ANALYSIS ON SELECTING THE TYPE OF COATING FOR BELT CONVEYOR DRUMS

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Annotation. This article discusses the relevance, importance and acting forces of the defects occurring in belt conveyor drums. The forces acting on the drums of belt conveyors used in mines were analyzed taking into account their structural features and operating conditions. As a result, erosion and cracking of the drum surfaces and problems arising from deficiencies in maintenance were identified. Based on this, in order to reduce the forces acting on the drums, we conducted research on extending their service life by changing the thickness of the materials from which the drums are made and the type of coating. The most commonly used materials for drum linings - rubber and polyurethane were compared. During the study, it was found that polyurethane has superior properties to rubber in terms of high strength, abrasion resistance, tear resistance, cold resistance, and long-term performance. Also, the abrasion resistance of polyurethane material was practically tested using the MI-1M friction machine, and technical indicators were analyzed based on the results.

According to the results of the article, it was concluded that the use of polyurethane coating for conveyor drums can be an effective solution to extend their service life, reduce maintenance costs, and ensure reliable operation of the drums.

Keywords: conveyor transport, structure, mechanical effects, drum, traction drum, tensioning drum, support, coating, deformation.

Аннотация. В этой статье рассматриваются актуальность, важность и действующие силы, возникающие при дефектах барабанов ленточных конвейеров. Силы, действующие на барабаны ленточных конвейеров, используемых в шахтах, были проанализированы с учетом их конструктивных особенностей и условий эксплуатации. В результате были выявлены эрозия и растрескивание поверхностей барабана, а также проблемы, возникающие из-за недостатков в техническом обслуживании. Исходя из этого, чтобы уменьшить усилия, действующие на барабаны, мы провели исследование по увеличению срока их службы за счет изменения

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толщины материалов, из которых изготовлены барабаны, и типа покрытия. Было проведено сравнение наиболее часто используемых материалов для облицовки барабанов - резины и полиуретана. В ходе исследования было установлено, что полиуретан обладает превосходными свойствами по сравнению с резиной с точки зрения высокой прочности, стойкости к истиранию, разрыву, холодостойкости и длительной эксплуатации. Также была проведена практическая проверка стойкости полиуретанового материала к истиранию с использованием машины трения МИ-1М, и по результатам был проведен анализ технических показателей. По результатам статьи был сделан вывод о том, что использование полиуретанового покрытия для конвейерных барабанов может стать эффективным решением для продления срока их службы, снижения затрат на техническое обслуживание и обеспечения надежной работы барабанов.

Ключевые слова: конвейерный транспорт, конструкция, механические воздействия, барабан, тяговый барабан, натяжной барабан, опора, покрытие, деформация.

Annotatasiya. Ushbu maqolada kamar konveyer barabanlarida yuzaga keladigan nuqsonlarning dolzarbligi, ahamiyati va ta'sir etuvchi kuchlari muhokama qilinadi. Minalarda ishlatiladigan kamar konveyerlarining barabanlariga ta'sir qiluvchi kuchlar ularning tuzilish xususiyatlari va ish sharoitlarini hisobga olgan holda tahlil qilindi. Natijada baraban yuzalarining eroziyasi va yorilishi va texnik xizmat ko'rsatishdagi kamchiliklardan kelib chiqadigan muammolar aniqlandi. Shunga asoslanib, barabanlarga ta'sir qiluvchi kuchlarni kamaytirish uchun biz barabanlar ishlab chiqarilgan materiallarning qalinligini va qoplama turini o'zgartirib, ularning xizmat muddatini uzaytirish bo'yicha tadqiqotlar o'tkazdik. Baraban astarlari uchun eng ko'p ishlatiladigan materiallar - kauchuk va poliuretan taqqoslandi. Tadqiqot davomida poliuretan yuqori quvvat, ishqalanishga chidamlilik, yirtiqqa chidamlilik, sovuqqa chidamlilik va uzoq muddatli ishlash jihatidan kauchukdan ustun xususiyatlarga ega ekanligi aniqlandi. Shuningdek, poliuretan materialining ishqalanishga chidamliligi MI-1m ishqalanish mashinasi yordamida amalda sinovdan o'tkazildi va natijalar asosida texnik ko'rsatkichlar tahlil qilindi. Maqola natijalariga ko'ra, konveyer barabanlari uchun poliuretan qoplamasidan foydalanish ularning xizmat muddatini uzaytirish, texnik xizmat ko'rsatish xarajatlarini kamaytirish va barabanlarning ishonchli ishlashini ta'minlash uchun samarali echim bo'lishi mumkin degan xulosaga kelishdi.

Kalit so'zlar: konveyerni tashish, tuzilish, mexanik effektlar, baraban, tortish barabani, qisish barabani, qo'llab-quvvatlash, qoplama, deformatsiya.

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Introduction. Today in the world, there are many ways to improve the technical and economic performance of belt conveyors, to ensure safe and high-quality transportation in mining operations, to ensure their efficient operation, to develop methods for absorbing the impact of loads on the belts of the conveyor and their supports, to improve the design of the conveyor belts. scientific research is being conducted to improve. In this regard, special attention is paid to conducting scientific research aimed at improving the reliability, durability, and efficiency of belt conveyors, reducing malfunctions of working elements, timely maintenance and repair work, and reducing costs.

In our republic, a number of scientific and practical results are being achieved by introducing advanced scientifically based measures to increase the service life of conveyor drums and drum linings based on the development of resource-saving technologies for ensuring the durability, reliability, and quality of belt conveyor rollers when transporting minerals and rocks mined in our country.

However, today, work on improving the design of belt conveyor drums, changing drum coatings, reducing the forces acting on the drum, and preventing erosion of drum surfaces under the influence of cutting rocks has not been fully studied. There is a need to extend the service life of belt conveyors and drums in mining enterprises, while reducing the time spent on repair work, and research in this area should be continued.

Due to erosion and cracking of the drum surfaces in belt conveyors, a number of shortcomings occur, including a decrease in conveyor efficiency, increased energy consumption, failure of the belt due to friction, and other changes.

The drum is one of the main elements of a belt conveyor. Drums are divided into tensioning and tensioning types according to the functions they perform in belt conveyors. A belt conveyor has a pulley mounted on a shaft that moves the belt as a result of the torque applied to it and the set speed.

a.

b.

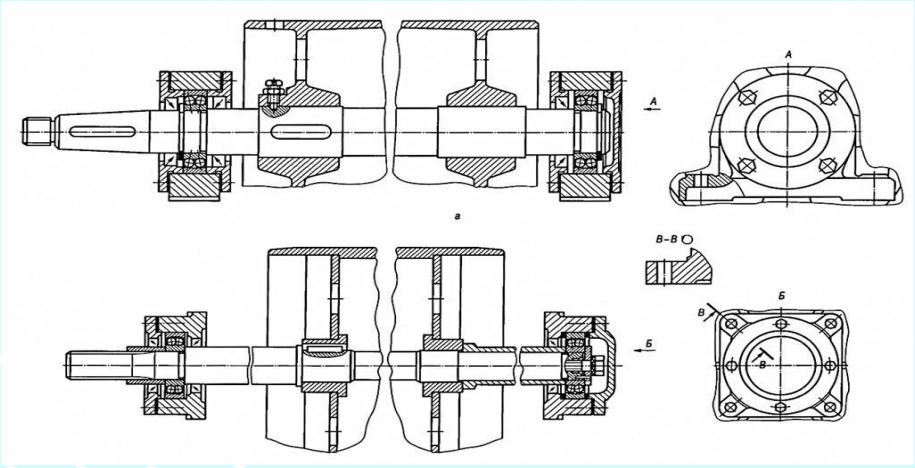


Figure 1 ***Pulling drum. a. cast. b. welded.***

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Scientific and practical research and studies have shown (figure 2) that the main causes of belt conveyor drum failure are insufficient lubrication during maintenance, mechanical damage, and the materials and coatings from which the drum is made.

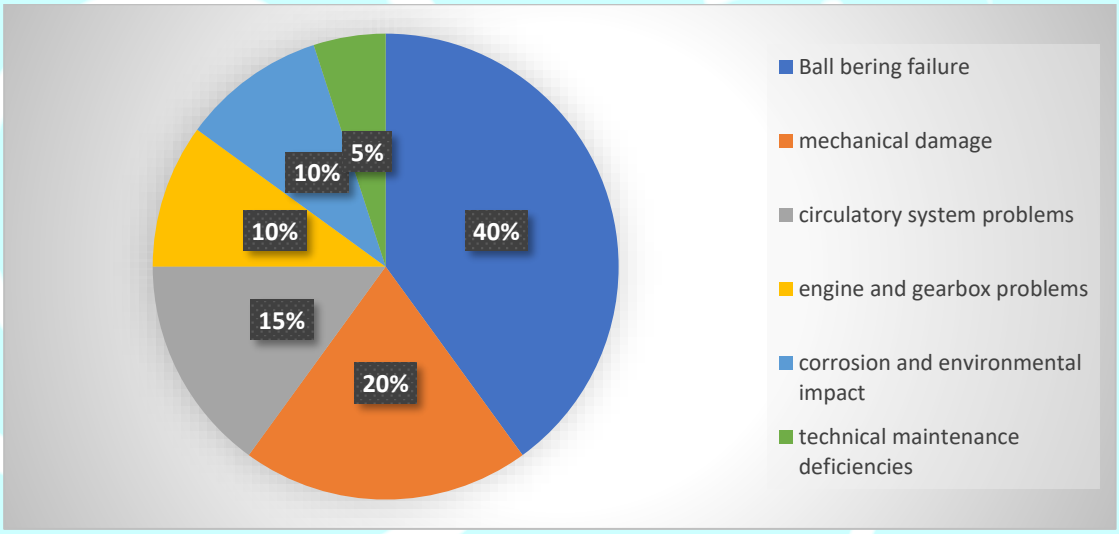


Figure 2. ***Causes of drum failure***

Unscheduled stops occur in conveyors due to the uneven flow of incoming cargo, the presence of large rocks, and the influence of gravity forces acting on the drums and their surfaces. This means that the drums are deformed, their surfaces are corroded, and the coating cracks as a result of the forces acting on the drums.

Since the conveyor operates in a chemically active and abrasive environment, the traction drum of the belt conveyor wears out quickly. Coatings are installed to prevent its corrosion.

The selected materials must have several properties.

- high strength and hardness;
- resistance to chemical influences;
- increase the coefficient of friction between the conveyor drum and the belt;
- resistance to corrosion and abrasive wear.

Materials and methods

Thus, during the research, it is necessary to study the properties of the proposed material for the coating of the traction drum and identify a material that meets the requirements and has the necessary properties.

The main material used for the coating of the traction drum is rubber. The positive property of rubber is its very high elasticity. It can undergo large deformations and almost completely return to its original state [11]. In addition, rubber is characterized by high tear and abrasion resistance, good electrical insulation properties, low density, low compression and low thermal conductivity.

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However, rubbers have low abrasion resistance, a narrow operating temperature range, a low modulus of elasticity and low hardness compared to other materials [9].

Polyurethanes are one of the most universal materials in practical applications. Polyurethane products are 50 times more durable than rubber, plastics and, in some cases, non-ferrous and ferrous metals. This long-term service life allows polyurethane parts to be manufactured with less material, reducing maintenance costs and, as a result, significant economic savings.

The operating temperature range of polyurethane products is from -50 to +80 °C, and for short periods can reach +100°C. Polyurethanes retain their elasticity even at very low temperatures and have good resistance to thermal shock. Polyurethane is one of the hardest elastomers, with a hardness of 30 to 95 units on the Shore scale [10]. It is characterized by high abrasion resistance and is not prone to breakage under load.

Polyurethane also has high tear strength and resistance to crack propagation, and is resistant to shearing shocks. Polyurethane products retain their shape and mechanical properties even when subjected to cyclic loads. In addition, products made of polyurethane can withstand repeated bending and do not deteriorate in the process.

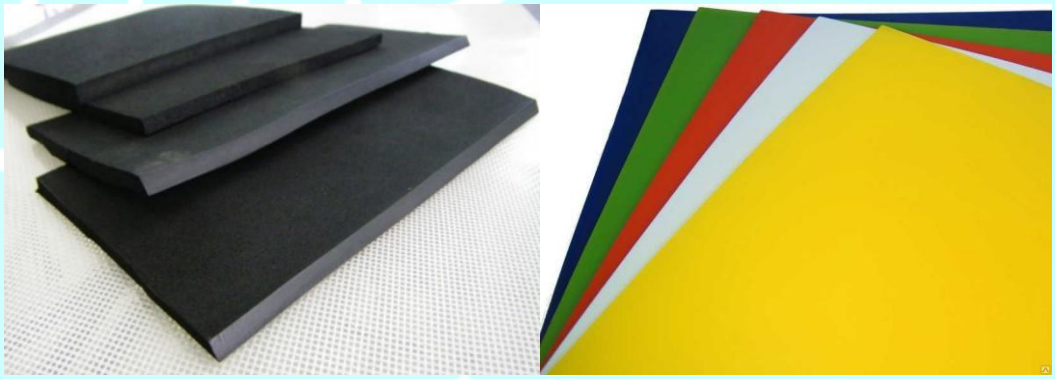


Figure 3. ***Drum lining material. a. rubber. b. Polyurethane***

A comparison of the properties of rubber and polyurethane in Table 1 below shows that polyurethane is much superior to rubber in terms of strength, abrasion resistance, and resistance to mechanical damage. Polyurethane material has higher fracture toughness than rubber, 5 times higher abrasion resistance, retains its elastic properties at low temperatures, and has a wide range of hardness (from soft to hard). Therefore, polyurethane is a universal and durable material, especially polyurethane is widely used in high pressure, abrasive wear, and low temperatures.

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Table 1.

Indicators	Rubber	Polyurethane
Shore hardness scale	65-75	40-98
Tensile modulus of elasticity 100%	12	29
Strength limit kg/cm^2	115	312
Tensile strength %	200	540
Frost resistance coefficient, -50 C	0,2	0,45
Abraziv mustahkamligi	2	10
Crack propagation resistance	20	58
Elasticity	30	40

The amount of material lost from the surfaces as a result of friction is determined in units of length. For example, the thickness of the worn layer is Δh, the volume is ΔV or the mass is Δm, and in this case, the wear is divided into linear, volumetric and mass types. In this case, the wear rate ΔI is determined by the following relations:

$$\Delta h = \frac{\Delta V}{A} = \frac{\Delta m}{\rho * A}, \quad (1)$$

Where: A – is the nominal area of the friction surface; ρ – is the density of the worn material.

Testing of polyurethane material for wear. To determine the suitability of polyurethane material as a coating for loads and high speeds, the MI-1M friction machine was used as a testing device. The MI-1M friction machine is designed to test materials for friction and wear. It is capable of operating in rotational, sliding and direct sliding conditions.

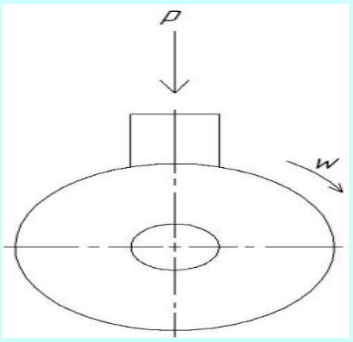


Figure 4. ***Kinematic scheme of friction surfaces.***

The kinematic scheme is presented in Figure 5. The samples (8 and 9) are driven by an electric motor (1). The transmission is carried out through a gear wheel (2), an intermediate shaft (3), an auxiliary shaft (6), an internal gear wheel (7) and interchangeable gears (11). The load on the samples is created by means of a device (12) with a pre-set spring tension.

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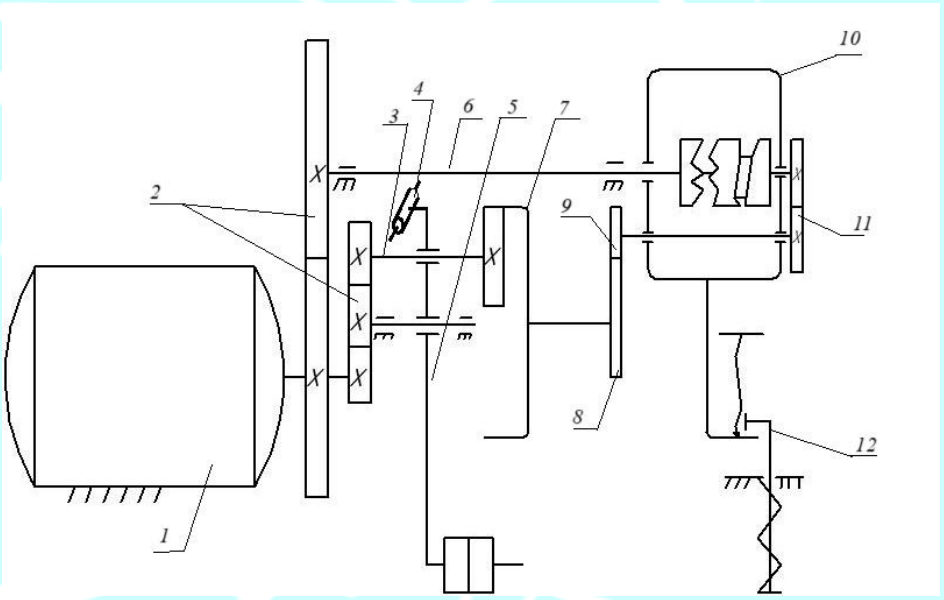


Figure 5. ***Kinematic diagram of the MI-1M machine.***

A pendulum device is used to measure and record the friction torque. The deflection of the pendulum (5), which occurs under the influence of the friction torque, is converted into the displacement of the spring along the chart tape located on the drum (4). The recording mechanism is provided with mechanical movement through the auxiliary shaft (6).

Table 2. Main technical parameters of the MI-1M machine.

Technical specifications	
Electric motor power, kW	1
Subsample rotation frequency, s^{-1}	7
Sample slippage, %	0, 10, 15, 20, 100
Maximum load , N	2000

The linear and mass methods are often used to determine erosion. In the linear method, the thickness of the eroded layer is measured using a microscope (magnification 20-300 times), while in the determination of mass erosion, high-precision scales are used. In the erosion process, there are quantities called erosion intensity and rate. The erosion intensity I is determined by the ratio of the weight of the eroded material to the length of the friction path Δm:

$$I = \frac{\Delta m}{L}, \quad (2)$$

L – length of the friction path, m;

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The linear wear intensity is determined by the following formula:

$$I_h = \frac{\Delta m}{\rho * A * L}, \quad (3)$$

The erosion rate V is determined by the ratio of the weight of the eroded material Δm to the time t taken to conduct the test:

$$V = \frac{\Delta m}{t}, \quad (4)$$

t – time taken to conduct the test, hours.

Based on the experiments conducted on the MI-1M friction machine, the linear wear intensity of materials in different situations was determined. In the experiment, materials of the same size were tested at different speeds (0.5 m/s, 0.75 m/s and 1 m/s) and pressures (20 N, 30 N and 40 N). In the first experiment, it was tested as a rubber layer. After the experiment, the weights of the samples at the beginning and end of the experiment were compared. We can see the results the experiment in figure 6.

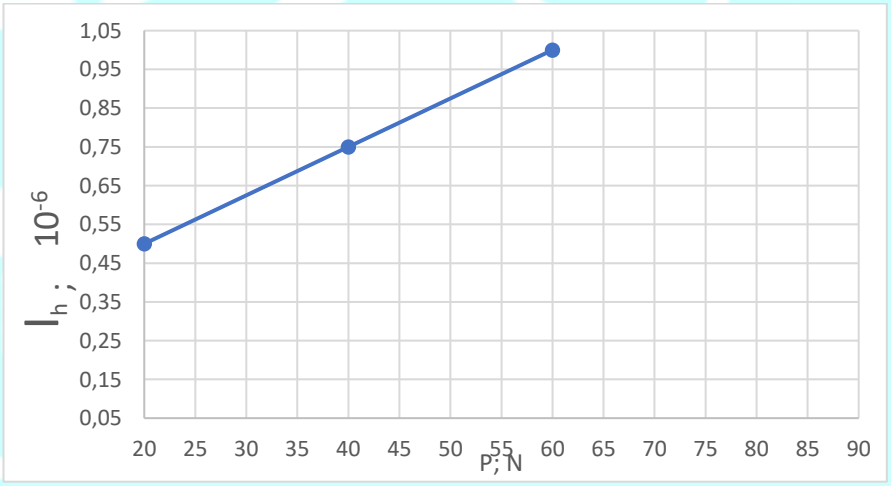


Figure 6. ***Graph of linear intensity of wear of rubber material versus load***

As seen from the graph, the linear wear intensity increases with the increase in the load applied through the roller. During friction, the material surfaces begin to wear gradually as a result of the breakdown of macromolecular chains.

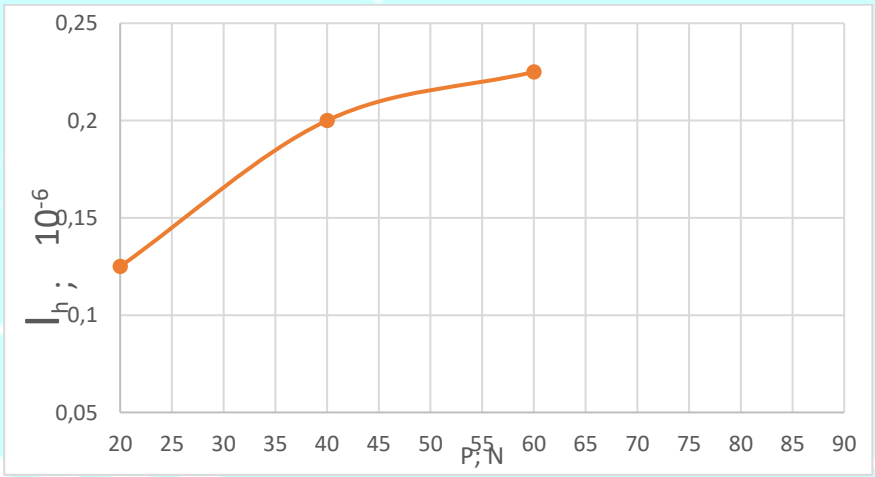


Figure 7. ***Graph of linear intensity of wear of polyurethane material versus load***

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In the next case, a polyurethane coating is tested. Figure 7 shows the graph of the linear wear intensity of the polyurethane material depending on the applied load. This graph also demonstrates that as the load increases, the wear on the layer surfaces increases. As seen from the graph, over time, the linear wear intensity gradually decreases. This is due to the expansion of the inner layers of the polyurethane material as the load increases, resulting in internal elastic deformation. As a result of this deformation, the linear wear intensity gradually decreases.

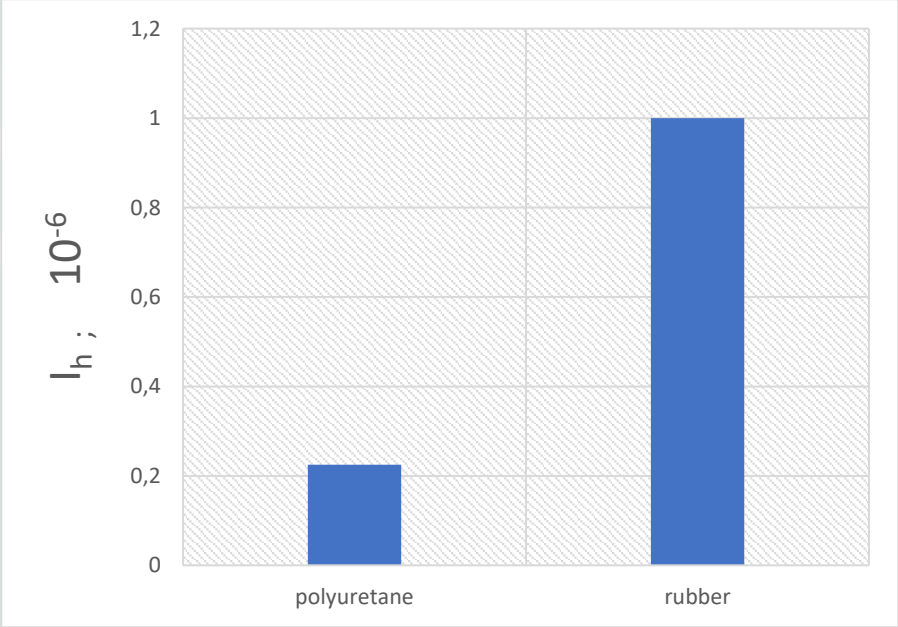


Figure 10. ***Diagram of the dependence of the wear intensity on the hardness of rubber and polyurethane.***

As can be seen from the diagram (Fig. 10), polyurethane layer has a lower linear intensity than rubber. Polyurethane's resistance to high temperatures and pressures allows it to operate under high loads and in aggressive environments. In this case, polyurethane is the best material for drum layer.

Conclusion. The results of the study showed that the forces acting on the belt conveyor drums used in mines vary depending on their design features and operating conditions. In particular, the erosion and cracking of the drum surfaces negatively affect the efficiency of conveyor transport. In order to eliminate this problem, it was determined that it is important to reduce the forces acting on the drums and use modern, durable materials in their manufacture.

The study compared rubber and polyurethane materials for the coating of traction drums. The results showed that polyurethane materials have higher strength, elasticity and wear resistance than rubber and are an effective solution for belt conveyor drums. Due to the high coefficient of friction of polyurethane

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coatings, resistance to mechanical damage and long service life, they are recommended for widespread use in the mining industry. To test the wear resistance of materials, an MI-M1 tribometry friction machine was purchased.

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