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SOLUTIONS FOR ISSUES IN THE AIR TRANSPORT SYSTEMS OF COTTON PICKER MACHINES

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Abstract. In this article it is described results of the analysis regarding the shortcomings of the horizontal and vertical spindle cotton picking machines manufactured in the country, based on the principles of operation and experiments of air transport systems that transfer cotton from the picking machines to the bunker. On the examples of JX-220 horizontal and semi-trailer vertical spindle machines with suspended structures, the moving air velocities in the air transport pipelines were measured using a Kanomax Anermomaster 6112 instrument and the results were interpreted. In high-yield fields, the decline in the harvesting qualities of machines of both constructions is to some extent characterized by defects in the air transport system. During the operation of the JX-220, the cotton collected and stuck in the front drum of the harvester is collected in the receiving chamber of the system due to the low air flow rate. The four-row MX-2.4 semi-trailer with a vertical spindle has a stairwell behind the tractor to facilitate maintenance, complicating the design of the air transport system. Experiments have shown that due to the increase in local aerodynamic resistance in the system pipes, the flow rate to transport the cotton to the bunker is insufficient. The results of analyses and experiments require research on the reduction of aerodynamic resistance in machine air transport systems.

Key words: air transport system, picking mechanizm, cotton, cotton wool, harvesting

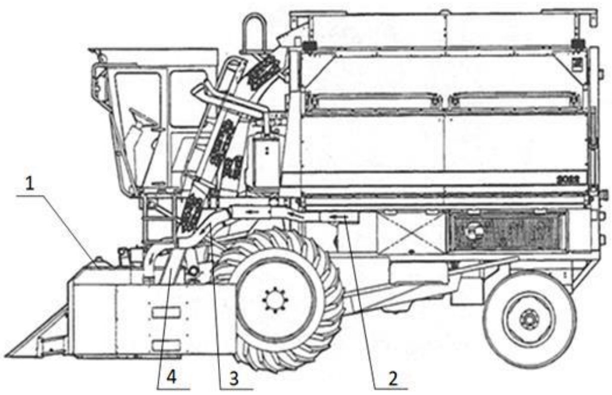
Introduction. According to the annual report of the International Cotton Advisory Committee (ICAC), the demand for environmentally friendly raw cotton and its products is increasing year by year [1]. Uzbekistan is one of the leading countries in the world in terms of cotton cultivation and processing, and the harvesting on the basis of mechanization is being carried out with modern horizontal and vertical spindle machines. In this process, when picking raw cotton, which is picked up by the plantations, into the bunker, an air transport system is used which has a low negative effect on the natural qualities of fiber and seeds. Horizontal spindle cotton machines are equipped with a “Jet er trole” system based on the ejection print, while vertical spindle machines have a system of sucking air from the apparatus and directing the harvested cotton to the bunker using a ventilator of low energy efficiency [2-4]. Some research and experimental design studies are being carried out in the USA and Uzbekistan based on the above-mentioned principles, and a number of organizations are working in this direction [5].

The article covers the problems of modern cotton-making machines based on the analysis of air transport systems and the necessary experience.

Leading companies from the USA, Italy, China, India and other countries John Deere, New Holland Case, Guanda, Huangxin and Tashkent Agricultural Machinery Plant (TAMP) use Case Cº as an example of horizontal spindle machines in analyzing the main principal aspects of air transport system in them. John Deere's two-row high-performance machines (1,417 M3/s), with high speed and high pressure (5,5 KPA), requiring great power (at least 30 ... 40 kW) were equipped with centrifugal ventilator at some time in the past [3, 4]. Such constructions are being used in modern multi-lane (3-6 lanes) machines as well.

Research method. The processes in air transport systems, the working element of the construction of two types of cotton picking machines, are explained in a theoretical (analytical) way. Static and working conditions of constructions are considered. The experimental aerodynamics method, the special modern instrument Kanomax Anemomaster 6112, measuring the air flow velocities in the secondary system pipes by the repetition method are used; the results are processed by mathematical statistical methods and shown as graphs and tables. The experiments and analyses revealed the problems in the air transport systems of machines and became the basis for their further solution.

Results and discussion. In figure 1, examplesof Case-2022 and JX-220 machines include the case in which cotton is being transmitted by air from the term apparatus (two-row) to the bunker and the observations of the receiving camera of the JX-220 machine[1]. The harvesting machine 1 consists of (Figure-1a), high-performance centrifugal ventilator 2, a pipe 3, which transmits the air from the ventilator to the receiving camera 5 by means of a high-speed "U" Simon slit, a pipe 4, which transmits the cotton to the bunker and other parts that carry out the harvesting process.



a)

b)

Figure 1. Horizontal spindle Cotton Machine: a–Case-2022 air transport system, b – JX– 220 receiving cameraof machine

The process in the air transport system is carried out as follows: the air flow that moves the cotton is absorbed from the outside as a result of the rotation of the propellers of ventilator 4 at a large angular velocity (N_v=4000 min^{-1}) and the pipe is directed to 3, at the exit from it the air cross-section is transmitted to transport pipe 4 on one side of the receiving chamber 5 by means of a small "U" shaped slit. From the second side of the receiving chamber,cotton wool is transmitted to it through the disc separator at a certain initial speed, and the "U" connected to the camera is directed upwards from the Simon slit and sent to the bunker through pipe 4, joining the negative pressure-absorbing current around it.

If, according to the rules of aero-hydrodynamics, a continuous environment moves at a greater speed than any narrow surface, negative pressure (absorbing current) appears around it, attracting the surrounding environment. Because the air transportation systems of horizontal spindle machines are based on that same principle, harvested cotton falls into the bunker directly through pipe 3 (Figure 1), not from the ventilator. This means that the speed of air passing through the " U " shaped slit, its volume in every moment and pressure are of great importance in the impeccable process of cotton transport. As a result of the experiments conducted with the permission of the TQXTZ leadership, the air velocity outflowing from the slit was recorded to be approximately 35 m per sec, using the Kanomax Anemomaster 6112 instrument.

The "N" distance in the receiving camera 5 in Figure 1 and its cross-section surface are of great importance for the reliable operation of the system. This issue is being expected to be solved on the JX-220 machine, since in high-yield fields there are cases when the camera is filled with cotton.As a result of the experiments and tests conducted in the Certification and Testing Center of Agricultural Machinery and Technologies (QXTTSM) and BMKB-Agromash JSC, construction combines (Case-

2022, Case-2155, DD-9930, DD-9940, etc.) and power and collar lubricants for horizontal spindle machines in the hanging form (JX-220) 1,6 compared to vertical spindle machines of the same classis 2, 3 times higherit is noted that the power consumption for the air transport system is two times higher [4].

In this regard, it is worth noting that the costs of semi-trailer cotton machines created in Uzbekistan are several times less: for production (2-4 times), for use (up to 2 times). At the same time, an increase in the reliability of machines is still urgent.Especially, the practical importance of carrying out research on the air transport system and improving it are of great importance.

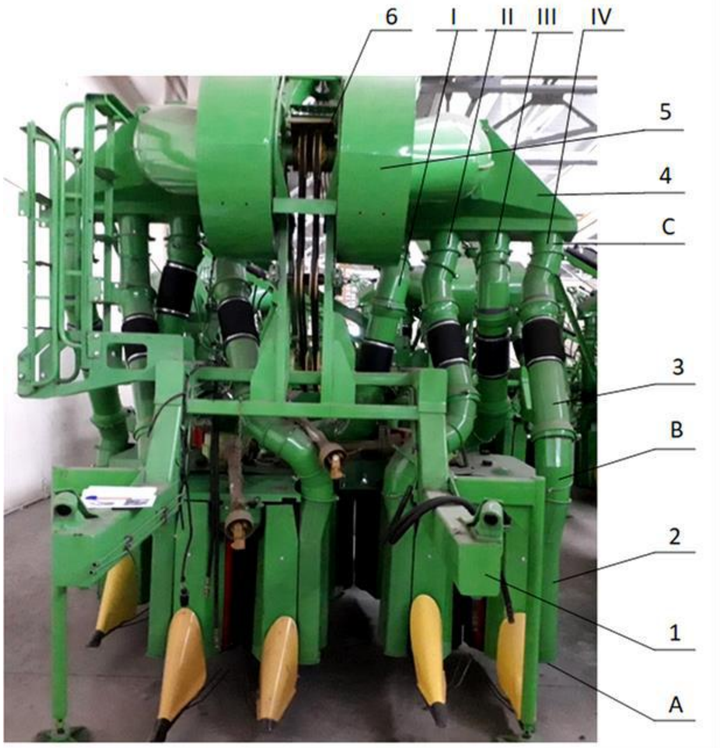


Figure 2. The semi-trailer MX-2,4 cotton mill and its air transport system.

Figure 2 shows the MX-2,4 semi-trailer vertical cotton harvesting machine designed for a four-row 60 cm range. The machine consists of an air transport system and a bunker based on a suction-compression printing system, consisting of 4 two-sided spindle drums of the same construction on each side and 6 brushless separators on each nozzle, a transfer from the ventilator through the pipes of the sought cotton to the bunker through which the bunker is transferred. Since the process in the terminology apparatus is widely covered in the literature, it is preferable not to go into it in detail [1, 4]. The air transport system, which transmits the cotton harvest to the bunker in the spindle unit, is configured as follows: all parts of the machine are frames-1 that can be installed, the receiving camera installed on the harvesting apparatus-2, the pipes that can enter each other transmitting the cotton to the ventilator-3, the inlet part is a pyramidal outlet part, the air collector connected to the fan body -4, the centrifugal low-pressure fan-5, the belt drive moving the fan blades-6, the cardan shaft-7. The working process of machine air transport system: the rear power draw of the tractor transmits the connected reducer by the governor to the valve 7 by the second outgoing governor Muftacoupling to the valve with the valve card, the second side of the Val provides movement through the cone-wheel reducer to the valve Guide Pulley,then the motion is transmitted to the drive pulley on the fan shaft, from which the motion begins to rotate the blades. As a result, the air moves through the elliptical hole on the side of the ventilator housing, sliding through the outside and the hardware side slit through the lower and side holes of the muffler 4, the transmitter tube 3, and the receiving Chambers 2. The cotton, which received the initial acceleration from the separator with a brush inside, falls into the cotton receiving chamber through the suction stream and reaches the bunker having passed through the ventilator. Semi-trailer creates conditions of wide use in work other than tractor due to the possibility of easy separation of the tractor from the cotton harvesting unit in the car. At the same time, the location of the harvesting apparatus on the stairs in the machine has made the design of the air transport system to some extent more complicated. An additional twist in the geometrical forms of the transmission pipes caused a decrease in the volume of air in the receiving chamber, sucking additional air from the outside at the places of entry of the pipes into each other. As a result, the structures of the transmission pipes as well as clamps are complicated and cause an increase several times local aerodynamic resistance to increase several times in them [19, 20]. Therefore, the shortcomings in the air transportation system of the MX-2,4 machine negatively affect the completeness of harvesting, one of its main indicators. To solve this problem, it is of practical importance to study the air velocity, which is one of the main indicators in the system.In this case, we performed the air velocity using the Kanomax Anemomaster 6112, measuring instrument at three locations (A, V, S) in the system shown in Figure 2 and four air-absorbing pipes at the point where they are connected to the mast.

This measuring instrument is made in Japan and has a special display screen, with the possibility of recording the speed, pressure and temperature of the air in the object being studied. In the process of measuring the air velocity, when the Velocity value of the accuracy level is 0,1 of ... 19,9 m/s it is 2% , when it is 20 ...50 m/s it equals to 3% . The experiments were carried out on the MX - 100 machine, which was aggregated with the TTZ-LS 2,4n tractor, and in each of the above positions (mainly A and C cross-sections), the results obtained were shown in the table with their average values after three repetitions.

Air flow rate in the air transport system of MX-2,4, cotton picking machine (based on air collector types)

Name of the manufacturing company		TAMP* / Technolog JSC**							
Measuring points in the pipes that transmit cotton to the bunker	By System height	A				C			
	According to the order of the pipes	I	II	III	IV	I	II	III	IV
Air flow rate**, M/s		20,8/21,3	20,8/21,4	19,7/20,2	18,0/24,3	7,5/7,9	5,0/5,5	5,1/7,7	6,2/6,3

* - TAMP construction in the numerator
** - Technolog JSC in the denominator.

According to the table, the air flow rates in air transport systems, equipped with hoods, which are produced in both enterprises, are close to each other. At the same time, the flow rate at the entry point A of the coupler, which is located at the farthest edge of the technologist AJ, is due to the characteristic of the construction, which is the excess of the coupler to 6,3 m/s, that is, the pyramidal construction of the coupler has a symmetrical shape, which reduces the local aerodynamic resistance up to 3 m/s. But flow rate under the receiving camera of the hardware associated with this point is equated with the TQXTZ construction. The reason for this is the abundance of local resistance in the transmission pipe and the excess of air flow, which is absorbed by the side of the receiving chamber.

From the results of the research conducted, it is known that local aerodynamic resistance in the pipeline increases when the bendings in the transmission pipes (the number of them is more than two) are as many as possible and their value approaches 90º .

From the experiments conducted on TAMP fields it is known that the air-transport systems of the MX-1,8, MX-2,4 semi-trailer machines adversely affect the quality of the harvest in fertile fields and the amount of cotton spilled on the ground increases, as the velocity of air flow in the receiving chamber of the harvesting apparatus is less than the rate of suspension of cotton pieces and stalks (6.3 ... 7.0 m/s) (see table).

Conclusion. 1. Based on the above-mentioned analysis and conducted experiments, the improvement of air traffic systems of cotton machines JX-220 suspended and semi-trailer structures is one of the pressing problems and needs solving.

2. The analysis of the structures of air transport systems of cotton-making machines in production and their working processes was conducted, and shortcomings in the system were covered.

3. As a result of the experiments conducted on the example of a four-row semi-trailer cotton-harvesting machine, it was determined that the air velocity in the hardware receiving chamber is not enough to transfer cotton to the bunker.

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SUBSTANTIATION OF THE MAIN PARAMETERS OF THE DISC PLOUGH

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Abstract. Ploughing is one of the most important and energy-intensive processes. Therefore, it is nesasary to improve energy-efficient and resource-efficient, as well as high-performance disc plough. Based on this, a disk plough was developed and its parameters were researched. According to the results of theoretical research, to ensure quality tillage, the disc plug should be equipped with discs with a diameter of 65 cm and a radius of curvature of 70 cm, and they should be installed at least 38 and 17 angles, respectively, relative to the direction of movement and verticality.

Key words: energy-efficient, rotation, parameteres, diameter, disk.

Introduction. Wheat is one of the main and important cereal crops in Uzbekistan [1, 2]. In Uzbekistan, due to limited land resources, after harvesting wheat [3], it is replaced by corn, soybeans [4], from which fodder for livestock [5, 6] and additional grains [7, 8], potatoes and vegetables and additional food is obtained. It also increases the income of farms. However, after wheat, the remnants of wheat stalks in the field and the decrease and hardening of soil moisture do not allow it to be prepared with quality equipment and technologies, preparing the soil for quality planting [9, 10, 11, 12].The land can be cultivated after irrigation, but during this period in Uzbekistan it is difficult to irrigate due to lack of water and increases water consumption. According to the results of the study of the working process of the existing plows, it was found that disc plows are acceptable when cultivating fields emptied of wheat for replanting. In recent years, plough in the form of spherical discs are widely used in the world for tillage. Because disc work tools are not only forward-moving, but also rotary-acting, disc-ploughs have less resistance to gravity than overturned ploughs, and operate without clogging with weeds and plant debris. In addition, disc ploughs are simpler in structure than tilting ploughs, requiring fewer repairs and maintenances. Because their cutting blades are less worn and constantly self-sharpening (due to rotation) and length (relative to the blades of shares), the discs last several times longer than shares. A number of scientists have been involved in the study of disk work bodies and plugs. When R.J. Godwin and others studied discs with a diameter of 610 mm and a radius of curvature of 700 and 1400 mm in the United States by varying the mounting angle relative to the direction of motion from 20 ° to 30 °, the traction resistance was lower when the discs were set at 20-22 °.

H. Harrison found that the mounting angle of the discs ranged from 30 ° to 45 ° and increasing speed would increase reaction of the soil to the disc from the side. Md.Monjurul conducted research on the reaction (resistance) strength of the soil to disk work tools. El-Shazly and others found to be acceptable that in Egyptian conditions, the mounting angle of the disc plough relative to the direction of movement is 45 to 50 °, the mounting angle relative to the vertical is 18-22 °, working speed is 6.3 km/h, plowing depth is around 15 cm. O.E.Omofunmi and others studied disk ploughs in Nigeria, N.Abdalla Osman, Li Xia, Zhang Dongxing in Sudan and China depending on the physical and mechanical properties of the soil, it was determined that in conditions of low soil moisture, at a working speed of 7 km/h, the resistance to gravity will be minimal, ensuring high-quality soil cultivation.

M. Hann, J. Gissible, R. Manian, S. Bukhari and others have shown that the performance of a disk plug depends more on the speed of the disk, the direction of movement of the disk and mounting angles relative to the vertical, and they should be 42-45 ° and 15-25 °.

Abu Hamdeh and Reeder have suggested that the reason for the increase in slip as the angle of inversion increases may be due to an increase in tensile strength. J. Arvidsson et al studied special tiags for various plowshares, plowshares, and disc harrows. The design of machining depth, working width, geometry and stability and forward movement speed was studied by Naderloo et al. Ch. Benard et al. conducted research on al bionic discs and convex bionic surfaces and studied the possibility of reducing the maximum resistance to a maximum of 19.5% to 9% reduction in maximum resistance.

Materials and methods. Based on the above, the Tashkent State Technical University conducted theoretical research on the development of a disk plug and the substantiation of its parameters in accordance with the soil and climatic conditions of the Republic. This article presents the results of theoretical research in this area to substantiate the disc diameter and radius of curvature, direction of movement and installation angles relative to the vertical of the disc plow to ensure quality tillage.

Theoretical mechanics and the rules of higher mathematics were used in the theoretical determination of disk plow parameters. In doing so, the piece of soil cut by the disk was taken as a particle, and its motion in a spherical disk in rotation was studied. It has also been determined that the motion of a soil particle consists of a complex motion due to its rotation along the disk and its forward motion along with the plow.

Based on these data, in accordance with STATE STANDARD 198-75 and taking into account, the disk working TOOLs used in the agricultural machinery of the Republic, the diameter of the disk for use in the developed disk plough was 65 cm and the radius of curvature was 70 cm.

Results and discussion. We determine the velocity of the soil from the disk to the side using the scheme shown in Figure 1, and by the velocities.

$$V_y = V_н^T(\sin\varphi_T\cos\alpha + \cos\varphi_T\sin\tau\sin\alpha) + V_к^T\cos\tau\sin\alpha\cos\beta, \tag{1}$$

there $V_н^T$, $V_к^T$ – relative and transfer velocities of soil fragments at the time of descent from the disk, m / s; $\varphi_T = \arcsin\frac{D}{2R}$ – half of the central angle of the arc formed in the diametrical section of the disc, degrees.

Expressing VнT and VкT by the parameters and speed of movement of the disk, we obtain the following final result.

$$\begin{aligned}
V_y = \Bigg\{ & -\frac{1}{e^{2f\left[\arcsin\left(\frac{D}{2R}\right)-\varphi_0\right]}}\Bigg[\frac{6fgR}{(1+4f^2)}\cos(\varphi_0+\beta)\cos\tau + 2gR\frac{(1-2f^2)}{(1+4f^2)}\times \\
& \times\sin(\varphi_0+\beta)\cos\tau + 4V_n^2\frac{R^2}{D^2}\cos^2\alpha\left(\frac{\sin 2\varphi_0}{f} - \sin^2\varphi_0\right)\Bigg] + \frac{6fgR}{(1+4f^2)}\cos\times \\
& \times\left(\arcsin\frac{D}{2R}+\beta\right)\cos\tau + 2gR\frac{(1-2f^2)}{(1+4f^2)}\sin\left(\arcsin\frac{D}{2R}+\beta\right)\times \\
& \times\cos\tau + 4V_n^2\frac{R^2}{D^2}\cos^2\alpha\left[\frac{D\sqrt{R^2-(0{,}5D)^2}}{fR^2} - \left(\frac{D}{2R}\right)^2\right]\Bigg\}^{\frac{1}{2}}\Bigg[\frac{D}{2R}\cos\alpha\cos\beta + \\
& + \frac{\sqrt{R^2-(0{,}5D)^2}}{R}\sin\tau\sin\alpha\Bigg] + 0{,}5V_n\cos\tau\sin 2\alpha\cos\beta
\end{aligned} \tag{2}$$

here g –is the acceleration of free fall, m/s2; f – the coefficient of friction of the soil on the working surface of the disc; τ – the angle of rotation of the work tool relative to the vertical axis, degrees; φ_0 – half of the central angle, which determines the initial position of the piece of soil, degrees; R – radius of curvature of the disk work surface, m; D – diameter of the working tool, m; α – is the mounting angle of the work tool relative to the direction of movement, β – is the angle of installation of the work tool relative to the vertical, degrees.

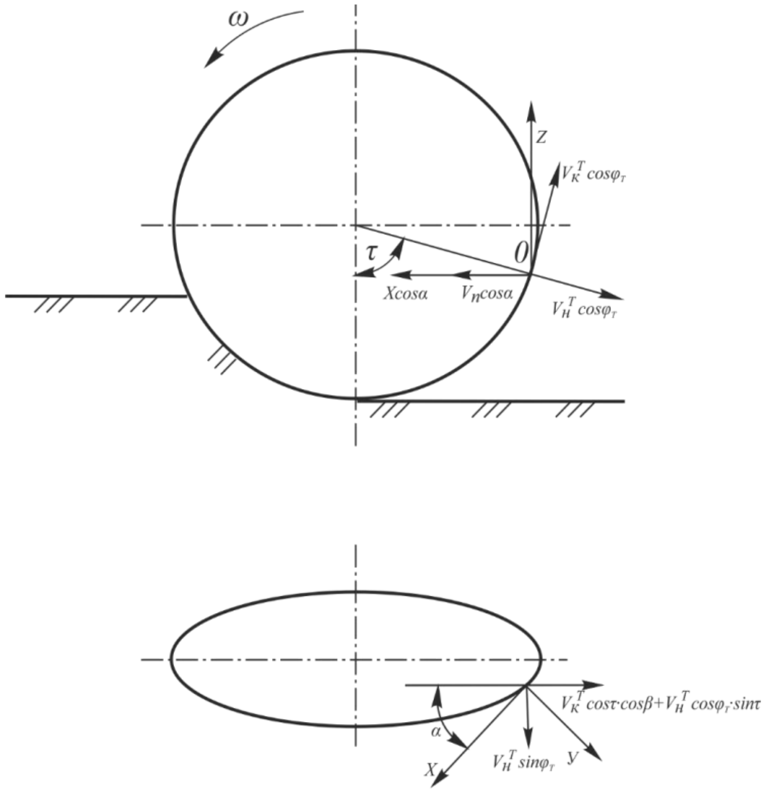
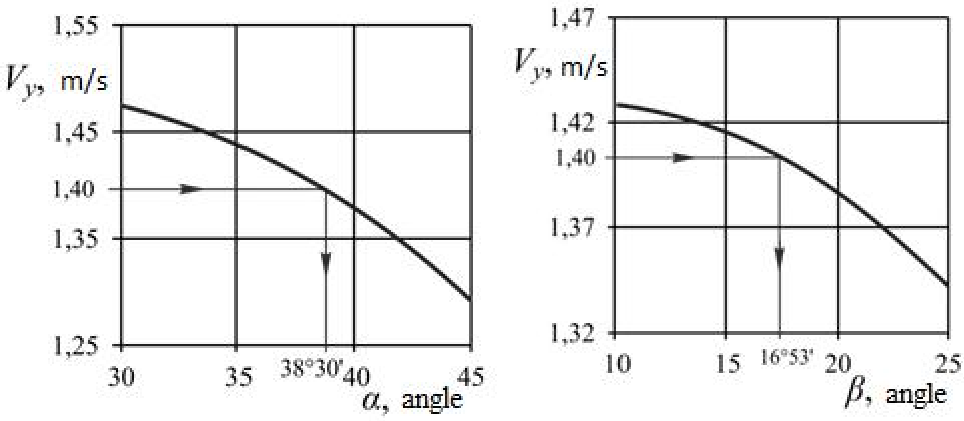


Figure 1. Scheme for determining the speed of soil throwing from the disk to the side

(2) It can be seen from the expression that for the above condition, ie the working condition of the soil throwing speed does not exceed 1.4 m/s, mainly the correct choice of the direction of movement of the discs and mounting angles relative to the vertical, diameter, radius of curvature and speed account.

(2) In Fig. 2, the graph of the change of Vy in relation to a, b, R, D and Vn is constructed. It can be seen that the increase in angles α and β and R leads to a decrease in Vy, and an increase in D and Vn leads to an increase in it.



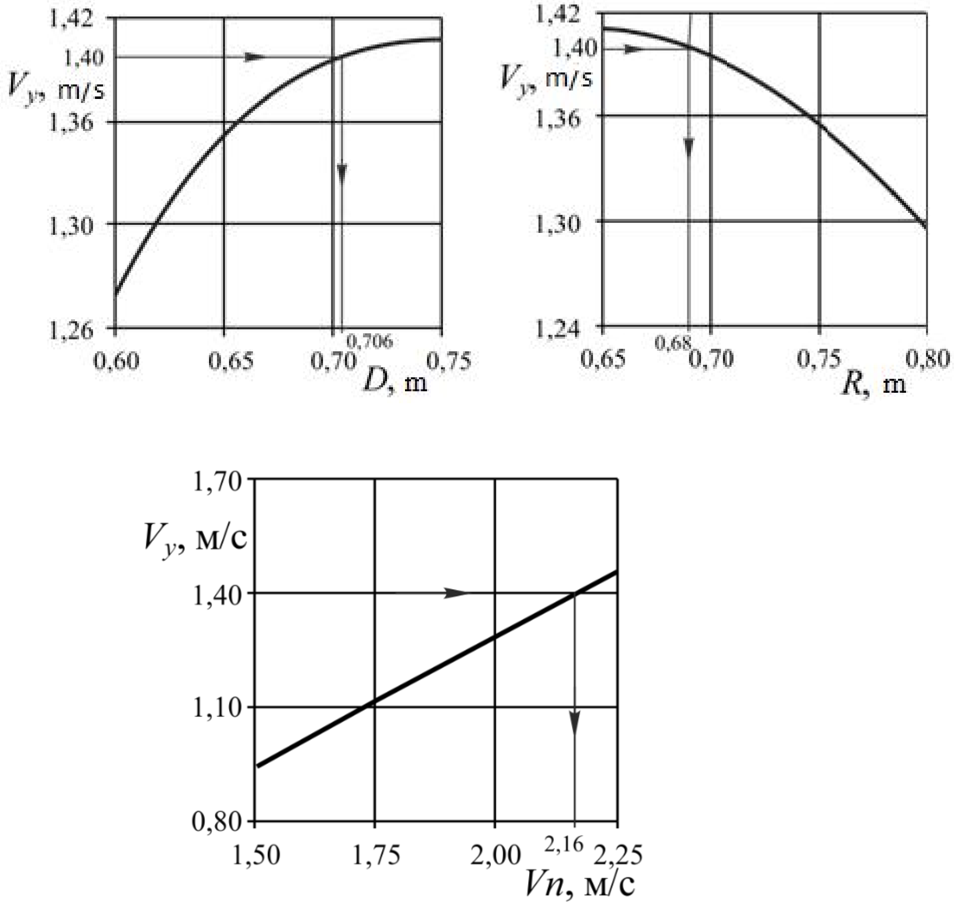


Figure 2. We accept discs of change graphs in relation to Vy a, b, R, D and Vn.

The data in Figure 2 show that for the Vy <1.4 m / s condition to be met and for plowing quality, the discs must be mounted at least 38 and 17 ° angles relative to the direction of movement and vertical, respectively, with a diameter not exceeding 71 cm and a radius of curvature of 68 cm. not less than, and the speed of movement should not exceed 2.2 m / s.

Conclusion. According to the results of theoretical research, to ensure quality tillage, the disc plough should be equipped with discs with a diameter of 65 cm and a radius of curvature of 70 cm, and they should be installed at least 38 and 17 angles relative to the direction of movement and verticality.

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RESEARCH IN LABORATORY OF THE TECHNOLOGICAL PROCESS OF THE SCREW EQUIPMENT FOR FORMATION OF LONGITUDINAL PAWLS BETWEEN COTTON ROWS AND SIMULATION OF THE OBTAINED RESULTS

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Abstract: In this article research results are analyzed the process of working with a screw device for the mechanization of longitudinal burns in laboratory conditions, which are still formed manually between cotton rows in cotton farms on irrigated areas. In it, the results obtained in laboratory experiments were obtained by processing them through mathematical modeling. Through the developed multi-factor mathematical model, the results of the experiment obtained in a special laboratory device were mathematically processed and the determination of the most optimal values was achieved. From the article, it is possible to analyze the method of mathematical processing and determine the optimal value for the results of experiments obtained in the laboratory apparatus. At the same time, the article provides a method of summing the interconnectedness of different sizes in different ranges by means of variability in a combined small range. The resulting value allows the detection and application of cord devices in any interrelated parameters, and taking into account the proximity of the received optimal values to the real value, it is recommended that the presented methods be used to solve similar issues.

Key words: pawls, screw, cotton rows, laboratory apparatus, cord divice, irrigation, cotton.

Introduction. In present days, large amount of cotton grown is suitable for irrigated farming. Nevertheless, cotton growing in irrigated agriculture demands more work. It is considered preferable for its productivity. Because of the crops' area of relief and uneven fields, the cotton irrigating process will be better done with the help of pawls dividing the small fields. In this process, along and across pawls should be made before irrigating and using them till the end of the crop period. Taking into consideration and making it in quantities is considered the actual problem. Nowadays, the process is being done by hand work by some farmers. Handmade capsizers that create surface pawls are also being used. This technique device does not give an opportunity to be used widely because it creates a cross pawl between cotton raw and done-in-two, the height of hurting cotton's young growth. Because of this problem, Tashkent Institute of Mechanization and Agricultural Engineers' Bukhara branch scientists are doing research work according to plan. The novelty of this recommended construction, which is created along the pawl between cotton rows, is defended by the useful patent model number FAP 00671 by the intellectual ownership of the Republic of Uzbekistan.

Statement of the problem. In order to examine, the results of theoretical study research to create this device, to work parameters, its measures and productivity. It planned to motivate energetic indication of works in laboratory and its parameters.
The model was made according to experimental research to do experiment in laboratory to create along pawls between cotton rows.

According to this laboratory model the following research work:

-investigate fixing corner, speed movement of soil raiser coil conveyor according to its number rotation

-determining productivity of rising corner of coil conveyor screw according to its axis.

-determining impact of coil conveyor step and its diameter to its energetic and agro technique indications.

-identifying working parameters and worth of rational working regimes by using more planning style of experiment:

Materials and methods. Special laboratory construction was projected and made to make an experimental research in laboratory. (Figure 1)

Laboratory construction consists of the following parts: Soil channel 1, free movement cart 2, (electric motor) 3, coil conveyor working organ 4, special appliance to fix in working movement cart 5, and position of turning threading combination according to working movement 6, redactor to send circular movement in work perpendicular plain 7, providing organ rotation number during the movement of the cart 9, toothed star 10, carrier 11 and carried belt passer 13, between pulley.

Laboratory construction works in following order. Electro motor which is moved cart frees in soil cannel1acts ahead 2.

Experimental construction is fixed by special device to the cart. Coil conveyor works by cone reducer fixed by belt passer cart. According to laboratory construction movement direction coil conveyor’s descent corner is changed by threading combination. Taken results by laboratory experiment are assessed by size of soil which is carried from construction.

In order to change descent corner by special threading combination (6) can have an opportunity to make corner to construction from 0 to 75 according to movement direction of laboratory.

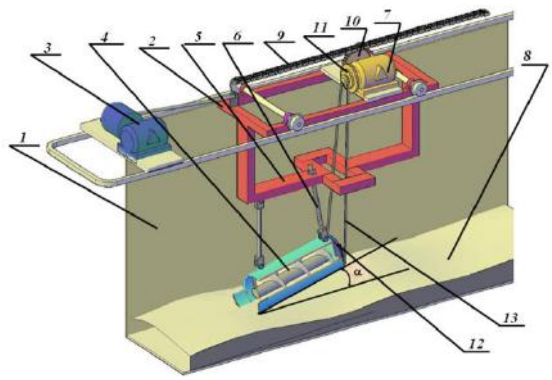

Figure 1. Laboratory construction to investigate technologic process of creating along pawl device between cotton rows

Main working element of laboratory construction is coil conveyor (4) which carry soil to the corner, to this rotatory and cart movement together is given to cone reducer (7), validator goes out from that is sent to coil conveyor carrier pulley (12) through rotatory movement belt (13) from 3 diametric pulley. The aim of it is to change pulley’s step, rotatory movement.

Laboratory model of creating along pawl between cotton rows’ construction is prepared according to working organ size 1/3 and fixed to soil channel cart through special device creating along pawl in soil channel laboratory construction, gives an opportunity to practice several speed movement in work regimes (Figure 2).

Requirement of soil and experimenting. Making laboratory experiments with hard soil, its wetness and granules are the same condition as fields.

Soil’s layer wetness 0…15 sm. keep the same with hardness of it 10.3…12.1 % and 0.16…0.33 MP.

In laboratory construction is aimed to determine descent corner according to movement direction of coil conveyor working organ, number of coil conveyor step and rotatory number, speed movement and coil conveyor diameter, effect of raising coil conveyor to energetic and agro technique indications, this is assessed by productivity of work.

Figure 2. Side view of laboratory construction which creat along pawl between cotton rows**.**

All indications are planned to do according to UZ RH 63.07: 2001 and TST 63.03:2001 “Experiment of agro cultural technique. Methods of economic effectiveness of experimental technique” Programs and methods of experiments RD 10.5.1-91 [1, 4]

Experiments make an opportunity fixing α=25°; 35°; 45°; 55° and 65°descendat corner according to horizon and speed movement of coil conveyor rotatory movement number ν=30; 42 ва 55 rot/min.

Version of coil conveyor diameter d_{sh}=80; 90 and 100 mm, raising corner γ=70°; 80°; 90° and its step q_{sh}=25; 35 and 45 mm are prepared on the base of theoretical research results.
5 repeated measuring process will be done on the base of these parameters the results are taken from 3 point of soil channel and determined average mathematical value in experiments.

Laboratory construction gives an opportunity moving in V= 0.5; 0.75; 1.2 m/s working organ of soil channel direction. These speeds coincide with II and III step of aggregate.
Special reducer elector motor fixed in laboratory construction and it provides rotator number (750, 1000 and 1500 rpm) and model 4A У128 works to move cart which is in soil channel.

Coil conveyor diameter, steps and raising corner parameters are determined by making 3 version experimental models coincide with laboratory device which is created pawl between cotton rows coincide with its value. So taken results from laboratory coincides with field and lands.

Discussion of research results. Mathematical modeling has always been highly valued as a method of solving scientific and technical problems.

The complex development of agriculture in all countries is determined by the demand for an annual increase in the level of mechanization. For a longitudinal pawl forming device between cotton rows, the slope angle relative to the direction of movement and the effect of the screw on the volume of soil transported in the change in the number of revolutions were mathematically modeled to avoid material-to-material and time-saving experiments [3, 4].

Experimental parameters in modeling, the results of changes in the volume of soil transported in the change of the angle of inclination relative to the direction of its movement and the number of rotations of the screw in the model of the pawl formation device tested in the soil channel in the laboratory of TIIAME Bukhara branch.

The experiments were obtained at five repetitive values on multivariate. We are one of them here α=25...65°да we present the results of the correlation and regression analysis for the experimental data obtained.

Table 1. Experimental parameters for modeling, i.e., the values of soil volume obtained when the slope angle of the pawl-forming device between cotton rows at a rotational speed of *n* are set at 25, 35, 45, 55, 65 degrees, respectively

Speed rotation / corner slope	The volume of soil transported (kg)				
	α=25	α =35	α =45	α =55	α =65
n=30 rpm	0.31	0.281	0.252	0.223	0.195
n=42 rpm	0.434	0.393	0.353	0.313	0.272
n=55 rpm	0.568	0.515	0.462	0.409	0.357

Here we consider the relationship between the slope angle of the pawl-forming device between cotton rows and the volume of soil obtained at that angle as a function.

The correlation-regression analysis method was used to model the correlation between the two indicators. In doing so, we first determine the degree of correlation between these two indicators.

In the study of correlations, two categories of issues are cross-cutting. One is to assess how closely (i.e., strong or weak) the relationship is between the events being studied. This is the function of a method called correlation analysis [4, 6, 7].

Correlation analysis is based on the determination of correlation coefficients and the assessment of their importance and reliability.

The correlation coefficients are twofold. The values obtained as a result of their calculation can be considered as the norm of correlation between X and Y events or, conversely, between Y and X events. Correlation coefficient (r) -1 from 1 lies on the border, if r=0 –no connection, $0<r<1$, lies on the border $-1<r<0$ - there is a feedback loop $r=1$ there is a functional connection, that is $|r(x,y)|\le 1$.

The bond density level is usually interpreted as follows. If $r<\pm 0.3$ almost no connection
$\pm 0.3<r<\pm 0.5$ weak connection.
$\pm 0.5<r<\pm 0.8$ middle connection.
$\pm 0.8<r<\pm 1$ strong connection.
The correlation coefficient is determined using the following formula [2]:

$$r_{xy}=\frac{n\sum_{i=1}^{n}x_i\cdot y_i-\sum_{i=1}^{n}x_i\cdot\sum_{i=1}^{n}\cdot y_i}{\sqrt{\left[n\sum_{i=1}^{n}x_i^2-\left(\sum_{i=1}^{n}x_i\right)^2\right]\cdot\left[n\sum_{i=1}^{n}y_i^2-\left(\sum_{i=1}^{n}y_i\right)^2\right]}} \quad (1)$$

The values showing the correlations between the values of Table 1, which show the angle of inclination of the pawl-forming device between the cotton rows, and the amount of soil obtained, are given in Table 2.

Table 2. Statistical regression module results

Name of coefficient	Speed rotation		
	30	42	55
Correlation coefficient	-0.99	-0.99	-0.99
Mathematical expectation	0.29	0.41	0.54
Dispersion	0.00281	0.00545	0.00939
Default error	0.0530	0.0738	0.09693

Table 2 shows that the correlation of the indicators in the experimental results is strong, and the negative value of the correlation coefficient shows that the correlation between the indicators is inverse (Table 1).

The second task in checking the correlation is to determine how much the second event changes depending on the change in one event, that is, to determine the regression equation. [5, 8].

Regression equations play an important role in solving practical problems. It allows the evaluation of the effectiveness of the events affecting the outcome event with practically sufficient accuracy.

Based on Table 1, when analyzing the relationship between the slope angle of the floor formation device between the rows of cotton and the soil volume obtained at that angle, we see that this relationship is parabolic. That's the connection

$$y_X = a + bx + cx^2 \tag{2}$$

In determining the coefficients of the equation for the given second-order parabola, the system of normal equations according to the method of least squares has the following form:

$$\begin{cases} Na + a\Sigma x + b\Sigma x^2 = \Sigma y \\ a\Sigma x + b\Sigma x^2 + c\Sigma x^3 = \Sigma yx \\ a\Sigma x^2 + b\Sigma x^3 + c\Sigma x^4 = \Sigma yx^2 \end{cases} \tag{3}$$

There N- number of experementation.

The number of revolutions in this system of equations n=30 rot/min we find from Table 1 (2) that the coefficients in the model are as follows.

$$y = 0{,}447261 - 0{,}003543 \cdot x + 0{,}000002 \cdot x^2 \tag{4}$$

Table 3. When calculating theoretical data using Equation (4), we see the following differences:

Slope angle, grad	Soil volume, kg	Theoretical volume, kg	difference
25	0.360	0.360029	0.00003
35	0.326	0.325886	0.0001
45	0.292	0.292171	0.0002
55	0.259	0.258886	0.0001
65	0.226	0.226029	0.00003

Now, when the number of revolutions is 42, we find from Table 1, based on experimental data (2), that the coefficients on the basis of the smallest squares of the model are equal to:

$$y = 0{,}620854 - 0{,}004734 \cdot x + 0{,}00002 \cdot x^2 \tag{5}$$

Table 4. When calculating theoretical data using Equation (5), we see the following differences:

Slope angle, grad	Soil volume, kg	Theoretical volume, kg	difference
25	0.503	0.502943	0.001
35	0.456	0.456029	0.0001
45	0.409	0.404957	0.0003
55	0.363	0.362629	0.0004
65	0.316	0.316143	0.0002

Also, when the number of revolutions is 55, we find from Table 1 that on the basis of experimental data (2) the coefficients on the basis of the smallest squares of the model are equal to:

$$y = 0{,}815761 - 0{,}006323 \cdot x + 0{,}00002 \cdot x^2 \tag{6}$$

Table 5. When calculating theoretical data using Equation (6), we see the following differences:

Slope angle, grad	Soil volume, kg	Theoretical volume, kg	difference
25	0.659	0.659029	0.00003
35	0.597	0.597086	0.0001
45	0.536	0.535571	0.0003
55	0.474	0.474486	0.0004
65	0.414	0.413829	0.0002

The lines formed on the basis of the above three models are shown in Figure 1 in comparison with the experimental points. The models shown in the figure are close to the experimental points.

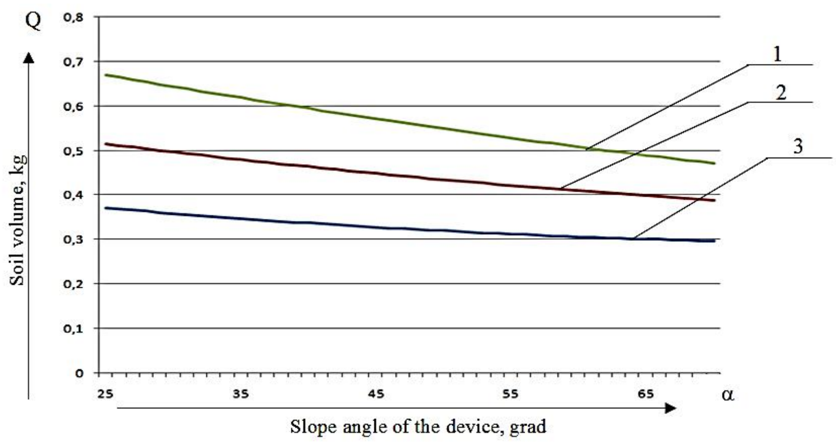

Figure 3: Diagram of the relationship between the slope angle of the floor formation device between the cotton rows and the soil volume obtained at that angle.
1) number of rotation n=30 rpm, 2) number of rotation n=42 rpm, 3) number of rotation n=55 rpm.

We also check that the experimental values are adequate to these derived models. As an example, we use Fisher's test for model (6) [9, 10].

Table 6. To do this, we refer to Table 5 for extended regression values

№	X(i)	Y(i)	y-theoratical	$y_i - \tilde{y}_i$	$(y_i - \tilde{y}_i)^2$
1	25	0.659	0.659029	0.00003	0.00000000
2	35	0.597	0.597086	0.0001	0.00000001
3	45	0.536	0.535571	0.0003	0.00000009
4	55	0.474	0.474486	0.0004	0.00000016
5	65	0.414	0.413829	0.0002	0.00000009
number	228	2.68	2.680001	0.00113	0.00000035

Before and using this y_i dispersion S_y^2 and the sum of the squares of the remains $\bar{S}_y^2$ we calculate:

$$s_y^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n} y_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} y_i\right]\right. \quad (6)$$

(6) if substituting the values of the variables in the formula

s_y^2=1/(5-1)·[1,474-(1/5)·(2,68)·(2,68)]=1/4·[1,474-7,1824/5]=1/4·[1,474-1,43648]= =0,037578/4=0,009395.

$$s_y^2 = \frac{1}{n-2}\left[\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2\right] = \frac{1}{5-2} * 0.00000035 = \frac{0.00000035}{3} = 0.00000012 \quad (7)$$

now we calculate the statistic F of Fisher criterion:

$$\tilde{F} = \frac{S_y^2}{\bar{S}_y^2} = \frac{0,009395}{0,00000012} = 8\,0317,75$$

A pair of degrees of freedom of the Fisher criterion
$(\nu_1; \nu_2) = (k-1; n-k) = (1; 3)$ we find from the table the critical point of 5%
FT = 0,95 (1; 3) = 5,32

According to the results of the experiment, $\tilde{F}$ = 80317.75> 5.32, which means that the regression equation we have determined does not contradict the results of the experiment, that is, it can be taken as the equation we are looking for with an error of 5%.

In all calculations, we used the capabilities of the Pascal programming language and the PascalABC programming environment, and the capabilities of the MathCAD design system when drawing graphs. [11].

Conclusion. Using this method will help you do hard and difficult experiments and get fast and suitable results.

Through the use of this style, one can easily get the best and fastest results during experiments. The results are worked out mathematically, and it gives an opportunity to prepare working examples without mistakes. So it will reduce working expenditure. It will also enable us to compare results which are taken from construction in the field and laboratory, and through that, research work will be assessed. The obtained regression equations can be used in experiments to determine the relationship between the slope angle of the floor formation device and the amount of soil obtained at this angle between the rows of cotton in the absence of experiments and in scientific research in this area.

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THE FUNCTION OF HUMAN RESOURCES DEPARTMENT IN CREATION OF NON-PROFIT BRANCH OF EDUCATION SYSTEM FOR INDUSTRY 4.0.

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Abstract. In this article analyzed that the role of modern human resourses in creation of suitable education system for the 4[th] Industrial Revolution. As companies in Uzbekistan are beginning to embrace Industry 4.0 elements, such as automation and digitalization of agricultural sector of economy, there is a strong need of hiring new generation of talent with solid background in computer programming skillsets and digital culture. Main challenge facing successful implementation of Industry 4.0 in acricultural sector is the lack of talent and absense of staff training. In this regard, organization of non profit STEM higher education institutions in Uzbekistan are key in digital transformation of the industry in the region. Key words.digital technologies, automation in agriculture, higher education institutions (HEI), STEM education, Industry 4.0, demography management.

Key words: agricultural, economy, technology, engineering, system.

Introduction. Nowadays marketization of higher education system grows dynamically. Expansion of for-profit higher education institutions (HEI) plays an important role in the coverage of population with HEIs. The main mission of HEIs are supply of the society with highly skilled workforce that create glooming economy. Recently, manufacturing sector of the economy is facing fourth industry revolution, which requires highly skilled graduates of science, technology, engineering and mathematics (STEM) schools. At the same time, the topic of organization of non-profit schools are lacking attention of policy makers of the region. In this research, the potential of non-profit STEM schools is discussed as the main driving force of talent search, education and supply to the rigorous manufacturing sector of the Central Asia and Uzbekistan in particular.

The first industry revolution started after the invention of internal combustion engine and motor power. Second industry revolution started with the invention of electricity. Third industry revolution occurred in the era of digitalization of all information and widespread expansion of personal computers. Fourth industry revolution is a cyber-physical system with high automation involving things and processes connected with each other via the internet, for which it is also called internet of things (IoT).

Transformation of small and medium size businesses into mature companies employing Industry 4.0 technologies require company workforce with ultra-modern skills. Therefore, it is important to stress the pillars of Industry 4.0 in education system, such as artificial intelligence, internet of things, big data, wireless networks, collaborative robots and cloud computing. Reduced routineness, increased demand for creativity, ability to code are current trends in the job market and these tendencies make many current jobs obsolete in the near future.

Like any other industrial revolutions, the key ingredient in this transformation is people, their knowledge, skillset and know-how. Work requirements are shifting from routine labor to programming and data analysis. For example, a sorting line powered with machine vision technology can suggest the best calculated time for a scheduled maintenance of a machine, but it is a human decision that makes decision about it.

Industry 4.0 requires many more STEM graduates in the near future worldwide. For example, starting from 2020, the number of jobs in mathematics and computer engineering will increase by 4.3% annually, in management - by 1.39%, in the financial sector - by 1.34% and in trade - by 1.25 %. Such trend will reduce the number of jobs for office workers by 6.06% per year, while the Internet will lead to increased demand for ICT workers by 4.54% per year and design and engineering professionals by 3.54%.

One of the ways in keeping up with industrial transformation is upskilling current workers and on-the-job training of existing workforce. Constant skills development helps companies to stay competitive in a highly dynamic manufacturing world. For this purpose, it is of high importance to create brain centers for retraining employees.

Hiring the best talent is a big task, but educating the talent is more difficult challenge. Second way of filling the job market with workforce is talent search and their education. Therefore, educating young generation of people with skills needed for the future industrial changes plays a paramount role in Industry 4.0 preparedness.

Other factor slowing the education system in this sphere is the fact that STEM specializations are not as competitive as other majors, such as economics, business administration or law. Because of rigorous intense curricula with deep study of math and physics, many pupils opt for humanitarian majors.

Moreover, due to the scarcity of universities in Uzbekistan, coverage of youth with HEIs has reached 25% [1]. Secondly, STEM education is out of reach for many low income families. Therefore, this paper presents an investigation of the effects of non profit STEM education higher education system on the formation of Industry 4.0.

Materials and methods. Demography challenges and demography management can be studied with focus groups of wide differences in the jobs (blue collar, white collar, etc.). They can be consolidated by using Mayring’s [2] content analysis. Interviewees can be chosen with the principle of maximum contrast. With the method of interviews and inductive approach of qualitative analysis, content post processing can be done during the study.

Education system’s responsiveness to labor demands can be modeled with analogy of vibrational analysis [3], i.e. two degree of freedom mass spring model (Figure 1), where the relation between education system transformation and perturbations in manufacturing sectors of economy are considered.

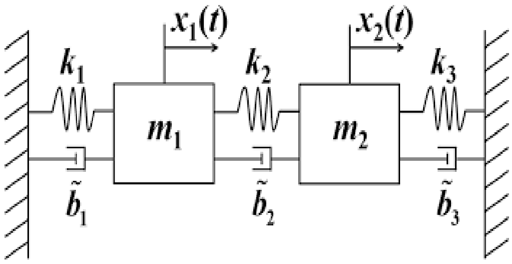

Figure 1. Vibrational mechanics analogy, where k and b are so called “stiffness and damping” coefficients, m1 and m2 are inertia of education and job markets respectively.

Research objective can be stated as following: what is the inertial displacement of m1 for the perturbations in m2 caused by Industry 4.0 revolution? Moreover, regression models can be built from the survey data to observe the relationships from hypothesis-specific dependent variables. Descriptive statistics of samples can be built for each model to build the predicted probabilities of achieving bachelor’s degree across time, social origin and tuition fee.

Research objectives. No doubt Industry 4.0 will have big impact to the manufacturing and service sectors of any economy, since the manufacturing has long been a key component of Uzbekistani economic diversification efforts.

Many researches have highlighted the potential impact of Industry 4.0 on future employment, but little research have been done in finding responsiveness of educational system to develop workforce able to employ next industrial revolution skillsets. As a vital part of the education system, non-profit private or government HEIs play an important role in creation of the well-rounded healthy society, where social lift is present.

Moreover, the topic of coverage of population with STEM HEIs is an important factor in the risk analysis of potential discrepancy between supply and demand in the job market due to the recent technological advances.More specifically, the following research questions need to be addressed:

1. What are the key Industry 4.0 features shaping the local job market?
2. What are the key parameters governing education responsiveness to job market changes?
3. What are the key Industry 4.0 features need to be developed in the local education system to bring up new generation of highly skilled workforce in line with the next industry revolution?
4. What is the impact of creation of a non-profit STEM school in Uzbekistan in short and near terms?
6. What is the financial burden of creation of non profit technical schools? Can the financial load of this project be offset by future socio economic potential in the region?

The main aim of this investigation is to conduct feasibility study of non-profit education institutions and its value to Uzbekistani job market in the context of fourth industrial revolution. Based on this main objective, the following tasks are set forth:

1. Analysis of the curricula of higher education system of Uzbekistan.
2. Analysis of demography of Uzbekistan.
3. Analysis of size, productivity and level of routineness of the manufacturing sector of Uzbekistan and Central Asia.
4. Quantifying the microeconomic issues of Industry 4.0 and problem statement in a macroeconomic stance.
5. Data collection, financial model and post processing and drafting recommendations for policymakers.

Preliminary Literature Review. A preliminary literature review shows that as a result of increasing growth in the for-profit private education sector in Uzbekistan, poorer families are ultimately left less able to access quality education than are their wealthier counterparts. Some scholars stated that the potential of non-profit education creates greater equity and accessibility.

According to Flynn [4], at present, educational systems appear not to be adapting fast enough to respond to future labor demands imposed by Industry 4.0. If not addressed, this challenge may result in the required skills being undersupplied, thereby fueling disparities between labor supply and demand, which consequently may cause unemployment levels to rise.

While a few nations in Central Asia, such as Kazakhstan for example, have opted for establishing new universities from scratch, most interested countries have adopted a strategy combining mergers and upgrading of existing institutions [5].

Some authors from eastern Europe concluded focused on the special case of a former socialist society, where higher education expansion has been very rapid and achieved mainly through marketization [6,7]. Their work highlighted the micro-level mechanisms that underlie the inequality dynamic present in education system in the case of Poland.

In the case of India, some experts suggested experiential learning. A digital capability center, for example, replicates an actual, digitally-enabled working environment that lets leaders learn in a way that’s far more realistic than a classroom, and far more effective in promoting exhibits.

In Uzbekistan, some researchers have highlighted the shift of the manufacturing sector to the next phase of digitalization [8]. Their research described the transformation process of a training-addressed process with reorganization of the structure of the existing engineering degree university. Some leading international consulting firms of Big Four, such as Boston Consulting Group have studied the oil-gas [7], automotive and agricultural machinery sectors of Uzbekistan and highlighted importance of shifting trends of local market in the shadow of global industrial movement towards Industry 4.0 and made their suggestions for policy makers. Industry experts of Uzbekistan proposed a draft Industry 4.0 Strategy of Uzbekistan based on the experience of G20 countries such as Germany, USA, Canada, Japan, China and South Korea. They proposed main directions for the basis of legislative and normative documents to support the introduction of Industry 4.0 elements [9].

Companies in Central Asia are beginning to embrace them at an increasing rate. For example, a regional aerospace manufacturing company is on course to establishing a digital factory in which product/ process traceability, process automation and digital feedback will be a norm. Another, in the retail sector, is using micro-location-based technology in the form of beacons that can track consumer and product flow. The potential is there to examine dwell times of consumers in stores, identify the presence of high-value customers, keep track of staff interaction with customers, allowing the aggregation of information and generation of 'big data' that can be analyzed and used to optimize product and sales.

By taking advantage of digitization, integration and automation opportunities, companies in the region can seek to stay relevant globally by taking actions as the era of digitally-connected smart infrastructure develops.

In the transition to a strategic role, there is a paradigm shift in the role of human resources (HR), which allows for a broader aspect of HR than mere administrative role. With Industry 4.0, the role of HR will change and thus require HR professionals to be strategic partners of the organization. The findings indicate that HR needs to ensure delivery, strategic shift and reskilling talent and ensure effective talent management.

Scholars suggested that there will be a change in terms of how HR delivers their work in near future. Currently, organizations deal with numerous people issues, such as improved mobility, an inter-generational workforce, changing digital job descriptions, work–life balance and pandemic lockdown. Therefore, it is imperative that HR improves its function to be digitally savvy and agile to be able to manage the distinctive, hyper-connected workforce. Moreover, emerging technologies and a different generation of employees will change HR processes such as talent on-boarding and off-boarding, as well as learning and development. Thus, there is a need to reskill and upskill people to meet the changing demand of work, to ensure that employees have correct and pertinent skills to compete in Industry 4.0.

Holistic model for navigating Industry 4.0 for human resources. In the Figure 2, there is a cyclic co-operational model of Industry 4.0 and HR. In this cyclic life model, modern HR accomplishes 4 main functions in Industry 4.0: 1) Effective HR delivery. HR Service Delivery refers to the function that supports and provides services to employees. The HR Service Delivery solution will span the entire employee lifecycle—from hire to retire, such as onboarding, payroll, and benefits.

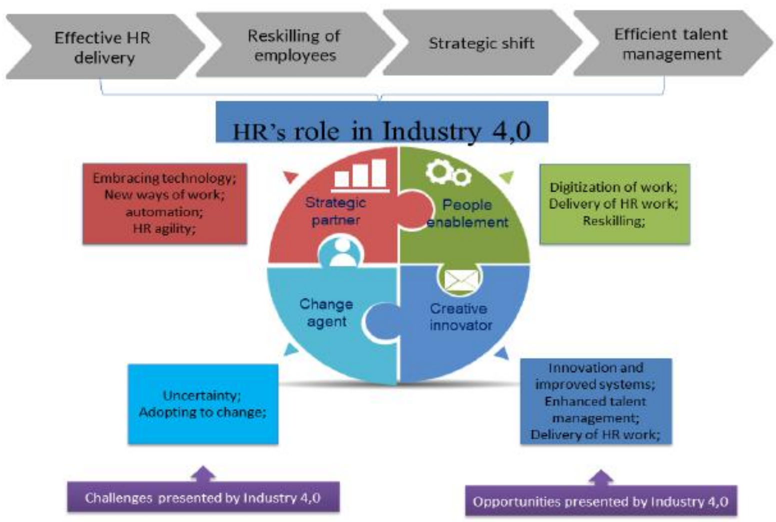

Figure 2. Authors' addition to the holistic model for navigating Industry 4.0 for human resource professionals.

2) Reskilling of employees. Companies can have a lot of benefits to learn knowledge from reskilling a workforce for the employees. It’s crystal clear that reskilling advantages not only top-level employees, but workers at all levels in the organization. In fact, it might be the case that retraining provides the most perks to lower-level employees in the general workforce. Some of them are chance of to change the position or job, gaining new skills, more likely to remain engaged, starting new career path.

3) Strategic shift. Industry 4.0 is a leading source of organizational growth and profitability. Many organizations try to have an effective and long-term innovative approach when face with innovation strive to offer.

4) Efficient talent management. Putting together an effective talent management strategy is something that many HR headers face some difficulties. There are a number of reasons. One would think that Business leaders would understand the importance of ensuring the appropriate people are driving their organizations to an optimal level of performance. While this is intellectually understood, however, it takes a particular level of thought and discipline to implement.

Conclusion. Companies in Uzbekistan are beginning to embrace Industry 4.0 elements. By taking advantages of automation and digitalization, companies are in need of hiring new generation of talent with solid background in computer programming skillsets and digital culture. Main challenge facing successful implementation of Industry 4.0 is the lack of talent and absense of staff training. In this regard, organization of non profit science, technology, engineering and mathematics higher education institutions in Uzbekistan are key in digital transformation of the industry in the region.

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ANALYSES OF EXPERIMENTAL RESEARCH ON CONDUCTED IN A HELIO WATER HEATING CONVECTIVE DRYING PLANT

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Abstract. In this article it is described that the drying process in a solar heating system. Medicinal herbs were analyzed to analyze the process. Systematic analysis was studied to optimize the process. Analytical methods of mathematical modeling were considered and the optimal temperature was selected. Using experiments on the computer and the physical model, the correction of the computer model in terms of mass transfer coefficient and heat transfer coefficient was carried out.

Key words: machine-building production, water, parameters, subsystem.

Introduction. Chemical, food, pharmaceutical, machine-building production, which implements a certain complex production technology, is a specific chemical-technological system (CTS), which requires production management contributing to high productivity and low costs to ensure that the product of the required quality is obtained and to realize the maximum possible environmental safety of production [1,2].

Drying is an operation that removes free water and some of the bound water without affecting the chemical structure of the plant material. The goal of this process is to reduce weight and minimize the risks of many unwanted chemical changes [3]. Drying triggers a complex phenomenon of heat and mass transfer. Hence the variety of drying modes and models.

Materials and methods. In industry, to carry out the drying process of medicinal plants, mainly the natural method is used, convective, greenhouse, chamber dryers that operate using solar and electric energy of high temperature and have a number of significant disadvantages: large dimensions and metal consumption, complexity of maintenance and repair, large heat and energy costs, minimum preservation of biologically active substances in the composition of the final product, etc.

To carry out the research, an experimental helium-water-heating convective drying unit was made, which makes it possible to carry out the process of dehydration and fixing the optimal parameters of dried medicinal plants (Fig. 1.).

In fig. 1 shows a laboratory solar water heating drying plant. It consists of a flat collector with a surface of 2 m2, a drying chamber with a volume of 1.5 × 2.5 m and a centrifugal fan. Drying experiments were carried out in August and September 2019.

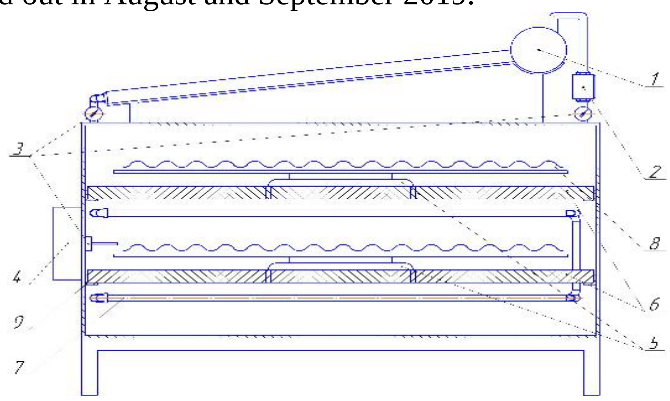

Figure 1. Schematic diagram of laboratory solar water heating plant: 1-solar collector; 2-circulation pump; 3-thermocouple; 4-control unit; 5-scales with digital display; 6-pallets; 7-pipelines; 8-raw material; 9-stand.

Analysis of the structure of the water heater dryer. On the basis of systems thinking, a solar water heating convective drying plant is analyzed. The use of the method of multistage analysis for a solar water heating drying installation makes it possible to consider the deep phenomena in it [4-6].

In the first hierarchical stage, a water-heating convective drying plant is considered in the form of a system with a material drying process

In the second hierarchical stage, it is taken into account that the solar water heating convection drying plant consists of supply elements, heating agents - water, a working zone and zones for removing agents. Indicators are determined - the input and output parameters of each subsystem.

At the third hierarchical stage, the long working area of the solar water heating drying plant can be represented as multi-apparatus. A multi-stage system analysis considered the installation, which is divided into quasi-devices of 8 pallets. Indicators are determined - input and output parameters of each subsystem - quasi-apparatus.

In the fourth hierarchical level, each quasi-apparatus can be imagined that each pallet consists of quasi-apparatuses, quasi-apparatuses of the material heating pipe and air. Indicators are determined - the input and output parameters of each subsystem.

In the fifth hierarchical level, In turn, the material can be divided into elements - quasi-devices, these are pieces or particles. Each element - a quasi-apparatus (pieces or particles) consists of quasi-layers. Indicators are determined - the input and output parameters of each subsystem.

By means of experiments on a computer and physical model, the correction, consistency of the computer model with the correction for the mass transfer coefficient and the heat transfer coefficient was carried out [7-9].

In the laboratory drying installation, the coolant - water is supplied by heat-conducting pipes 7, which are heated from the collector 1. A pump 2 is installed at the top, with the help of which the water flow is regulated and lowered down. Further, this water moves up the rows, heating the inner chamber of the dryer. Heat transfer pipes 7 are attached to the frame of the drying chamber by means of special fasteners. Hot water is used as a heat agent. Removable trays 6 are placed in the water heating drying unit. The movement of hot water ensures a uniform flow of heat through the unit. The temperature is controlled by thermocouples 3. It can be adjusted if necessary. In order to maximize the quality of the final product, the temperature is automatically maintained during the drying process using a thermostat located in the chamber.

The proposed design of the solar water heating convection unit allows to intensify the technological process of drying plant raw materials, in particular, ginger roots.

Fresh ginger roots were sorted out, the dirt was removed and the remaining dirt was cleared of other contaminants. They were cut into rings with a thickness of 0.5-0.6 mm and pre-dried in the shade in the open air for 1 - 2 hours to reduce the initial moisture content.

The input and output parameters of the elements at each stage of the hierarchy were determined, the interactions of the parameters of the selected system were determined, and a step-by-step multistage system analysis of drying was carried out.

Input parameters of the investigated object - helium-water heating convective installation: the mass of the material to be dried, the amount of moisture in it, temperature, mass transfer coefficient, density and heat capacity of the material; mass (consumption), density, heat capacity, air temperature, the amount of energy supplied to the device.

The output parameters also correspond to the mass of the material, the concentration of moisture in the composition, temperature, humidity, pressure, the amount of energy expended, etc.

Table 1. The process of drying ginger root at 70 ° C with a mass of 70 g.

time, s	Weight, g	Temperature, 0C	Xexp	Xacc	ΔX	Δ_{X2}
0	70	70	70	70	0	0
5560	52.5	69	59,6	60	-0,4	0,16
7800	47,8	69,6	52,6	54,5	-1,85	3,42
10100	40,4	69,7	49,7	49,4	0,3	0,09
15000	34.4	69,9	41,1	39,3	1,8	3,24
19600	32,1	69,96	33	32,2	0,8	0,64
25000	28.2	69,98	25	26,1	-1,1	1,21
30000	26.8	69,99	21	21,5	-0,5	0,25
35000	25,9	69,99	18,8	18,7	0,1	0,01
42000	24,8	70	15,2	15.3	-0,1	0,01

Mean square deviation:

$$\sigma = \sqrt{\frac{\sum \Delta x^2}{\pi}} = 0{,}95 \quad (1)$$

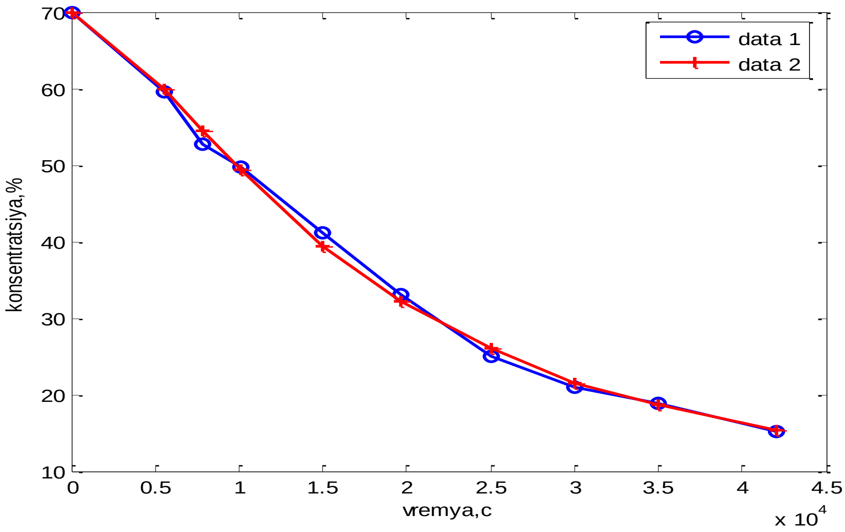

Figure 2. Diagram of the drying process of ginger root at 70 ° C with a mass of 70 g. (the red line is the result of the experiment, the black line is the graph of the change in humidity over time, calculated in the model).

Experiments were carried out on the basis of the initial data of the helium-water heating drying installation and the values of the change in material moisture, the temperature of the material, the mass of the material to be dried, the amount of water passing into the gas phase, the work performed by the energy for drying the material were obtained. They are in good agreement with the results obtained on the mathematical model (Fig. 2). On this basis, we can recommend a number of ways to optimize this installation and its use in the production of thermolabile drugs.

Conclusion. On the basis of systems thinking, a solar water heating convective drying plant is analyzed. A multi-stage system analysis divides the installation into quasi-devices - pallets (each pallet consists of quasi-devices), heating pipe, material, housing and air. The material is divided into pieces or into particles based on a quasi-apparatus. With the introduction of the initial data, experiments were carried out to establish changes in the moisture content of the material, the temperature of the material, the mass of the material to be dried, the amount of water passing into the gas phase, the work performed by energy to dry the material. They are in good agreement with the results obtained on the mathematical model. On this basis, it is possible to recommend the use of a solar water heating convection drying plant.

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IMPACT OF THE ANTIOXIDANT FEATURES OF LUBRICANTS ON THE WEAR OF AGRICULTURAL MACHINERY PARTS

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Abstract. In this scientific article it is analyzed that the influence of the oxidation process of motor oils on the operation of the engine. The main reason leading to the formation of high-temperature deposits in engines is oxidation processes occurring in the volume of the oil and on the metal surface. These deposits negatively affect the reliability, efficiency, and durability of the engine. Among the numerous properties on which the assessment of the quality of lubricants based on antioxidant properties are important. Therefore, we suggested introducing detergent additives into the engine oil. The action of such additives gives the ability to loosen, wash away deposits from the surface of parts, and transfer insoluble substances into suspension. The results of laboratory studies of samples of industrial oils and samples with the addition of new additives and recommendations for their use are presented.

Key words: oxidation, antioxidant, agricultural machinary, metal, oil oxidation, fuel, dynamic.

Introduction. Every engine, even of the same brand, works in different conditions and wears out differently. Modern internal combustion engines require high quality lubricating oils to ensure optimum operating conditions.

The reliability and durability of the car depend on the quality of the lubricants used. In this regard, all lubricants without exception must meet the quality requirements of the standard.

The highest quality oils will not ensure the operation of mechanisms without wear if they contain at least a small amount of mechanical impurities.

The amount of mechanical impurities is strictly limited and for engines, oils should be no more than 0.015%. Studies of the contamination of lubricating oils in the operating conditions of machinery show that in hot climates and high dustiness of the air, engine oils are intensively contaminated with mechanical impurities, water, fuel and organic products, which leads to premature aging of the oil.

Oil oxidation occurs either in its entire volume or in a thick layer, or in a thin layer when the oil is pumping through the cylinder-piston friction units.

In the latter case, the hydrocarbons of the oil are in particularly difficult conditions of temperature and contact with atmospheric oxygen and metal.

Oil oxidation on heated engine parts occurs under two conditions - dynamic and static (inflow and at rest).

Oxidation of oil in the stream occurs during engine operation when the lubricating oil is continuously circulate and engine parts are constantly lubricating with new portions [1-5].

Oil oxidation at rest occurs only when the engine stops, when the oil circulation stops, and the parts for a certain time after stopping the engine retain a sufficiently high temperature.

Analyze of research. During the operation of internal combustion engines, their units and parts are contamination with various deposits. The process of formation of deposits is associated with thermo-oxidative transformations of products of incomplete combustion of fuel and oil components. The main reason leading to the formation of high-temperature deposits in engines is oxidation processes occurring in the volume of the oil and on the metal surface.

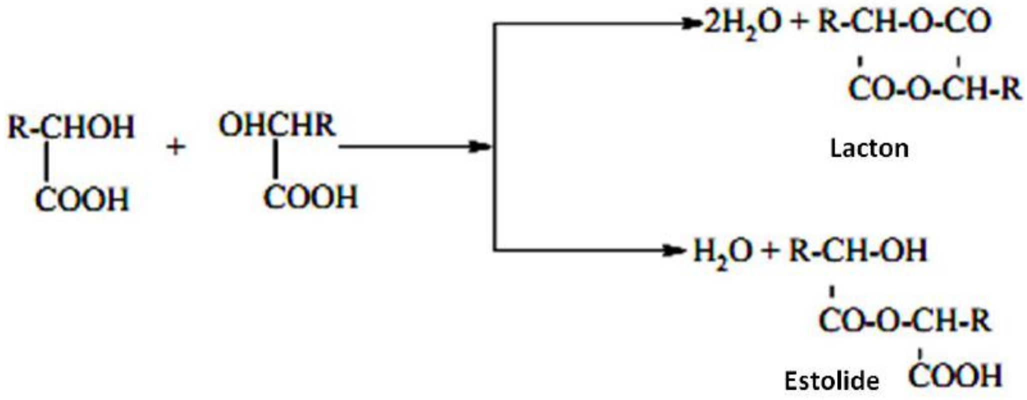
Oxidation products of hydrocarbons (resins, organic acids), present in the oil in a dissolved state, increase the viscosity and acid number, and asphalting compounds, which are the basis for the formation of varnishes and especially dangerous sticky deposits, contribute to the occurrence and burning of piston rings.

Products of deep oxidative polymerization, differing in high-temperature zones and returning to the crankcase, like other precipitated deposits, continue to have a negative effect on the oil. These deposits have a negative effect on the reliability, efficiency and durability of the engine.

Increased air pressure accelerates the oxidation process, as the process of mutual diffusion of oil with atmospheric air is enhance. In this case, the temperature has a decisive influence on the oxidation process.

The purpose of this work is to study the process of oxidation of engine oil during engine operation and suggests ways to improve antioxidant properties.

The primary products of hydrocarbon oxidation are hydroperoxides. The process develops according to a radical-chain mechanism, and, thus, it considered autocatalytic. Hydroperoxides further decomposed and converted into other oxygen-containing compounds. More and more oil hydrocarbons are involved in the oxidation reaction. As a result, depending on the conditions and chemical composition of the oil, the following products can accumulate in the oxidized oil: low and high molecular weight acids, hydroxy acids, alcohols, aldehydes, ketones, phenols, lactones and other substances [6-7].



Hydroxy acids readily transform into unsaturated acids

$$R\text{-}CHOH\text{-}CH_2\text{-}COOH \longrightarrow R\text{-}CH{=}CH\text{-}COOH + H_2O$$

Oxyacids condense into cyclic internal ethers - lactides

$$R\text{-}CHOH\text{-}CH_2\text{-}CH_2\text{-}COOH \longrightarrow R\text{-}\underbrace{CH\text{-}CH_2\text{-}CH_2\text{-}CO}_{O} + H_2O$$

Oxyacids and products from condensation: lactides, estolides and others are also very poorly soluble in hydrocarbons. Therefore, they either form carbonaceous deposits, such as carbon deposits or deposited on various parts of the piston group of the engine in the form of a thin and very durable layer, resembling in appearance a varnish coating. On less hot parts, hydroxy acids give sticky deposits. The formation of varnish films is the result of the oxidation of oils in a thin layer. Varnish deposits cause the piston rings to burn and overheat the parts on which the deposits have formed.

All this leads to a decrease in engine power, its quickest wear and an increase in oil consumption.

The catalytic action of metals has an important effect on oil oxidation. The catalytic effect of metal ions on oil oxidation suppressed by metal deactivators, which are organic compounds that bind metal ions into inactive complexes. The catalytic action of metals ceases when it covered with a protective film created by oxidation products [8].

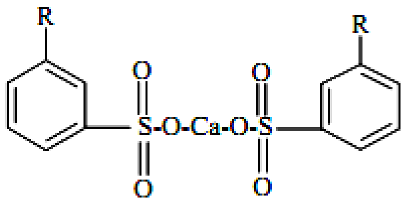
As a result of oxidation, the chemical composition of the lubricant and its physicochemical properties change. All this affects the ability of the lubricant to perform its intended functions, limits its service life, and worsens the technical condition of engines. Oils that are not resistant to oxidation tend to sludge more quickly and to a greater extent than stable oils. Oils with special additives are less prone to sludge formation than pure oils because additives allow better retention of insoluble impurities and better resistance to oxidation.

Phenols and amines used as antioxidants, and organic compounds of sulfur and phosphorus used as metal deactivators. Antioxidant additives also include substances that reduce the activity of the catalytic action of metals, their oxides and salts on the oxidation process - metal passivators. However, the existing antioxidant additives cannot to the required extent inhibit the oxidation of oils in the medium-temperature zone and completely prevent the formation of varnish-forming substances in it [8].

Before giving recommendations on the use of any additives, it is necessary to study the mechanism of their action, without the knowledge of which their effective use is impossible.

Analyzes show that substances containing both sulfur and nitrogen are very effective against oxidizing properties. Tests of several dozen of these compounds as oil additives have shown that they are very effective not only for fresh oils, but also for used and recovered oils.

As antioxidant additives, we used an additive calcium alkylaryl sulfonate (CK-3) - calcium salts of aromatic sulfonic acids [9]:



These additives have the ability to improve the quality characteristics of oils. In the oxidation of mixtures of hydrocarbons, aromatic hydrocarbons have an inhibitory effect on the oxidation of naphthenes. This is because the oxidation products of aromatic hydrocarbons, phenols, have antioxidant functions.

Thus, the best group composition of the oil from the point of view of its chemical stability corresponds to a mixture of low-cycle naphthenic, aromatic and hybrid hydrocarbons with long saturated side chains.

This additive protects oils from oxidation by a chain-breaking action by reducing the number of radicals generated. The effect of such additives based on their ability to loosen, wash away deposits from the surface of parts, transfer insoluble substances into a suspension, and keep these particles in this state without coarsening.

The advantage of this additive over other additives is that it is quite effective at relatively low temperatures (up to 150-175 ° C) and is stable up to 300 ° C. To achieve the desired effect, it is required to apply it in quantities of 5-10%.

This antioxidant protects the oil from oxidation by acting to terminate the reaction chain by reducing the amount of radicals formed [2].

This inhibitor (InH) easily gives up its hydrogen to the radicals of the main oxidizing substance, thus transferring them to an inactive state and replacing them with In- radicals, which, due to their relatively low activity, are unable to regenerate radicals and continue the chain:

$$R\cdot + InH \rightleftharpoons RH + In\cdot$$

$$ROO\cdot + InH \rightleftharpoons ROOH + In\cdot$$

The action of such additives will be mainly aimed at preventing the formation of the primary oxidation products - peroxides.

Based on this, we analyzed M-10V2 motor oils and SK-3 sulfonate additive. From literary sources, it known that antioxidant additives introduced into oils up to 15%.

Method of research. The action of such additives mainly aimed at preventing the formation of the primary oxidation products - peroxides.

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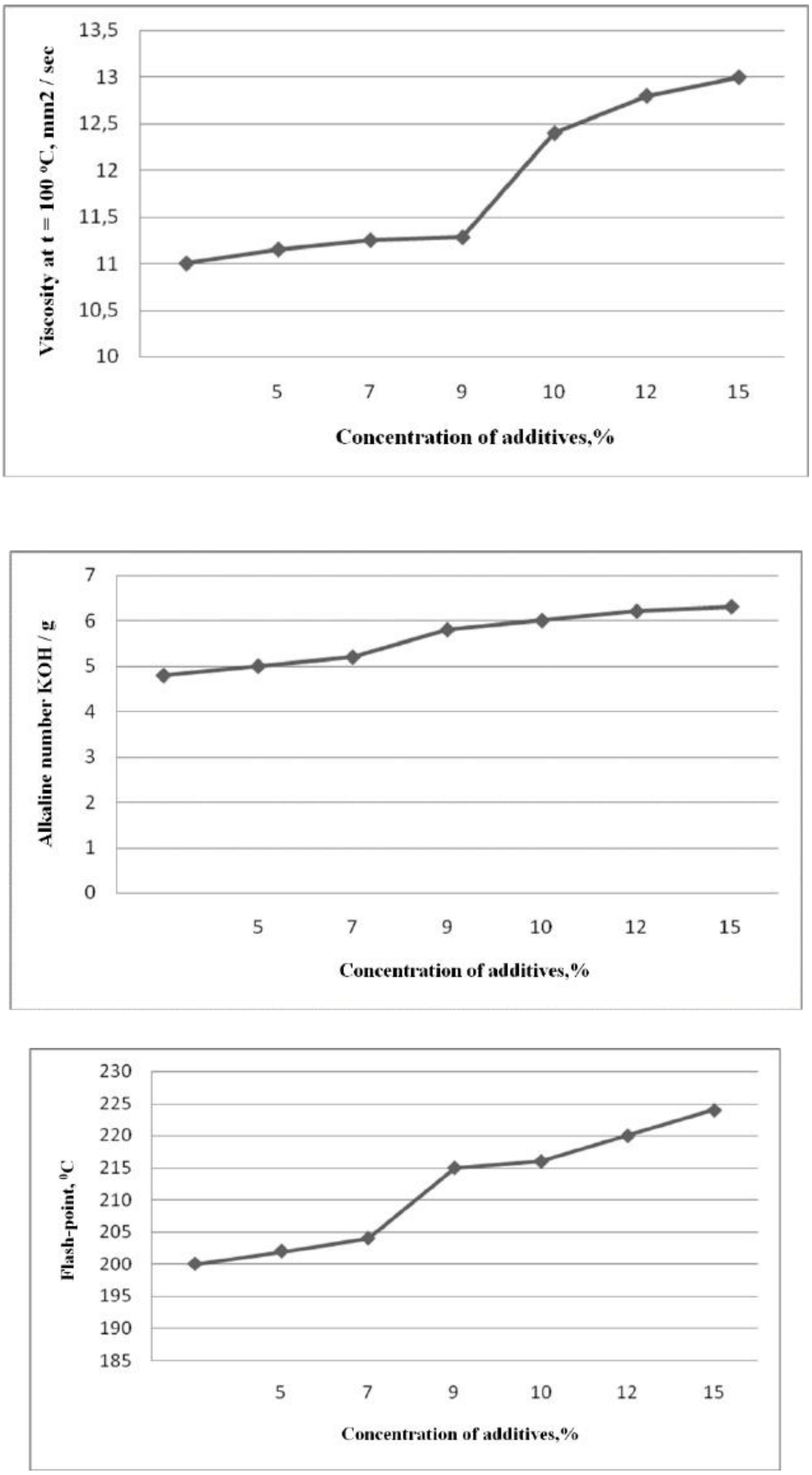

Figure 1. Physicochemical indicators of engine oil for various concentrations of additives

Conclusion. According to the results of laboratory studies, when the additive introduced into engine oil, they gave a positive result. From the results of the analysis, we have selected the content of additives SK-3 9%, which shows the optimal value of viscosity and base number. With a further increase in concentration, the viscosity increases strongly, which can lead to increased frictional losses. With an increase in viscosity, the thickness and resistance to mechanical stress of the oil layer between the rubbing surfaces increases.

The reserve of neutralizing properties that characterizes engine oil, called the base number, can vary from 5-10 mgKOH / g. The oxidation products of hydrocarbons present in the oil in a dissolved state contribute to the reduction of the base number. At the same time, acidic products accumulate in the oil, which increases the corrosive wear of parts. All this can lead to contamination of the parts of internal combustion engines with various varnish deposits. In our example, the base number increased from 4.8 to 6; and the flash point rose to 2240C, indicating the effectiveness of the additive added. This means that when using such an additive, the service life of the engine oil will increase.

Based on the analysis performed, it was found that the synthesized additive has a high detergency and can be used to effectively reduce the formation of varnish-forming substances arising on pistons and related parts.

According to the results of laboratory tests, when the additive introduced into M-10B2 engine oil, the physicochemical indicators gave a positive result in comparison with M10B2 oils. TBN increased from 5.0 to 6; and the flash point rose to 2240C, indicating the effectiveness of the additive added. This means that when using such an additive, the service life of the engine oil will increase.

Based on the results of the analysis, we selected the additive content of 9%, which shows the optimal viscosity and base number. With a further increase in concentration, the viscosity increases strongly, which can lead to increased frictional losses. With an increase in viscosity, the thickness and resistance to mechanical stress of the oil layer between the rubbing surfaces increases.

Studies show that the addition of an additive reduces the process of piston ring wear by 3-4%, as well as an increase in efficiency by 1%, which leads to an increase in engine power by about 4%.

In the future, these oils can be admitted to the next stage - to operational tests on special equipment.

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