RESEARCH AND DEVELOPMENT OF A SPECIAL AIR CUSHION CONVEYOR DESIGN FOR THE TRANSPORTATION OF BULK CARGOES

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Resume

The scientific task of the nozzle scheme uses for formation of an air cushion by using the energy of a jet of air supplied under pressure, simultaneously to form an air cushion, as well as to create the driving force of a load-bearing web, was formulated and the main idea of the work was defined. The optimal option to significantly increase the productivity and length of special types of conveyors is to use the energy of a jet of air supplied under pressure simultaneously as an air cushion and as the driving force of the load-carrying body, which makes it possible to sharply reduce the coefficient of resistance to movement of the load-carrying body and improve its operating conditions. Supporting the load-carrying body with an air cushion allows to increase the speed of movement to 8 to 9 m/s and more, increase the reliability and safety of conveyor operation, and protect the environment.

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Nomenclature

1. AC - air cushion
2. ACCB - air cushion conveyor belt
3. LIWT - Leningrad Institute of Water Transport
4. KarSTU - Karaganda State Technical University
5. AB - air bag
6. HCHC - hovercraft carrier
7. KRU-350 - conveyor drives
8. CIS-Commonwealth of Independent States

1 Introduction

It is known from practice that a conveyor of a length of 13200 m is operated in Austria. The length of modern conveyor routes reaches 100 km. An increase in the length of conveyors that make up the line causes a decrease in the number of wires, tensioners, electrical equipment, starting equipment and various auxiliary equipment, which increases the reliability and productivity of the line, reduces capital and operating costs [1].

The main direction of mechanization is the introduction of conveyor transport into production, which, in terms of its technical and economic indicators, is higher than the rail and road transport. A comparison of the belt conveyors, rail and road transport of a capacity of 5-25 million tons per year and a transportation range of 5.25 km, speaks in favor of the former. Thus, with relatively identical capital investments, the operating costs (for conveyors in galleries) are 1.42 times more and 3.4 times less; the reduced costs are 1.15 times more and 2.85 times less; The metal consumption is 1.46 and 1.29 times less; the energy consumption is 1.2 and 6.48 times less; the track area is 4.5 and 4 times less than in rail and road transport, respectively. Labor productivity using the belt conveyors is comparable to productivity in railway transport and 33.8 times higher than productivity in the road transport [2].

The belt conveyors are capable of overcoming slopes up to 20% can be automated, preserve the landscape of the area, they are characterized by the absence of noise. The use of belt conveyors in open-pit mining makes it possible to develop a productivity of 15,000 m /h. which is 40% higher than the productivity of railway transport and 20% higher than the productivity of automobile transport. In addition, the transportation path is reduced by 13.3 times and 3.2 times compared to the named transports, respectively [3].

An increase in productivity and an increase in the length of belt conveyors with an increase in drive power, which is limited by the strength of the belt and its adhesion to the drum, is one of the most important questions of this construction.

Currently, the industry produces tapes made of synthetic fabrics (nylon, dacron, viscose) with a tensile strength per gasket and rubber, which significantly increases the productivity and length of belt conveyors. Thus, the Alexandrovsky Machine-Building Plant Karaganda city, Kazakhstan produces KRU-350 conveyors with a length of 1,500 m

The most effective means to significantly increase the length and productivity of the conveyor is the use of an air cushion (AC) to support the belt instead of roller supports. This allows to reduce the resistance to the movement of the belt, increase the safety of the transported cargo and the environment. The absence of rotating roller supports in an air cushion conveyor belt (ACCB) will reduce the component of resistance to movement from deformation of the load and belt when moving along the roller supports, reaching 40-70% of the total resistance, increase its reliability and safety of operation. The ACCB does not require the construction of galleries [4].

The air cushion field is analyzed using theoretical inference, numerical modeling and experimental research. An intelligent experimental platform is developed. A three-dimensional distribution of the air film pressure and the distribution of the air film thickness along the conveyor belt in the width direction are obtained. The experimental result is analyzed by comparing with the theoretical calculation and numerical simulation. The numerical and theoretical results are in good agreement with the results obtained in the experiments. A model of the air film formation behavior of the air cushion belt conveyor under stable load is presented. The optimized film thickness and pore distribution are obtained based on the comprehensive energy consumption. This study provides a basis for optimizing the design of the air cushion belt conveyor [5].

The disadvantages of the ACCB include:

- the need for additional energy for the formation of the AC under the conveyor belt;
- the difficulty of starting the ACCB in case of blockages;
- the ACCB are of large concentric loads on the tape and the asymmetry of the location of the load along the width of the tape;
- the efficiency factor of the fans providing the AC with air is low, which causes significant energy consumption for its formation.
- the flat tape in ACCB has low transverse stability, which limits its use.

However, some of these disadvantages are eliminated by known means. The development of the ACCB is of a great importance both in the Commonwealth of Independent States and abroad. To date, the research of this type of continuous transport machines has been carried out by the teams of the Leningrad Institute of Water Transport (LIWT) Russia city Saint Petersburg, the Bauman Moscow State Technical University Russia city Moscow, the Moscow Mining Institute Russia city Moscow. According to the results of the Higher Technical School in Twente (study, ACCB are manufactured for the foreign market. One of them, purchased by Belarus, was installed for the grain transportation at the Minsk bakery, Minsk, Belarus.

2. Methods

2.1. Systematization of a special design development of an air-cushion conveyor for transporting the large-piece cargo

The most effective means to significantly increase the length and productivity of the conveyor is the use of an air cushion. Therefore, the development and creation of conveyors and hovercraft devices is an urgent task.

The study of these schemes, and the design of the hovercraft conveyor, made it possible to identify common features by which their classification is possible.

A fan pumps air into the chamber under the device, which creates an excess pressure necessary for air to flow out along the periphery under the edges of the chamber. Under the devices of the first group [1-2], excess pressure is created and maintained by a jet curtain formed when air flows through a slit nozzle on the periphery of the device. In the devices of the second group [1-2], the lifting force is created by excessive pressure under the wing of the device when it moves near the support surface. This scheme is effective at high speeds of movement of the device.

For example, to move over an unprepared (uneven) surface without contacting it, in vehicles such as ships and all-terrain vehicles, the gap between the elastic fence and the support surface ranges from several to tens of centimeters. This gap, which requires significant air consumption, can be ensured by using a chamber or nozzle air cushion formation scheme in the design of vehicles.

At the same time, in an air cushion of this type, the excess pressure is negligible (several hundred pascals), which determines the low load capacity per unit area of the device. This practically eliminates the possibility of using such devices (or hovercrafts) for transport

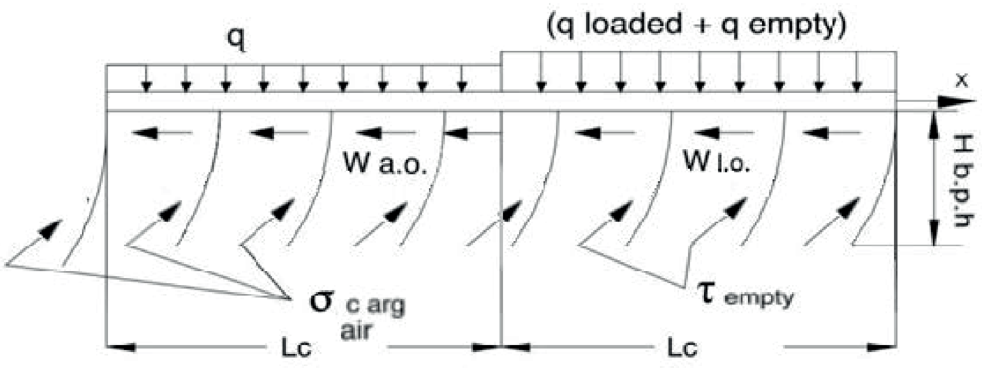


Figure 1 *Calculation model of a conveyor with an air cushion pneumatic drive*

operations, since the airflow flowing out from under the device with high speed and significant noise, having high kinetic energy, causes intense dust formation.

To reduce the friction between the mutually touching surfaces, gas-lubricated "air bearings" are used in a number of special devices and mechanisms. In such bearings, an air cushion is created between the sleeve and a shaft or the shaft end and a bearing, as a result of external blowing, which, according to the method of formation, can be attributed to slot-type pillows.

Hovercraft devices of this type are increasingly referred to in the technical literature as aerostatic supports (AS). This name is due to the fact that the external load on the support is balanced by the resultant aerostatic forces of overpressure. In various industries, aerostatic supports with an elastic diaphragm are mainly used for transport operations.

2.2 Increasing the efficiency of a special air-cushion conveyor

Increasing the efficiency of a special air-cushion conveyor operation using tools an air cushion and special devices, is a popular and urgent task.

The novelty of the work is the consideration of the main parameters characterizing the efficiency of using an air cushion, that is, the flow rate and air pressure to maintain the load-bearing body.

Valves are used to reduce air consumption in conveyor structures. In the absence of a load on the load-bearing organ (belt), the valves will block or completely close the holes through which air exits under the load-bearing organ (belt) and thereby reduce its consumption. When a load appears above the valve, the spring is compressed and the valve is compressed, while the outlet opens and air enters under the belt. Depending on the load, the passage section of the outlet will be larger or smaller, and therefore the air flow will be maintained automatically, depending on the need for it. The disadvantage of this device is the contact of the load-bearing body (tape) with the valves, which causes its wear. Due to the compression of the springs of the balls, there is resistance to their rotation, which somewhat reduces the efficiency of using an air cushion.

In the conveyor design, the role of the air flow control device is assumed by the belt crest with beveled sides that overlap the air supply openings in the belt chute upwards. With an increase in the load on the load-bearing organ (tape), it, bending down with a ridge, opens a large part of the cross-section of the opening, and the air supply under the load-bearing organ (tape) increases; with a decrease in the load on the load-bearing organ (tape), the ridge will overlap and the compressed air consumption will decrease.

2.3. The basics of calculating a conveyor with an air cushion pneumatic drive

The creation of promising conveyor designs that allow the transportation of bulk cargoes according to a non-unloading scheme is a popular task.

The novelty of this work is a development of a methodology for calculating the parameters of a new design of an air-cushion pneumatic conveyor for large-volume cargoes.

The structural formula of this conveyor, according to the classification of special types of conveyors, developed taking into account the regularity of the distribution of forces in traction and driven circuits, has the following form:

$$\frac{[((C_{\mathrm{argo}} * L_{co})_{canvas} + (e * B * h)_{airbag})]}{[((C_{-}argo * L_{-}co)canvas + (e * B * h)_{-}airbag)]}, \quad (1)$$

where:
L.C.O - load-carrying organ,
Canvas - canvas of the load-carrying organ.

The principle of operation of this conveyor is as follows: the energy of the jet of air supplied under pressure is used simultaneously as the air and the driving force of the load-bearing conveyor web.

The use of an air cushion makes it possible to reduce the coefficient of resistance to the movement of the load-bearing body, increase the speed of its movement, therefore, reduce the energy consumption of the conveyor and, accordingly, significantly increase the length of the shaft per drive. Due to the outflow of compressed air at an angle to the vertical, the load-bearing web receives translational movement. The calculation model of the conveyor with pneumatic air cushion drive is shown in Figure 1 and is presented in the form of a rod of a constant cross-section and stiffness along the sections of which stresses: σ_{air}^{cargo} on the cargo and τ_{air}^{empty} empty branches.

The blades have the following geometric parameters:
R is the radius of the blade sector shape, m;
H $b.p.h$ is blade pad height, m;
$B_{C.a.c.b.w}$ is conveyor air cushion blade width and
$l_{s.b.a.l.t.v}$ *is* spacing of blades along the length of a transport vehicle.

The amount of lifting and traction (driving) forces created by the air jet is significantly influenced by: the applied pressure, the size of the guaranteed gap between the support and bearing surfaces, the angle of inclination of the air jet, as well as the geometric parameters of the blade (R, B^{Canvas}, h^{Canvas} and $l_{s.b.a.l.t.v}$).

The condition for creating a lifting force, that is, an air cushion, can be written as follows:

$$\begin{aligned}&\sigma_{air}^{cargo} * \sin\alpha \geq 0.5\sin\alpha \geq (q_{loaded} + q_{empty}) * \\ &* \cos\beta * e_{sbaltv}, \\ &\tau_{air}^{empty} * \sin\alpha \geq 0.5\sin\alpha \geq 0.5 * q_{empty} * \\ &* \cos\beta * e_{sbaltv},\end{aligned} \quad , \tag{2}$$

where:
σ_{air}^{cargo} and τ_{air}^{empty} are the pressure forces of the compressed air jets , respectively, on the cargo and empty branches , N;
α is the angle of inclination of the nozzle for supplying a jet of compressed air to the blade, deg;
$(q_{loaded} + q_{empty})$ is the linear weight of the load and the load-bearing web, respectively, N/m;
β is the angle of inclination of the conveyor, deg;
e_{sbaltv} is the installation step of the blades along the length of the conveyor, m.

Condition the creation of a traction (driving) force should be written as follows:

$$\begin{aligned}&\sigma_{air}^{aargo} * \sin\alpha \geq 0.5\sin\alpha \geq (q_{loaded} + q_{empty}) * \\ &* \cos\beta * \omega_{air}, \\ &e_{sbaltv} + (q_{loaded} + q_{empty}) * \sin\beta * e * \omega_{air} + \\ &+ (q_{loaded} + q_{empty}) * e_{sbaltv} * \alpha / g, \\ &\tau_{air}^{empty} * \cos\alpha \geq 0.5[q_{empty} * e_{sbaltv(e * \omega_{air} * \cos\beta - \sin\alpha)} + \\ &+ q_{empty} * \alpha * e_{sbaltv} / g,\end{aligned} \tag{3}$$

where:
ω_{air} is the coefficient of resistance to the movement of the load-bearing web in the presence of an air cushion g = 9.81 m/s^2 is the acceleration of gravity.

Movement resistance force for the conveyor is:

$$W_p = W_{air} + W_{t.m.f.l.c.f}, \tag{4}$$

where:
$W_{t.m.f.l.c.f}$ - Motion resistance force of traction driving force,
W_{air} - Air cushion movement resistance force.

Determination of the power of the pneumatic conveyor drive.

The power of the pneumatic system, as is known, is the following dependence:

$$N = P_{air} l/t = \rho S l/t = \rho S v_{launch}, \tag{5}$$

where:
P_{air} is the pressure force created by the compressed air jet, N; l is the distance of movement of the air jet, m; t is the expiration time of compressed air before contact with moving elements, s; S is the air pressure area, m; v_{launch} is the expiration rate of the compressed air jet, m/s. As mentioned earlier, the compressed air jet performs two functions, that is, it creates an air cushion, lifting the supporting elements, and a driving force to move the load-bearing body.

1. It has been established, that open-air circulation circuit requires less energy to form air space, and a closed circuit can be successfully used when transporting goods that have a harmful effect on the environment.
2. It was revealed that maintaining the load-bearing body of the air cushion over the entire supporting surface requires less energy consumption than discrete; maintaining the loaded and empty branches of the power body with air flows creates greater vertical stability than the general flow, but requires greater energy expenditure for the formation of an air cushion, and maintaining both branches of the power body of the conveyor with a common air flow requires less costs when the flow moves from the loaded load-bearing body to empty than vice versa.
3. Based on the analysis of existing designs of air-cushion devices and vehicles, taking into account their characteristic features, a systematization has been developed and the areas of application of air-cushion devices have been established.
4. It has been established that devices for increasing the efficiency of the air cushion mostly have practical application in stolports. The use of labyrinth seals can reduce the air consumption from the air cushion by 30%.

3 Experimental studies and methods for calculating the basic parameters of a special AIR cushion conveyor

3.1 The object of the study and the methodology of experimental research

In order to verify the main theoretical dependencies, study the cargo transportation process, clarify the main parameters, evaluate the performance of a special air cushion conveyor and the effectiveness of using air cushion to maintain the load-carrying body, studies were conducted at an experimental laboratory facility at Abylkas Saginov Karaganda Technical University.

The specific objectives of the study were:

- verification of the main theoretical dependencies obtained earlier;
- clarification and justification of the main design parameters of a special air cushion conveyor;
- assessment of the operability of a special air cushion conveyor and the effectiveness of using air cushion to maintain a load-bearing body.

The research program included the following main stages:

- determination of the efficiency of a special air cushion conveyor and the effectiveness of using air cushion to maintain the load-carrying body;
- determination of the rational aerodynamic parameters of a special air cushion conveyor during the transportation of bulk cargo;
- verification of theoretical dependencies for determining the air flow rate for the formation of air cushion.

The experimental research program also included visual observation of the operation of a laboratory installation simulating the movement of a load-bearing body using the air cushion and an assessment of the operability of the design of individual components. The laboratory experimental installation was developed and manufactured at Abylkas Saginov Karaganda Technical University, which has the following technical characteristics:
width of the load-bearing body B=0.4 m,
length of the conveyor installation $L_{conveyer}$ = 6.5 m,
diameters of the drive and tension drums 0.4*e,
speed of movement of the load-bearing body, m/s:
first gear-1.54,
second gear-2.81,
third gear-5.04,
fourth gear-7.8,
fifth gear-11.7,
conveyor belt thickness,
tensioner stroke, electric motor power N = 4.0 kW,
rated rpm, n =1, 500,
efficiency = 78 %,
gearbox-gearbox of the GAZ-53 car,
the gear ratio of the V-belt gears:
the first is 1.66,
the second is 0.98,
the belt of the loading device:
length L = 4 m,
fan motor: type -AO2-41-2,
efficiency = 0.84 %,
nominal number of revolutions per minute 2890,
the gear ratio of the V-belt transmission is 1.04,
fan: type - VVD-5, developed pressure -4875 N/m2 (ati),
capacity Q_{air} = 1365 m^3/h,
thyristor frequency converter:
type - TP4-40, power N =39 kW,
frequency control limits - 4.88 to 58.5 Hz,
voltage change-20 to 230V,
diameter of the central pipeline d = 0.127 m,
diameters of the pipeline sections d = 0.06 m.

3.1.1 The experiment plan

The nature of the functional dependence of the coefficient of the load-bearing body resistance to movement on the air flow rate at different pressures and air densities, the speed of movement and linear load, the scheme of formation of the air cushion is unknown in advance, which makes it impossible to determine the intervals between the experimental points of this function. The nature of other functions is also unknown.

To identify the nature of the functions, six to seven experimental points with different air flow intervals were selected, determined by the area of economic feasibility of using air cushion to support the load-carrying body and the maximum capabilities of the air supply source.

The experimental research program included: a general assessment of the performance of a special air cushion conveyor; establishment of rational aerodynamic and geometric parameters of the system; determination of linear load; determination of the speed of movement of the load-bearing body; determination of the power consumed by the drive engine.

The experiments were carried out according to the following method:

- one of the hovercraft schemes was created;
- a certain linear load was created on the load-bearing body of the conveyor;
- the measuring equipment has been adjusted;
- compressed air was supplied by a fan in the same amount to all sections of the gutter;
- the conveyor was started and, with a steady movement of the load-bearing body, the quality of creating an air cushion was monitored by measuring the power consumed by the electric motor of the drive;
- in the absence of problems in the installation, the oscilloscope recorded the signals of load cells measuring the traction forces in the load-bearing body and the force of resistance to movement of the loading device, the air flow and speed of movement of the load-bearing body were measured, the air pressure under the load-bearing body along the width and in the gutter sections;
- the conveyor stopped;
- the compressed air supply stopped;
- the installation of the initial readings of the devices was checked;
- compressed air was supplied in the same amount to the conveyor chute and the previous positions were

performed, starting from the fifth position;

- the air flow rate changed and the previous positions were performed starting from the fifth position;
- the speed of movement of the load-bearing body changed and the previous positions were performed, starting from the fourth position;
- the linear load was changed and the previous positions were performed, starting from the fourth position;
- the scheme of formation of the air bag was changed and the previous positions were fulfilled, starting from the fourth position;

The waveforms were processed using the method of variation statistics [1-2]. With the existing methods of obtaining variation series by ordinates and peaks, preference is given to the peak method. The sequence of operations for obtaining the values of the measured parameter with a set confidence interval was carried out according to the methods [1-2]:

- the measurement results were presented in the form of a grouped series of variations,
- the mathematical expectation was determined $m_x = \sum X_i P_i$,
- with the standard deviation $\sigma_x \sqrt{(X_i - m_x)^2 P_i}$.

A confidence probability was assumed:

- half of the relative interval for the standard deviation was found,
- the value of half of the confidence interval d was determined.

The experimental graphs were constructed using the least squares method.

3.2 Analysis of the results of experimental studies of a special air cushion conveyor.

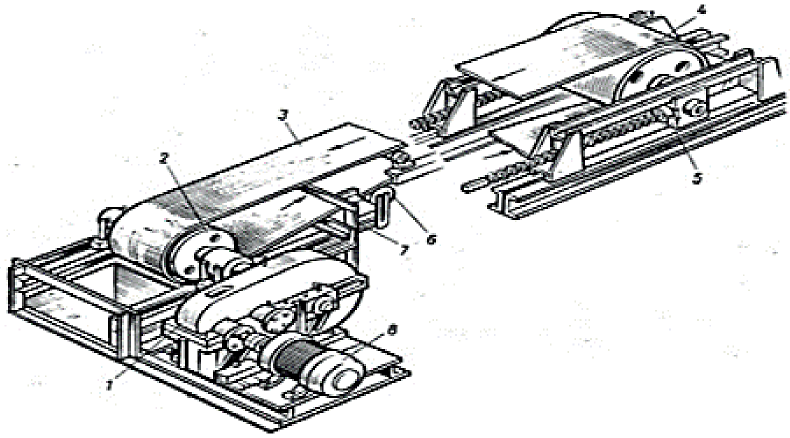
The hypothesis of a "flexible" cargo-carrying body was tested by experiments. To do this, a material (sand) with a volumetric weight, Y_{gr}=*16328* N/m^3, was poured onto the load-bearing body, freely lying in the gutter, consisting of three meter sections. The height of the material in the center of the load-bearing body above the drainage holes, located along the perimeter of the section of the middle section of the gutter, was measured by means of chips.

Air was forced under the supporting body of the conveyor using a fan, and after separating it from the chute with uniform air movement, the pressure under the supporting body was measured with pressure gauges connected by flexible tubes to drainage. holes. By measuring the pressure in the middle part of the gutter, the influence of atmospheric pressure through the ends of the gutter is eliminated. The experimental results and calculated data show satisfactory results. The result increases with increasing linear load (the height of the load on the load-bearing body) and at nominal loads, and the discrepancy between the experimental and calculated results is 8.6%, which is explained by the small influence of the rigidity of the load-bearing body and the forces of internal friction of the load.

Throttling of the air flow was performed by changing the cross section of the outlets. Experiments have revealed that the highest air bag with a nozzle formation scheme both in the center of the load-bearing body (Figure 2) and along the edges of the load-bearing body occurred with the ratio of the total area of the through holes of the nozzles to the reference area of the load-bearing body K = 0.02.

With a change in this relationship, in one direction or another, the height of the AB is smaller both in the center and along the edges of the load-bearing body. Thus, with an increase in the ratio to K=0.048, at linear loads of 143 and 207 N/m, the height of the air cushion is less from 13.1% to 89% and from 11.21% to 101% in the center of the load-bearing organ; from 15.02% to 42.5% and from 7.02% to 42% along the edge of the load-bearing organ, respectively, loads when changing the complex indicator from 0.074 to 0.06.

Due to the dependence of the height of the air cushion, with a nozzle formation scheme, on a complex



1- gearbox, 2 - drive drum, 3 - conveyor belt, 4 - tension drum, 5 - tensioner, 6 - roller supports, 7 - conveyor frame, 8 - electric motor

Figure 2 *Tension station of a special air cushion conveyor* indicator of the air parameters, it has a linear character, which indicates an increase in the proportion of dynamic pressure in total pressure, especially with an increase in the height of the AB. The height of the AB, with a nozzle formation scheme, is greater along the edges of the load-bearing body than in the center.

In order to identify the best scheme for the formation of AB, experiments were conducted with the chamber scheme.

The tension of the grooved load-bearing body is uneven in width due to the difference in distances between the extreme and middle points of the drum and the gutter. Experiments have revealed that at low values of the complex index (0.06-0.061), the load-bearing body contacts the gutter with the edges, and not the center. Therefore, in the air cushion conveyor with a nozzle scheme, maintaining the load-bearing body of the AB will probably be the best, since in this case, the height of the AB is 7.02, 42% larger.

3.3 Comparison of diagrams of the air pressure distribution in the air cushion at rest and in motion.

The air pressure in the air cushion during the movement of the load-bearing body decreases compared to the pressure at rest by 1.95, 4.88% along the edges of the load-bearing body and by 11.7 to 17.6% along the center of the load-bearing body for the nozzle formation scheme, which indicates an increase in the height of the air cushion. Consequently, the air consumption, required for the formation of air cushion during movement of the assembly line, should be taken to be 9.75 to 14.6% less than at rest, which will reduce the energy consumption and increase the vertical stability of the assembly line.

The tension of the monocoque body before running into the chute and after escaping from the chute, as well as the resistance force to the movement of the loading device, were measured using load cells.

The readings of the load cells were recorded by an oscilloscope on photographic paper. The air cushion conveyor with a nozzle circuit reacts more strongly to changes in the linear load and the speed of movement of the load-bearing body. For example: an increase in the linear load by 42% causes an increase in the coefficient of resistance by 3* to 49%. An increase in the speed of movement of the load-bearing body by 2.69 times causes a decrease in the coefficient of resistance to movement in the HC with a nozzle circuit by 22 to 45%. An increase in the air flow rate in a low-load area will cause a sharp increase in resistance in the nozzles, as a result of which air consumption will decrease. In an area of a large load, a decrease in the flow rate through the nozzles will lead to the opposite phenomenon.

4 Conclusion

1. Analysis of the systematization of air-cushion conveyors revealed the presence of a wide variety of air-cushion conveyors, the further development of which will make it possible to obtain new types of structures and schemes that are currently unknown. From the above systematization of air cushion devices, it has been established that the use of one or another air cushion formation scheme is explained by the compliance of the capabilities that this scheme can provide with the operational requirements for a particular device.
2. To increase the efficiency of the air cushion in a conveyor, the authors propose to use the energy of the air jet supplied under pressure, to simultaneously use both the air cushion and the moving force of the supporting conveyor belt. At the same time, it is necessary to develop the new, more modern devices for protecting the air cushion and air circulation circuits, which have priorities at the level of inventions.
3. The obtained dependencies make it possible to determine the main parameters of a conveyor with a pneumatic drive on an air cushion.
4. Experimental studies have confirmed the operability of a special air-cushion conveyor and the effectiveness of using an air cushion to support the load-carrying body when transporting cargo with uneven loading of up to 18%.
5. An engineering methodology for calculating and selecting the main parameters of a special air-cushion conveyor has been developed.
6. The adequacy of the theoretical assumptions of the essence of the air cushion, in the promising design of a special air cushion conveyor, to the real conditions was confirmed, i.e. the discrepancy between theoretical and experimental studies is no more than 12 to 13%.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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