complex effect of the polymer coating applied to the surface of the spring using common technologies - deposition from a fluidized bed or spraying of suspensions with subsequent curing has been established.

Model coatings made of thermoplastic polymer (CEVA, PA 6) have a favorable effect on the nature of stress distribution in the surface layers of the turn, reducing the maximum value from 98 MPa to 90 MPa (Fig. 8), which increases the resistance to high-cycle loads.

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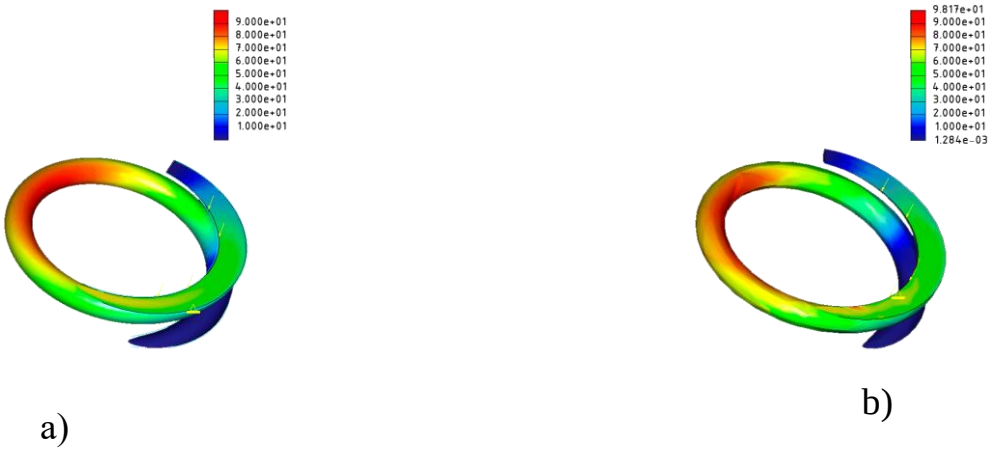

FIGURE 8. The stress-strain state of the spring coils of the brake chamber: a) - coated; b) - without coating

The carried out model studies with varying the design of the elements and their dimensional parameters made it possible to substantiate the possibility of using construction materials based on thermoplastics of the polyamide class for their manufacture. Due to this, not only the required operational parameters of the brake chamber are provided, but also its resource increases, due to an increase in corrosion resistance with an increase in manufacturability and assembly. The use of structural composites for the manufacture of rod and disc elements allows optimizing the design solution of this element of the brake chamber, which largely determines its resource and the safety of vehicle operation.

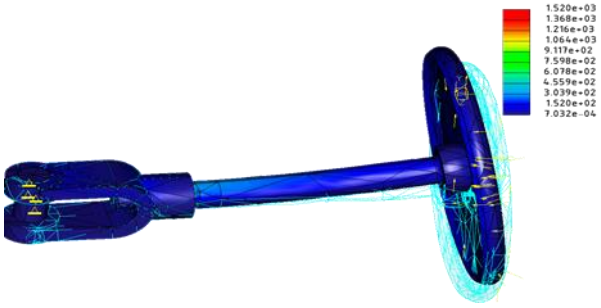

FIGURE 8. Disc model with brake chamber rod

Evaluation of the effectiveness of the design and technological solutions developed on the basis of model studies was carried out using the bench equipment of JSC "Belcard", which allows testing in an accelerated mode. Model coatings based on oligomeric and polymer matrices were applied to the power spring of the brake

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chamber with various technologies of activating treatment of the surface layer (Tables 1-2).

The experimental samples were subjected to bench tests at a given number of loading cycles, as well as corrosion tests at a temperature of 303–308 K in a chamber with a humidity of 90% by spraying a 5% aqueous solution of NaCl. The results of the evaluation tests are presented in table. 1.

TABLE 1. Characteristics of the model coatings of the brake chamber spring

№	Type of pre-processing	Material	Application method
1	Phosphating (composition "Foscon-8")	Ethylene vinyl acetate copolymer (Sevilen)	Fluidized bed
2	Shot blasting	Ethylene vinyl acetate copolymer (Sevilen)	Fluidized bed
3	Shot-blasting, undercoating PRIMGREENL.A.T. 12035 BME25K	Polyamide 11 (Rilsan)	Fluidized bed
4	Phosphating (composition "Foscon-8")	Polyamide 11 (Rilsan)	Fluidized bed
5	Mechanical treatment with sandpaper	Enamel EP-1236 (Lida)	Pneumatic spraying (2 layers)
6	Mechanical processing with sandpaper, EP-045 primer	Enamel EP-1236 (Lida)	Electrostaticspraying

TABLE 2. Coated Brake Chamber Springs Evaluation Results

№	Types of anti-corrosion coatings	Spring 30.3519368
1	Pretreated ethylene vinyl acetate copolymer - phosphating	Insignificant corrosion damage is observed in the areas in places that are difficult to paint over (the places where the ends of the supporting turns adjoin the neighboring ones).
2	Pre-shot blasted ethylene vinyl acetate copolymer	Insignificant traces of corrosion are observed in places that are difficult to paint over (where the ends of the support turns adjoin adjacent ones).
3	Pre-blasted polyamide 11 with applied undercoat PRIM-GREEN L, AT. 12035 BME25K	Barely noticeable traces of corrosion are observed in places that are difficult to paint over (where the ends of the supporting turns adjoin adjacent ones).
4	Polyamide 11 withpre-treatment - phosphating	Corrosion-damaged areas are not observed over the entire surface of the product.

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№	Types of anti-corrosion coatings	Spring 30.3519368
5	Enamel EP-1236 with preliminary mechanical treatment with emery paper	Slight traces of corrosion are visible in areas of under-staining of the coating (partly on the milled surfaces of the support turns and in some places between the turns).
6	Enamel EP-1236 with preliminary mechanical treatment with emery paper and primer EP-045	The areas damaged by corrosion are not observed over the entire surface of the product, except for the place of the coating chip that occurred during the compression (the place where the edge of the reference loop adjoins to the adjacent one). Barely noticeable, point marks damaged by corrosion in places of underpainting, coating chips.

CONCLUSION

With the use of the Pro / Engineer and Ls-DYNA software products, modeling and evaluation of the parameters of the stress-strain state of structural elements of the brake chamber of various types of vehicles, which determine the parameters of its service life and reliability, have been carried out. Local areas of increased stresses due to structural, technological and materials science factors have been identified. The choice of methodological principles for the creation of functional composites based on industrial thermoplastics for the manufacture of structural elements of brake chambers with increased service life has been substantiated.

Compositions and technology of composite materials based on polyamide 6 containing mechanically activated inorganic modifier - kaolinite have been developed. It is shown that the introduction of a mechanically activated filler into the matrix in an amount of 0.1 - 0.8 wt. % leads to an increase in the tensile strength parameter from 45 MPa, characteristic of the original PA 6, to 55 - 60 MPa with a maximum of 80 MPa with a modifier content of 0.5 wt. %.

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