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MEASURES TO PREVENT CORROSION AND NOISE IN TRANSPORT AND TECHNOLOGICAL MACHINES OPERATING IN MOUNTAINOUS CONDITIONS

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Abstract. When using transport-technological machines in complex conditions, the body and its parts are more susceptible to corrosion, which leads to faster failure of transport-technological machines, increased vibration and noise in the driver's workplace. Due to increased noise and vibration in the workplace, the driver may tire faster, reduce the quality of movement of vehicles and technological means, cause occupational diseases, and reduce traffic safety. To prevent this, it is necessary to use new types of multifunctional anti-corrosion coatings with high physicochemical properties, reliability, and durability. Such coatings are very important for increasing the durability of the bodies and parts of transport and technological machines. The purpose of the research is to study the possibilities of reducing noise and vibrations of transport and technological machines using multifunctional anti-corrosion coatings.

Keywords: transport, technological machine corrosion, coating, multifunctional coating, noise

1. Introduction.

Highways pass through mountain passes and ridges at great heights (1500-2000 m above sea level). Such roads consist of a number of disadvantages, such as large longitudinal slopes (up to 10-12%), serpentines (sharp turns) (up to 10 turns per 1 km), significant turns with a small radius (8-10 m) (15-18 turns per 1 km), insufficient width of the roadway and roadbed, pavement deformation, and poor visibility. Some sections of roads are damaged during heavy rains and downpours.

In addition, the weather in high-mountainous areas is unstable: large temperature fluctuations are observed throughout the day. For example, during summer, the sun's temperature can drop to +30...+40°C during the day and to +5...+10°C at night. Landslides and glaciers are common during winter. [1].

The listed factors affect the reliability of vehicles, complicate traffic flow, reduce speed, increase transportation costs, and serve as the main cause of road accidents.

The peculiarities of mountain conditions depend on a number of features of the car's operation. For example, at an altitude of 1000 m above sea level, the power of carburetor engines decreases by an average of 12% due to a decrease in air density and a decrease in weight charge, fuel consumption increases, and the performance of pneumatic brakes deteriorates.

The complexity and curvature of the vertical profile of mountain roads influence the operating mode and energy load of vehicle braking systems. When driving on mountain roads, the number of brakes per 1 km of road reaches 10-19, the temperature of the friction surfaces on some sections of mountain road routes reaches 460-490 °C in the rear braking mechanisms and 270-290 °C in the front ones. [2].

Due to the fact that the driving wheels transmit large torques during uphill movement, frequent braking during prolonged descent, as well as numerous turns with a small radius, tires wear intensively.

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The condition of the road network and the complexity of the road profile negatively affect reliability. As a result, the engine, brakes, and loads are used more frequently in the motion process, and as a result, they operate less reliably, and fastening and adjustments are often disrupted. All this leads to accelerated wear of parts and assemblies, fatigue phenomena in them, and ultimately to failure.

In mountainous conditions, especially in subtropical regions, increased air humidity causes rapid corrosion of car electrical conductor terminals, parts, assemblies, units, especially cabins, bodies, wings, and standards.

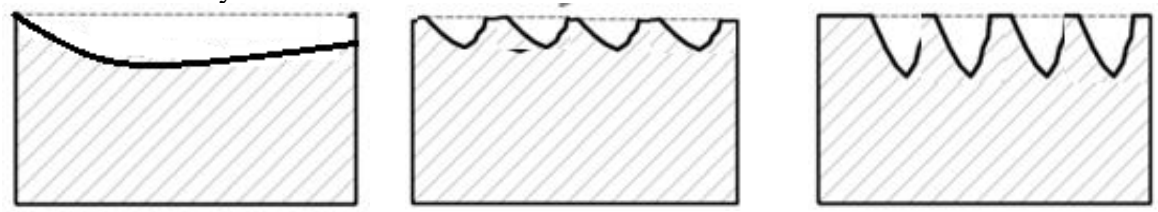
All this indicates the need to pay special attention to the technical condition of the vehicle when operating it in mountainous conditions.

The research work highlights the issues of multifunctional coating to increase the durability of body parts and assemblies of transport and technological machines operating in mountainous conditions.

In the world, research is being conducted on the application of multifunctional protective coatings to increase the durability of transport and technological machines and thereby reduce vibration and noise levels. In this regard, obtaining multifunctional coatings that are anti-corrosion, noise-proof, vibration-damping is a pressing problem. Therefore, the problem of combating metal corrosion is of great importance in scientific and technical work in this area.

2. Methods and result.

Corrosion of metals occurs gradually. Five stages of corrosion have been identified. In the first stage, small bubbles form and rust spots appear. In the second stage, iron oxide Fe2O3 is formed and total rust is formed. In the third stage of corrosion, the substrate completely detaches. It happens at a high speed. Therefore, the coatings protect the metal from corrosion. In the fourth stage, deep pits are formed, and point corrosion occurs. In the fifth stage, large open holes are formed, and corrosion occurs intensively on both sides of the substrate.



a) uniform b) dotted d) pitting, deep dotted

Fig 1. Types of corrosion

The word “corrosion” is applied to many metals (including non-ferrous metals), alloys, as well as concrete and some plastics. Rust is the result of the corrosion process. This term applies only to iron, which is part of steel and cast iron. And when we say "steel rustes (or corrodes),” we mean the rusting (oxidation) of the iron it contains. [1].

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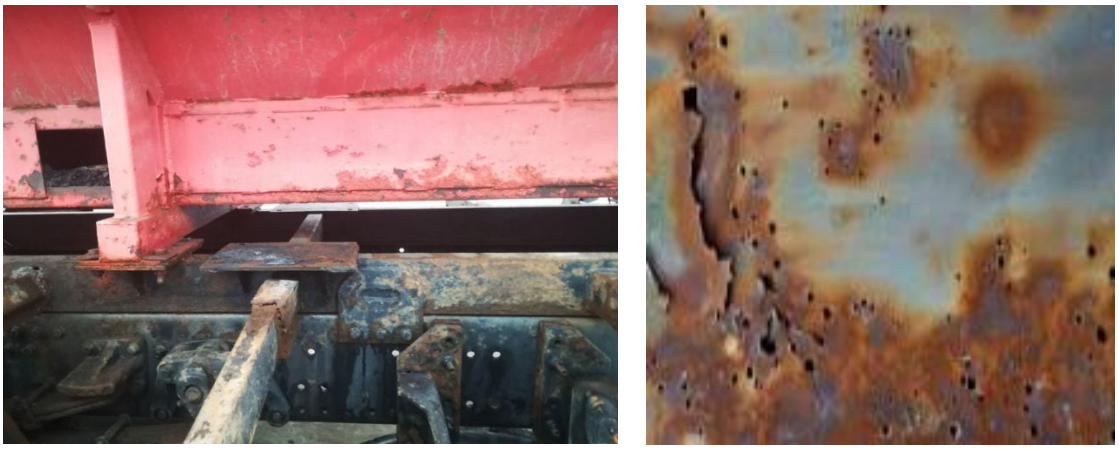

Fig 2. Corrosion of transport and technological machines

The degree of corrosion is assessed by the number of corrosion foci (focal corrosion index kp). Corrosion depth (kr) (mm/year) is the average or maximum depth of corrosive destruction of metal during a certain period of use of products. Corrosion susceptibility (kc) (hours (days), which is the operating period before the start of the corrosion process. The area where corrosion damage reaches 1%, is called the beginning of the corrosion process and is determined by the condition of the metal surface. The change in metal mass due to the loss or increase of corrosion products during operation is called the change in metal mass and is determined by kt (g/ (m2·h). One of the main indicators of mechanical strength is the indicator of decrease or increase in the metal mass, characterizing the change in the metal strength limit (%) during operation.

The main factors in operating conditions are accelerated testing methods. In this case, acceleration of the corrosion process cannot be achieved by changing its mechanism, for example, by introducing a more aggressive component of another nature. The test mode should be chosen so that a high corrosion rate is ensured throughout the entire test period [3].

GOST 9.908-85 “Unified system of protection against corrosion and wear of metals and alloys” defines methods for determining the indicators of corrosion and corrosion resistance, the main indicators of corrosion and corrosion resistance (chemical resistance) of metals and alloys, such as continuous, pigment, intercrystalline, layered corrosion, spot corrosion, corrosion cracking, corrosion fatigue, and methods for their determination. [4].

Paint and varnish coatings are a common means of protecting transport and technological machines from corrosion. They are relatively inexpensive; relatively simple coating; easy restoration of damaged coating; combined with other protection methods.

The method of selecting materials and applying these coatings in the atmosphere and in a number of corrosive environments provides sufficiently reliable protection of metal structures from corrosion. A continuous film forms on the metal surface. The resulting film prevents aggressive environmental influences and protects the metal from corrosion.

The protective properties of composite polymer coatings are higher than those of paint coatings. The specific properties of composite polymer materials made it possible to use them in various industries, in particular, in the protection of metals from corrosion[6].

Plastics and resins have high corrosion resistance in many aggressive environments.

Pentoplast is a polymer material that protects pipes, collectors for draining hydrochloric, nitric, and other acids, pump casings, and impellers from corrosion [7].

Thus, anti-corrosion coatings have good adhesion to metal surfaces, mechanical strength, and chemical resistance.

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Also, polymer coatings protect parts from mechanical damage, absorb noise and vibration during the operation of technical means and road construction equipment, which, in turn, affects the performance of the vehicle driver.

3. Results

For the development of a multifunctional anti-corrosion coating, the object of research was a thermosetting oligomer - epoxy resin of the ED-16 brand, plasticizers - dibutyl phthalate (DBF), dioctil phthalate (DOF), curing polyethylene polyamine (PEPA), epoxy urethane coatings were used to give the polymer plasticity, flexibility, and transform hard, brittle resins into elastic materials that can take any shape. The hardener is introduced into thermosetting resins to convert polymers into a non-melting and insoluble state during the hardening process. Titanium was used as a filler.

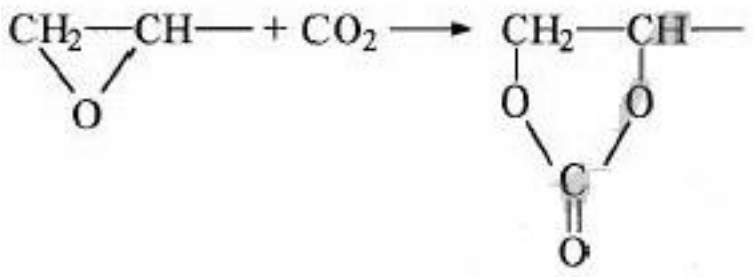
To increase the mechanical strength of polymer materials, improve their dielectric, frictional, or conversely, antifriction properties, thermal stability, reduce shrinkage, and reduce cost, special additives - both organic and inorganic fillers - are introduced into them. Fillers in most cases determine not only the mechanical properties of polymer materials, but also the type of coatings.

As a result of applying hardeners, the water resistance of the coating increases and resin pouring improves. Polyethylene polyamine and some other amines, added to the resin in an amount of 5-10%, are most often used as hardeners.

An anticorrosive coating was obtained by synthesizing epoxy urethane with an additive based on local raw materials, and tests were conducted to determine the physicochemical and operational properties of the coating.

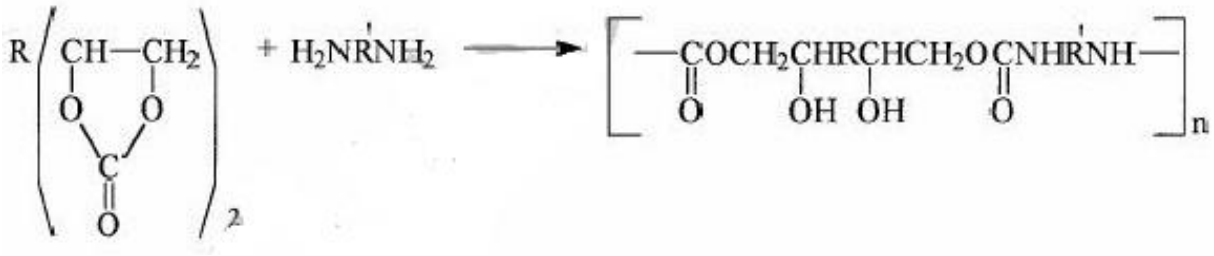
The epoxyurethane coating was obtained as follows.

1. Cyclocarbonates were obtained by the action of carbon dioxide on epoxy compounds:



Epoxy oligomers were used as starting materials.

2. As a result of the interaction of diamines with cyclocarbonates, an epoxyurethane coating was synthesized:



Determination of the anticorrosive properties of the epoxyuritan additive was carried out under laboratory conditions according to GOST, 10% hydrochloric acid (HCl) was used as an aggressive medium. The results of the analysis are presented in Table 1.

Table 1

Results of the analysis of the anticorrosive properties of the synthesized anticorrosive coating

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Sample	Mass, g		Mass loss	Note
	Before trials	After trials		
Copper M	5,1072	5,1069	0,0003	Durable
Steel, D	10,8331	10,8330	0,0001	Durable
Aluminum AL-9	2,0691	2,0690	0,0001	Durable

4. Conclusion.

1. Based on the analysis of scientific and technical literature and patent sources, the effectiveness of protecting transport and technological machines from corrosion, vibration, and noise with multifunctional anti-corrosion coatings has been theoretically and experimentally substantiated.

2. A scientifically based approach to the creation of a multifunctional anti-corrosion coating for the anti-corrosion protection of transport and technological machines has been developed.

3. For the synthesis of multifunctional epoxyurethane coatings, modification of epoxy resin of the ED-16 brand with cyclocarbonate is recommended.

4. A new composition of an anticorrosive coating containing epoxy resin with a polymer additive, possessing high strength, improved physical, mechanical, and operational properties, has been developed and recommended.

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