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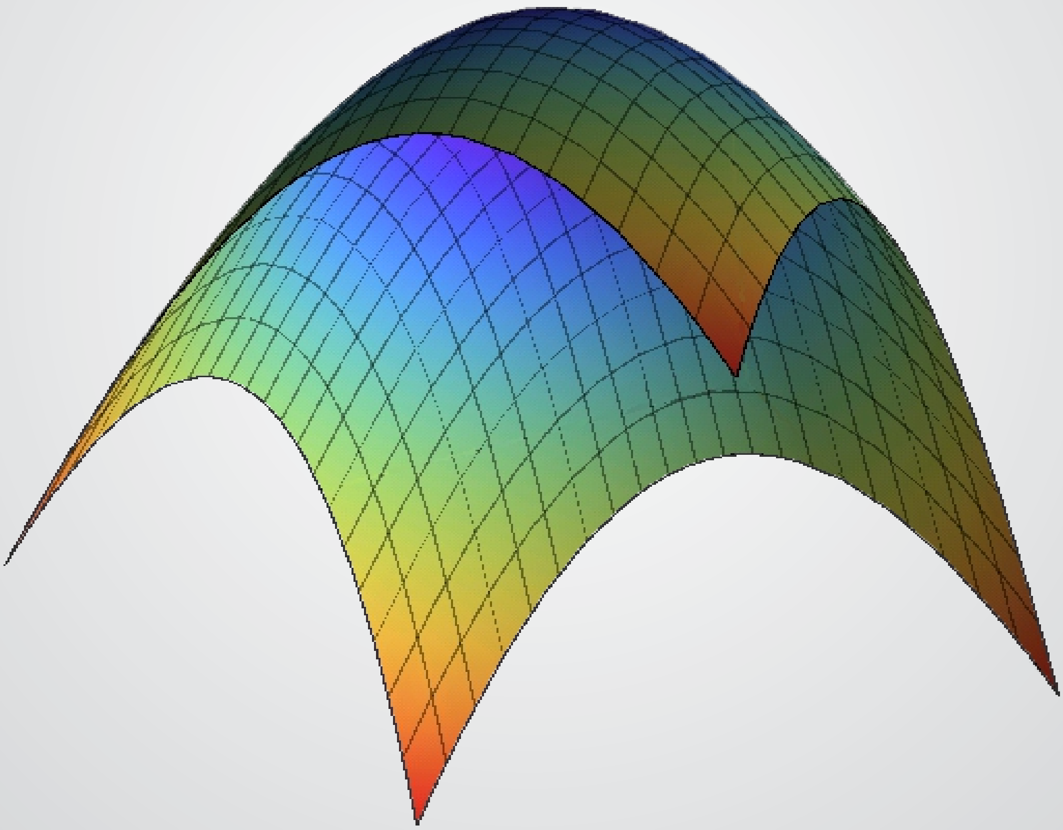

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THE CRITERION ANALYSIS OF TECHNOLOGICAL SCHEMES AND STRUCTURES OF VEHICLES FORMING TRANSPORT PACKETS FROM PACKING OF GOODS

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Abstract. *In this article the analysis phase diagrams of the formation of the transport package on the example of several selected variants of technological schemes. The scheme of formation of transport packets reflects the direction of travel of the container cargo or other means of packaging (pallets, pads, and trays) and the amount of cargo transported in one operation. Technological scheme of the packaging is the basis for the development of the structure and layout of machines. Each structure of the transport packet can be implement in different schemes of forming. It is established that the choice of the scheme of formation of the transport package, you need to make after the development and analysis timeline, as between the indicators of the circuit of formation is the sum of the paths traversed by the load, the number of transactions and the impact on cargo, there is no functional dependence.*

Key Words: packet, structure, container, cargo, technological scheme.

I. Introduction

The formation of transport packets packing of goods in general consists of three main processes: preparation of loading units to be packaged. In the first stage, analysis of technological schemes is evaluated by the number of operations *Non.* The scheme with fewer operations will be priority. In the task used the criterion of sum of ways in addition to the number of operations $\sum S$, which takes place each shipment from the first operation and before placing in the package. The way the cargo is determined by the scheme of formation, dimensions of cargo, pallet and package, as well as the necessary clearances Δ. Using the method of operational analysis [2], it is possible to determine the amount of shock loads that sees the load in the packaging process. The first shipments experienced the greatest amount of shock interactions. As a result of comparison circuits forming an over pack for each $\sum S$, *Non* - was obtained conflicting results on the number of shock interactions on the cargo. The results at this stage do not give a clear functional relationship to the choice of variants of technological schemes it is impossible to produce. In addition, the schemes of formation do not say the possibility of combining each operation or groups of them. The combination makes it possible to cut the speed of movement of the working bodies, the shock load compared to sequential execution. Therefore, the last choice of the scheme of formation should be carried out in later design phases. In scientific sources [1..6], the choice of rational schemes of designing structures and machines recommended by the nature of the movements, design of the working bodies, the machine dimensions, power consumption etc. However, these works are not induced dependence between the type of surgery, duration of processing of the product, energy. These dependencies need to know when designing machines. Based on the schema of the formation of the cargo rocket carried out the construction timeline of the palletizer machin e according to the given cycle of the supply of goods – t and the coefficient of irregularity of the cycle – K1 [3,4], which depends on the stability of the technology of the previous operation processing load.

II. Materials and methods

2.1. Plant material

To carry out the synthesis, it is necessary to develop variants of the structural diagrams of the machine, which find the type of the forming surfaces along which the load moves, the type of working bodies, their relative position, the number and type of actuators of the operating bodies and actuators. The cyclorama is rationally represented as a network model to ease analysis and synthesis of technological operations. Network model - a theoretical description of the principles of the set of network protocols that interact with each other. The model is usually divided into levels, so that the protocols of the higher level would use the lower-level protocols (more precisely, the protocol data of the higher level would be transmitted using the underlying protocols-this process is called encapsulation, the process of extracting the higher-level data from the lower-level data by de-encapsulation). Models are both practical (used in networks, sometimes confusing and / or incomplete, but decisive tasks), and theoretical (showing the principles of implementing network models, sacrificing performance / capabilities).[7]

2.2. Statement of the problem research

The duration of the working cycle of formation of the package, you can define:

$$Tp = \frac{n_n \cdot t_{гр}}{K_1}, \quad (1)$$

n_n - amount of loads is in a package.

Limitation of duration of workings and single strokes of workings organs at moving of loads, which are formed and rows, layers, feet, stacks:

$$t_{p(K)} \le \frac{n_p \cdot t_{гр}}{K_1}, \quad (2)$$

n_p - amount of loads, moved for an operation.

Thus, the type and design features of working bodies influence the structure of the technological process. The process is determined by the duration of all operations that comprise it, their duration and relative location in time and coincides with the structure of the technological cycle of the machine.

The time of the technological cycle of the machine is:

$$T_T = \sum_{i=1}^{n} T_i = \frac{T_p}{\varphi_1 \cdot \varphi_2}, \quad (3)$$

T_i - the duration of the i-th operation; φ_1, φ_2 - coefficients of registration in time, respectively, the formation of the package and operations. Since the coefficients φ_1, φ_2 can have different values - the task of developing a rational cycloramas is based on the fundamentals of synthesis.

The network model of the cycloramas of machines that do operations consistently has one possible path, hence, it is critical. The network model for a joint operation cycle has several possible paths and only one of them will be critical. When analyzing the parameters of the network model, the task of improving the technological process is solved, which is cut to finding ways to reduce the number of operations on the critical path. Also, the volume of work performed at these operations is reduced by combining operations to transfer them to a non-tense area.

Networking processing can be performed based on existing network maneuvering methods [4], determining the total time reserve of each path. In this case, the critical path is the one in which the total time reserve is zero. With a sub critical path, it will be close to zero. If the event "i", the event "j" immediately follows, then the early date for the event is:

$$t_p(j) = \max[t_p(i) + (t_j - t_i)], \quad (4)$$

$t_p(i)$ - early deadline for the event “i”;

$(t_j - t_i)$ - the duration of the operation.

Early and late terms for the implementation of the first event, i.e. The beginning of the technological cycle is zero, and the last event, i.e. End of the technological cycle are equal to TT. The late period of the "i" event is defined as:

$$t_p(i) = \min[t_n(j) - (t_j - t_i)], \quad (5)$$

$t_n(j)$ - the date of the subsequent event.

2.3. Analysis of the model

Therefore, for the analysis of the network model, it is necessary to find the duration of each operation, to prove critical and sub critical paths and to find operations thereon. The working bodies in this case have increased speeds because of the time limit. According to the calculation and analysis of the network and structural diagrams of the machine, it is necessary to test the scheme of the formation of the transport package. The results get at the first stages of design allow us to obtain parameters with sufficient accuracy for comparison: productivity, energy intensity, package formation, machine dimensions. [8]

Thus, after the calculation of the cycloramas, the variants of the structural diagrams and schemes for the formation of the packet must be compared in terms of energy intensity and dimensions. Compari son of the formation schemes and machine structures by dimensions should be carried out separately, after optimization of other parameters. Therefore, at this design stage, the criteria that determine the basic parameters of the machine are the energy costs for package formation and energy efficiency. Optimization of these criteria by minimizing their values allows to reduce operating costs, machine speed due to the reduction of the power of the machine drives. This is possible, since the drives are considered as components of assemblies, parts, actuators in the design of the machine. [9] The energy costs for performing the i-th operation are:

$$A_i = \int_0^{v_i} \frac{m \cdot v_i^2}{\eta_i} dv + \int_0^{S_i} \frac{F_\tau}{\eta_i} dS_i, \quad (6)$$

v_i - the maximum speed of movement of the working body; m - the reduced mass of the cargo, the working element, the elements of the actuator and the driving link of the drive; η_i - instantaneous values of the efficiency of the actuator drive; S_i - course of the working body; F_τ - the projection of the main force vector on the elementary displacement of the working element. At this stage of the design, the quantities are unknown, v_i, m, η_i - therefore assumptions are accepted.

The efficiency of the actuator is assumed to be constant, and the acceleration energy is taken into account by the motor overload factor during start-up and braking K_{ni}:

$$K_{ni} = 1 + \int_0^{v_i} m \cdot v_i^2 dv (\int_0^{Si} F_\tau dS)^{-1}. \quad (7)$$

The work of the force system on the final section of the trajectory of the movement of its application point will, taking into account the accepted assumptions:

$$A_i = \frac{K_{ni}}{\eta_i} \int_0^{S_i} F_\tau \cdot dS. \quad (8)$$

The work will be spent on performing the operation, if necessary, orient cargoes:

$$A_i = \frac{K_{ni}}{\eta_i} \int_0^{Q_i} M \cdot dQ. \quad (9)$$

M - the resistance force at run-time "i" is the operation.

Q - the angle of rotation of the load during the "i" - operation.

Assumption - on the discrete sections of displacement F_τ =const and M = const, the workload diagram is constructed η_i and, given the value of K_{ni}, determine the energy costs for each operation from dependences (8) and (9).

The assumption on discrete areas of displacement and = const, construct the load chart working on and asking the value, and is determined by the relationships (8) and (9) the energy cost of each operation. The estimated engine output during repeated short-term work and when changing the load will be determined as [6]:

$$P_{p_i} = \frac{A_i}{t_i - t_i^0}, \quad (10)$$

t_i, t_i^0 - the start and end time of the "i" - operation.

Thus, at this stage of design, minimization P_{p_i}, only quantities are subject to, since, with the assumptions assumed, A_i =const. With the successive execution of each operation, the energy efficiency of the machine is:

$$\mathrm{P_c} = \sum_{i=1}^{n} \frac{A_i}{t_i - t_{i-1}}, \quad (11)$$

t_{i-1}-is the start time of the next operation. To achieve this goal, there should be a minimized function (11) if such restrictions are fulfilled:

$$\sum_{i=1}^{n} (t_i - t_{i-1}) \le T_T;\ t_i < t_{i+1} \quad (12)$$

And initial conditions: $t_1^0 = 0, t_n = T_T$;

t_1^0 - the start time of the first operation.

$$\sum_{i=1}^{n} (t_i - t_{i-1}) \le T_T;\ t_i < t_{i+1}$$

$$t_n = T_T; i = 1 \dots n\} \quad (13)$$

The solution of the objective function is to determine the duration of each operation:

$$T_i = t_i - t_{i-1} \quad (14)$$

At present, there are a sufficient number of methods for solving the optimization problem. At this stage of design, we use a simplified methodology. Assume that there are no functional limitations. Knowing that the quality index is differentiable, we find the value of "n" parameters, by solving the system of "n-1" equations obtained by equating zero, partial derivatives of the quality index for each of their parameters [7]:

$$\begin{cases} \frac{dP_c}{dt_1} = 0 \\ \frac{dP_c}{dt_2} = 0 \\ \frac{dP_c}{dt_{n-1}} = 0 \end{cases}$$

$$\begin{cases} \frac{A_2}{(t_2 - t_1)^2} - \frac{A_1}{(t_1 - t_0)^2} = 0 \\ \frac{A_3}{(t_3 - t_2)^2} - \frac{A_2}{(t_2 - t_1)^2} = 0 \\ \frac{A}{(T_T - t_{n-1})^2} - \frac{A_{n-1}}{(t_{n-1} - t_{n-2})^2} = 0 \end{cases} \quad (15)$$

We modify the system of equations using the Gauss algorithm [8], we obtain:

$$\begin{cases} \sqrt{\frac{A_2}{A_1}}(t_1 - t_1^0) = t_2 - t_1 \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ \sqrt{\frac{A_n}{A_{n-1}}}(t_{n-1} - t_{n-2}) = T_T - t_{n-1} \end{cases} \quad (16)$$

Now we substitute the restrictions $t_1^0 = 0, t_n = T_T$; We perform alternate substitution of the previous equation into the succeeding ones, we get:

$$t_1 \sqrt{\frac{A_n}{A_1}} = T_T - t_{n-1} = = (t_{n-1} - t_{n-2}) \sqrt{\frac{A_n}{A_{n-1}}}$$

Whence, it is determined t_{n-1} , t_{n-2} where the functions t_1 . Using system (16), we obtain:

$$t_1 = T_T \frac{\sqrt{A_1}}{\sum_{i=1}^{n} \sqrt{A_i}} \quad (17)$$

Substituting (17) into (16), we define ti for each operation, then using the system of equations (15), we determine the duration of each operation:

$$T_i = t_i - t_{i-1} = = T_T \frac{\sqrt{A_1}}{\sum_{i=1}^{n} \sqrt{A_i}} \quad (18)$$

Solving the obtained expressions together with (10), we define the minimum of the objective function:

$$\min P_c = \frac{1}{T_T} (\sum_{i=1}^{n} \sqrt{A_i})^2 \quad (19)$$

Consider the effect of the objective function on the number of operations.

Let's take the same work ($\sum A_i = const$). Two and three working bodies (two and three operations) in the course of time $T_T = const$.

First option: A_1=1 W·s, A_2=1 W·s, T_T=10 s - then ΣAi=1 W·s, T_T=10 s. $\Sigma A_i = 10 W \cdot s, T_1 = 2{,}5s; T_2 = 7{,}5s.$ And the total power expended: min Pc=1,6 W.

III. Results and discussion

The second option: A_1=1 W·s, A_2=1 W·s, A_3=8 W·s

Then T_1=2.07 s.; T_2=2.07 s.; T_3=5.86 s,

min Pc=233 W.

Thus, with the same work done for a constant cycle time, the total power increases with increasing number of operations due to a decrease in the utilization rate of the engines over time and the introduction of an additional motor. Analysis of the formula (18) shows that in the presence of idle moves in the path under consideration, in view of the difference in the work spent on performing idle and running strokes, their optimal performance for the same mechanism will also be a difference [10].

In this case, it is necessary to install an electric motor with a variable, variable speed of the driving link. When equipping the mechanism of the mechanism that makes the working and idle strokes in the cycle time position T_T, the motor with different speed of rotation of the driving link fulfills the conditions

$$K_p = \frac{n_j}{n_i} = \frac{T_i}{T_j} , \quad (20)$$

Where Ti and Tj – Duration of working and idling mechanism; ni and nj – Rotor speed of the electric motor at idle and idle; Kp – Coefficient of regulating the speed of the motor rotor.

It's obvious that ni< nj as Ai >Aj. When carrying out the "i" operations with a motor with adjustable rotor speed in series with operations performed by other motors and taking into account the limitation (12), we get:

$$\sum_{i=1}^{i} T_i = \frac{T_1}{K_{p1}} + \frac{T_1}{K_{p2}} + \cdots .. + \frac{T_1}{K_{p2}} = = T_1 \sum_{i=1}^{n} \frac{1}{K_{pi}} \quad (21)$$

Then the quality score of the objective function is written in the form

$$P_c = T_1 \sum_{i=1}^{i} A_i * K_{pi} + \sum_{i=1}^{n} \frac{A_i}{T_i} \quad (22)$$

Solving the system of equations (15) from the partial derivatives of the quality index, we obtain an expression for determining the duration of operations performed by a mechanism with an engine in which the rotor speed is regulated:

$$T_i = \frac{T_T}{K_{pi}} \sqrt{\sum_{i=1}^{i} A_i * K_{pi}} * \ldots$$

$$\ldots * \left(\sqrt{\sum_{i=1}^{i} A_i * K_{pi} + \sum_{i=i+1}^{n} \sqrt{A_i}} \right)^{-1}$$

(23)

And for other mechanisms:

$$T_i = T_T \sqrt{A_i} * \left(\sqrt{\sum_{i=1}^{i} A_i * K_{pi} + \sum_{i=i+1}^{n} \sqrt{A_i}} \right)^{-1}$$

. (24)

The optimum power on the path under consideration is:

$$= \frac{1}{T_T} \left(\sqrt{\sum_{i=1}^{i} A_i * K_{pi}} * \right.$$

$$\left. {}_1 K_{pi} + \sum_{i=i+1}^{n} \sqrt{A_i} \right) *$$

$$\left. \sum_{i=1}^{i} A_i * K_{pi} + \sum_{i=i+1}^{n} \sqrt{A_i} \right).$$

(25)

When designing palletizer machines everywhere possible to realize the specified performance because of the large number of operations that lie on the shortest path. In this case we have to consider the transfer of operations from the critical path, it is extremely difficult and leads to an undesirable change of the structural configuration of the car due to the introduction of additional mechanisms.

To reduce the speed of the working bodies to the maximum permissible under the scheme of formation of the transport stream, a transition from sequential operations to a sequentially-combined operation. It is necessary to develop additional constructive solutions that ensure trouble-free operation of the units operating in combined cycles.

IV. Conclusions

1. It is established that the choice of the scheme of formation of the transport package, you need to make after the development and analysis timeline, as between the indicators of the circuit of formation is the sum of the paths traversed by the load, the number of transactions and the impact on cargo, there is no functional dependence.

2. Analysis of sequences performed with the use of graphs, allows you to develop the objective function of minimizing the driving power of the functional modules palletizer of the machine and determine the optimal values of the duration of the activity.

3. Study of parameters of the network model timeline gives the opportunity to compare the design options of forming transport packets according to the criterion of efficiency palletizer machines with single speed and multi-speed movement of the rotor of the motor for sequential operation.

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CLEANING OF SEWAGES WITH USE OF PINOTENK

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Abstract. *For the rational use of water, it is necessary to decrease a water consumption or more qualitatively to carry out used (muddy) water treatment. Cleaning of effluents is one of the most important ecological problems for today. Utilization of hydrocarbons contained sewages is a difficult process, but possible as compared to cleaning of household flows. Oil products in sewer water are in the dissolved and emulsified condition. For the removal of such contaminations fraction it is expedient to use the process of biosorption before a bioscrubbing. The exception of oil products from effluents is expedient to carry out in pinotenk, that is a device with gas-liquid reflow. Processes of biosorption of contaminations and their partial oxidization by the organisms of active silt are taking place in pinotenk.*

Keywords: pinotenk, bioscrubbing, biosorption, active silt

I. Introduction

Cleaning of sewages is one of main questions for today, as any branch of industry does not exists without the use of water. Next to industrial and domestic contaminations of sewages it is possible to distinguish the separate group — hydrocarbons contained flows. Contaminations of these sewages (products of oil-processing) are mainly in the soluble condition or as small including, that does not allow to apply the specific method of cleaning. There are many different methods of cleaning, and their choice depends on a concentration and content of contaminations in sewer water; from the further setting of sewages. By the most effective method for cleaning of hydrocarbons contained sewages is biological [1]. But for passing of bioscrubbing process it is necessary to apply the previous exception of oil-processing products. It can be carried out using of physical and chemical methods, namely floatation and sorption. Sorption methods consist of organic and inorganic contaminants secreting on natural and synthetic sorbents, using of ion-selective materials. Floatation is a process of molecular adhesion of contaminating substances particles to the surface of distribution of two phases: water and air, water and a hard substance. The process of cleaning of sewages from fusible substances (solvents, oil products) by using of floatation consists in formatting systems "particles of contaminations and phials of air", that emerge on a surface and are utilized [3, 4, 5, 6].

II. Materials and methods

The object of research is the hydrocarbons contained sewer water. Correlation of biological oxygen demand (BOD) and chemical oxygen demand (COD) of these sewages is 0,43, that shows the possibility of oxidization of contaminations by the active silt organisms, although the speed of oxidization is lower than one during the cleaning of domestic sewages [2]. Therefore, we propose the combination of biosorption process, that passes in pinotenk and oxidization process with the use of hanging up layers of active silt in aerotank-clarifier.

Researches were carried out on the laboratory setting of the combined reactor that includes pinotenk and aerotank-clarifier [7, 8].

Pinotenk is a column with horizontal perforated by metallic plates, on that there is a small layer of water with a silt that is blown through by an intensive blast on the chart of counterflow. A foamy layer appears on the surface of the plates. It has the developed surface of contact between reactive phases, due to what the process of oxidization of contaminations by active silt flows with high speed. Such contacting conditions are friendly to the biosorption of the emulsified oil-processing products by the active silt, that is given by airlift from the hanging up layer of aerotank-clarifier, distributed for the surfaces of plates and contacts with contaminations of liquid and oxygen of air on all surface of contacting phases.

III. Results and discussion

The determinations of dissolved oxygen concentration on the different levels of pinotenk and the concentration of contaminations after BOD_5 in the tests selected for the same levels were made. The results are presented on the Figure 1.

These results testify that silt mixture that goes out of pinotenk in aerotank-clarifier is practically oxigenated, and contaminations (for BOD_5) in a sewer liquid are partly transferred from a liquid phase on the flakes of silt that is given by airlift from the zone of hanging up layer of aerotank- clarifier in pinotenk. No doubt, some part of contaminations that are in the soluble condition and easy oxidabled substances are used by a silt as a feed. Silt mixture that is oxigenated in pinotenk requires less time for staying in aerotank-clarifier. It explains high efficiency of sewer water cleaning with the small duration of its cleaning in aerotank-clarifier.

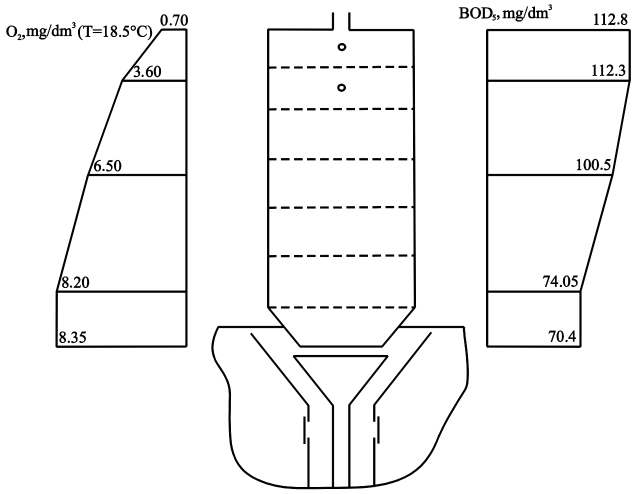

Figure 1. *Distribution of concentration of O_2 and BOD_5 is on the height of pinotenk*

The results of experience on determination of hanging up layer role and zone of laminarisators role in removing of dissolved, colloid and hanging up contaminations are presented in the Table 1. Obtaining of the samples BOD_5 and the concentration of hanging up substances and sampling places are presented in the Table 1.

Table 1. *The results of experience on determination of hanging up layer role and zone of laminarisators role in contaminations removing*

Sampling place	With laminarisators		Without laminarisators	
	BOD_5, mgO_2/ dm^3	Hanging up substan-ces, mg/dm^3	BOD_5, mgO_2/ dm^3	Hanging up substan-ces, mg/dm^3
Zone of suspend water	32,15	40,50	32,1	40,30
Above a hanging up layer	18,55	20,00	24,3	16,20
Above laminarisator	-	13,00	-	-
Exit	-	7,3 – 8,7	-	-

The phials of air saturate the fluid inside the aerotank-clarifier zone of aeration, at that time, as even at intensive recirculation in the degassing zone they are absent. Therefore, the zone of degassing provides the effective removing of phials from fluid, creating good conditions for further technological processes of separation and clearing up of silt-water mixture.

The concentration of suspension is observed in the lower part of laminarisators. The equable motion of these particles downward and along on plates is noticed visually.

The sharp rise of the hydraulic loading (3X) leaded the beginning of bearing-out of suspension, but destruction of hanging up layer was not observed. The bearing-out of suspension during the overload took place in that part of laminarisators that was under a collapsible tray. It is explained by some toxicity of streams in a protective zone that takes place only during considerable overloads and appropriate, to our opinion, for the small-scale installations. Normal loads could not cause the phenomena of suspensions bearing-out even in small-scale setting.

IV. Conclusions

The obtained researches showed that the proposed technology can be successfully used for cleaning of hydrocarbons contained sewages with different origin.

Due to the use of pinotenk as first degree of cleaning in the block of biochemical oxidization, cleaning indexes get better considerably, namely efficiency of exception of oil products increased from 93,2% to 98,5%, that to our opinion, explained by the process of biosorption, that flows in foamy layers. In addition speed of exception after oil products increased from 15,58 mg/(g per hour) to 25,25 mg/(g per hour).

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STABILITY STUDIES OF OLIGOFRUCTOSE AND INULIN IN DRINKS PREPARED FROM AROMATIC EMULSIONS

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Abstract: *This article describes the use of emulsions for the production of beverages with inulin and oligofructose for for the restaurant business and industry. Inulin and oligofructose are high quality ingredients for the production of dietetic foods. Inulin and oligofructose can be used as some pure dietary ingredients to create functional foods with different stated properties, and as ingredients that improve the taste and texture and allows replacement of sugar and fat. The best results are obtained with a combination of dietary and technological concepts, which enables the development of high quality innovative food products.*

The work purpose – stability research inulin and Oligofructose depend on pH value, temperature and a storage time of foodstuff in which they were used.

Keywords: emulsion, drink, oligofructose, inulin, temperature, beverage storage, hydrolysis, pH

I. Introduction

Emulsions are widely used in many branches of food technology. While using aromatic emulsions in functionl beverages production a series of advantages is observed, in particular the blending time is decreased as there is no need to add aromatizer, to choose dye and stabilizer.

It is known that certain food additives that are used in the manufacture of food products can change their functional and other properties during storage and distribution.

Inulin and Oligofructose can be used as dietary ingredients for the creation of functional foods with different properties, and as ingredients that improve the taste and texture that allows replacement of sugar and fat. The best results are obtained with a combination of dietary and technological concepts, which enables the development of high quality innovative food products [1].

There are two groups of inulin – native (standard), which have the same structure and differ only by the properties of the particles, and which are derived from long-chain inulin standard by removing the low molecular weight fraction and which also differ from each other only by the properties of the particles.

The main technological properties of inulin are:

1) Ability to replace fat in foods with the presence of the aqueous phase;

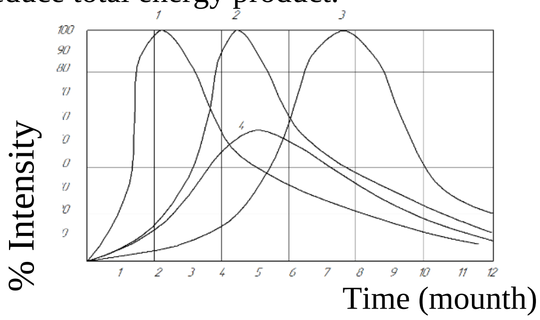
2) Ability to improve the taste of low-fat products, bringing them to the properties of normal fat content of products;

3) Ability to act as a texturing agent, emulsion stabilizer and thickener.

Oligofructose is a natural polysaccharide having the same molecule structure as inulin but shorter in length. Oligofructose is a natural component of natural inulin. Oligofructose produced by partial hydrolysis of inulin. This technology is also similar to the processes in the sugar and starch industry.

It is known that the solubility of Oligofructose exceeds the solubility of sucrose, making it the soluble dietary fiber in the world. Oligofructose does not crystallize any precipitate and leaves the mouth dry and sandy taste. Oligofructose is not destroyed in the majority of high-temperature processes. Moderate reducing ability of Oligofructose may lead to the formation of a weak brownish colour due to the reaction of melanoidin producing.

It has a neutral slightly sweet flavour, without foreign taste and aftertaste. Its sweetness profile is very similar to the profile of sweetness of sucrose (Pic 1). Therefore, the main technological feature is that it can replace sugar in various formulations, which allows not only to obtain foods low in sugar or sugar-free, but also to seek to reduce total energy product.



Pic. 1 *Intensity profile:*
1 – Acesulfame-K; 2-Saccharose;
3-Aspartame; 4-Oligofructose

Since Oligofructose has little sweetness, it is usually used in combination with intense sweeteners or fructose. However, it masks the unpleasant aftertaste of intense sweeteners and sharp sweetness of fructose, improves taste and gives the food a mild, uniform taste.

Distinctive of Oligofructose is its ability to show synergy with intense sweeteners, which allows you to reduce the dosage of these sweeteners while maintaining the desired level of sweetness. This effect, as well as the ability to enhance the fruit flavour, is widely used in the manufacture of soft drinks.

It is known that in acidic medium and high temperature inulin and Oligofructose can be hydrolysed to form shorter chains and fructose, resulting in partial or complete loss of their dietary properties, and, in some cases, to enhance sweetness of the finished product.

The problem of aroma and flavor stability is also solved because in such a case an emulsifier plays a role of aromatic part adsorbent and provides delicate and mild aroma.

The advanced technology of aromatic emulsions is associated with the peculiarities of hydrocolloids application. Constant attention to the research of these compounds is stipulated by their importance for the food industry. However, despite the large number of studies on the physical and chemical properties of hydrocolloids, there is insufficient scientifically based data on their use in food emulsions [2, 8, 9].

Emulsions are thermodynamically unstable. With time they tend to break down into their constituent oil and aqueous phases. The term 'emulsion stability' therefore refers to the ability of an emulsion to resist this breakdown, as indicated by growth in average size of droplets or change in their spatial distribution within the sample. The more slowly that these properties change, the more stable is the emulsion. In practice, stability is a relative term which depends on the context. For some food emulsions, such as cake batters or cooked sauces, the required time-scale for stability is only a few minutes or hours. But for other products, such as soft drinks and cream liqueurs, emulsion stability must be maintained over a period of several months or years [3, 4].

A hydrocolloid ingredient may act as an emulsifying agent, as a stabilizing agent, or in both of these roles. An emulsifying agent (emulsifier) is a surface- active ingredient which adsorbs at the newly formed oil-water interface during emulsion preparation, and it protects the newly formed droplets against immediate coalescence. Given that polysaccharides are predominantly hydrophilic in molecular character, and most hydrocolloids are not surface-active, they cannot act as primary emulsifying agents. There is really only one hydrocolloid - namely, gum arabic - which is commonly employed as an emulsifying agent. The main emulsifying agents used in food processing are the proteins, especially those derived from milk or eggs. A stabilizing agent (stabilizer) is an ingredient that confers long-term stability on an emulsion, possibly by a mechanism involving adsorption, but not necessarily so. In O/W emulsions, the stabilizing action of hydrocolloids is traditionally attributed to the structuring, thickening and gelation of the aqueous continuous phase [4].

The functional role of these small-molecule emulsifiers in food technology is typically not for emulsion making, but for other reasons: controlling fat morphology and crystallization; promoting shelf-life through interaction with starch and gum arabic; and destabilizing emulsions by competitive protein displacement from the oil-water interface [4, 6].

A stable emulsion is one where the droplets remain sufficiently small and well separated that Brownian motion alone keeps them evenly dispersed throughout the continuous phase. The physic-chemical principles of O/W emulsion stability are based on the classical colloid theories of electrostatic and steric stabilization. Electrostatic stabilization arises from the presence of electrical charge on the surface of the droplets, or more usually on the adsorbed stabilizer layer at the surface of the droplets. The greater is the charge density at the surface, and the lower is the ionic strength (electrolyte concentration) of the continuous phase, the more stable is the emulsion. Steric stabilization arises from the presence of a polymeric (steric) barrier at the droplet surface. To confer long-term stabilization, this polymer must be present at sufficient concentration to cover the oil-water interface completely, and it must remain permanently attached to the surface, with at least part of the molecule projecting away from the surface into the aqueous medium. Steric stabilization is increasingly supplemented by electrostatic stabilization in emulsions containing adsorbed proteins at pH values well away from the protein’s isoelectric point (p)[7].

Whether emulsion droplets will remain dispersed or will tend to stick together depends on the nature of the antiparticle pair potential between the droplet surfaces. Generally speaking, colloidal stability requires that the antiparticle repulsion should be of sufficient range and strength to overcome the combined effects of gravity, convection. Brownian motion and the ubiquitous short-range attractive forces together drive the system towards its final and inevitable phase-separated equilibrium condition (**Fig. 1)**.

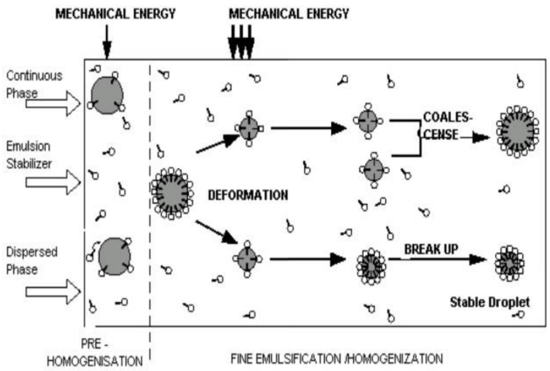


Fig. 1 *Emulsification and stabilization*

The aim is to study particle size effects on the stability of emulsions during storage and use in the manufacture of beverages and their stability during 180 days [5, 8].

II. Materials and methods

A stability study of inulin and oligofructose in the drinks was conducted according to standard laboratory methods: varying the acidity of the drink, changed the pH, the temperature changes by heating, and storage time - by putting a drink on the resistance. Using standard laboratory equipment: pH meter, saccharimeter and thermometer [8, 9].

The soft drink with dry matter content 10.0% have been used as the object of studies in beverages alter the pH value of the medium, temperature and holding time.

We studied the effect of pH and temperature on the degree of hydrolysis of Oligofructose. Samples were prepared beverage containing Oligofructose 20% and 40%. Results are presented in Table 1 and 2.

The pH and temperature effect dependence in Oligofructose hydrolysis degree (the beverage 20% content).

Table 1

Tempera-ture, ° C	Machining time, min	Degree of hydrolysis Oligofructose at different pH values,%		
		pH = 6.0	pH = 4.0	pH = 3.5
85,0	2,0	0	<1,0	5,0
85,0	5,0	0	<1,0	6,0
90,0	5,0	0	<1,0	10,0
95,0	2,0	0	1,0	10,0
95,0	5,0	0	1,0	16,0

From the data table shows that the pH equal to or above 4.0 the hydrolysis occur slightly at all temperatures. While reducing the pH becomes more critical. Thus, at pH 3.5 and 95 ° C for 5 min is na16% hydrolysis.

The same trend is observed in beverages containing 40% Oligofructose. The data are presented in Table 2.

The dependence of the effect of pH and temperature on the degree of hydrolysis Oligofructose (the content of the beverage 20%)

Table2

Tempera-ture, ° C	Machining time, min	Degree of hydrolysis Oligofructose at different pH values,%		
		pH = 6.0	pH = 4.0	pH = 3.5
85,0	2,0	0	< 1,0	4,0
85,0	5 ,0	0	<2,0	5,0
90,0	5,0	0	<2,0	9,0
95,0	2,0	0	<2,0	10,0
95,0	5 ,0	0	<2,0	15,0

Further investigate the influence of pH and temperature on the degree of hydrolysis of inulin. We prepared alcoholic beverages containing 10% inulin. Results are presented in Table 3.

The pH and temperature effect dependence on the degree of hydrolysis of inulin (the content of the beverage 20%) [10, 11].

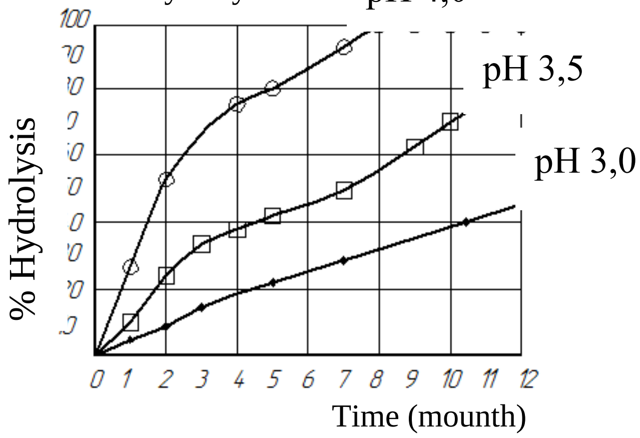
Table 3

Tempera-ture, ° C	Machining time, min	Degree of hydrolysis of inulin at different pH values,%			
		pH = 6.5	pH = 4.0	pH = 3.5	pH = 3.0
70,0	5,0	0	<1,0	<1,5	1,0
	15,0	0	<1,0	<1,5	5,0
	30,0	0	<1,0	<2,0	7,0
	60,0	0	<2,0	<2,5	13,0
90,0	5,0	0	<2,0	<3,0	17,0

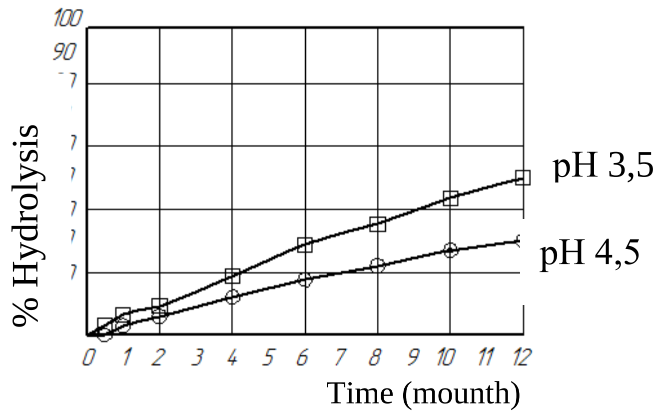
From the data table shows the effect of pH and temperature on the degree of hydrolysis of inulin. If the pH is higher or equal to 4.0, the total hydrolysis at all temperatures is low. At lower pH, the temperature is an important parameter. Thus, at 70 ° C for 60 min is 13%, at 90 ° C is 17%.

Later the stability has been established of inulin and Oligofructose in storage drinks. For this purpose, we used non-alcoholic beverages containing 10% dry matter and various dosages of Oligofructose and inulin. Results are presented in Pic. 2 and 3.

Pic 2 shows that the degree of hydrolysis of Oligofructose can be quite high in beverages with pH 4.0 and a shelf life of up to 6 months to produce 20% probability overdose Oligofructose to compensate for its acid hydrolysis.



Pic. 2 *Hydrolysis Oligofructose during storage for 12 months at 20 º C and different values in pH*



Pic. 3 *Hydrolysis inulin during storage for 12 months at 20 º C and different values in pH*

Pic 3 shows the change in the degree of hydrolysis of inulin during storage of non-alcoholic beverages for 12 months at 20 º C.

It follows that inulin is more suitable as an ingredient, such as fiber and acid drinks with long shelf life. Thus, pH 4.0 hydrolysis after 6 months of storage does not exceed 15%, which can be easily compensated with 15% overdose of inulin. This ensures consumers claimed dietary fiber content for the duration of life. Hydrolysis products do not cause changes in taste due to a low enough concentration of inulin, no more than 2% of the recommended for this application.

On the basis of these studies is found that the degree of hydrolysis of Oligofructose at different temperatures and pH, changes with different intensities.

III. Results and discussion

Thus, at a pH equal to or above 4.0 and a temperature of 85-90 ° C, the hydrolysis of Oligofructose is low. In the case where the pH is reduced, and the temperature rises, the hydrolysis process is increasing dramatically. Thus, at pH 3.5 and 95 ° C the degree of hydrolysis of the Oligofructose in the product increased by about three times.

IV. Conclusions

The use of aromatic emulsions in the manufacture of functionl drinks has several benefits, including: reduced duration of blending, as there is no need to pick up the flavor, color and taste.

In the study of the degree of hydrolysis of inulin at 70-90 ° C in an acidic environment, it was found that at pH = 4.0 and above, hydrolysis is negligible. However, with a decrease in pH and the temperature rises to 95 ° C, the hydrolysis of inulin increased approximately two-fold. In addition, slight with increase in sweetness of the finished product without degrading its consumer properties have been showed.

The process of storing drinks not observed the emergence of oil rings on the surface of the drink, there was no change in color, taste and aroma of the drink. Drinks made with the addition of gum arabic emulsions have better storage stability compared with a drink on starch (**Fig. 2**).

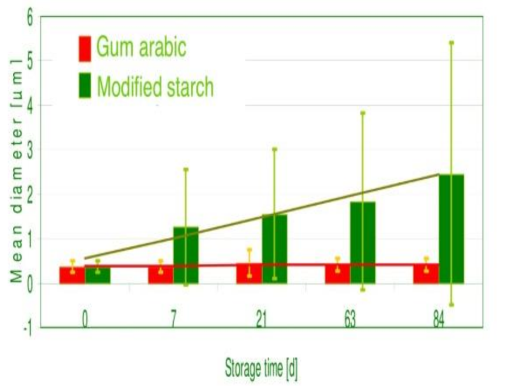


Fig. 2 *Emulsion – long-term stability*

Complete the emulsion must have the following parameters: the size of the oil particles (up to a micron); organoleptic - appearance, color, smell (aroma) and taste according to recipes; density (1,030-1,100), g/cm^3; pH (3, 3 ± 0, 7); stability in the drinks.

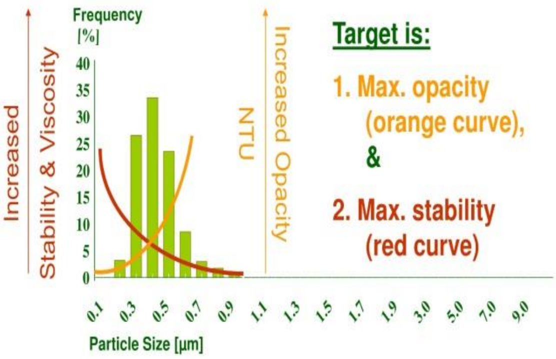


Fig. 3 *Emulsion summary*

The best result of research in emulsions - is to obtain the maximum number of particles of about 1 micron (**Fig. 3**).

Creating a stable emulsion system is a pressing issue in the food industry, so these studies are useful and important for the development of new food products.

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QUATERNARY AMMONIUM SALTS AS ANTIMICROBIAL AGENTS PROTECTING OF AGRICULTURAL PRODUCTS WAREHOUSES AND WOODY CONTAINERS

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Abstract: *The industrial quaternary ammonium salt (the mixture of Quat) katamin AB and them impregnated on zeolites sample has been studied as antimicrobial agents for protecting of agricultural products warehouses and woody container. Effective protection of storage facilities and containers for agricultural products from microbial growth is achieved by applying the proposed biocides. The two biocides showed the same activity. Katamin AB on clinoptilolite has technical useful for applications only.*

Key Words: quaternary ammonium salts, biocides, Katamin AB, zeolite, Escherichia coli, Staphylococcus aureus, bactericidal and antimicrobial properties, agricultural products warehouses and woody containers.

1. Introduction

Although now days instead to wood and cardboard packaging the newest containers are used, but they are also not secured from taint - the action of microbes. No matter the produce it`s need to ship and store–fruits, berries, greens, and many more, this newest packaging will increase efficiency and reduce waste from agricultural products. They are maintaining product integrity and expedite product transportation providing also ventilation and sanitation.

The other frequent cause during the agricultural products storage and transportation is humidity, and depending from that - condensation. During the transport of hygroscopic loads in unventilated containers, condensation can in principle be prevented if the relative humidity of the air inside the container is low enough that its dew point is always below ambient temperature. When using dehumidifiers, their type and quantity should be carefully selected for the type of agricultural products and for the time of transportation also.

It should be noted that hygroscopic coffee, the, spices and other similar products make great demands on absorbents of moisture. It should be taken into account also, that desiccants are unlikely to prevent condensation in the case of rapid temperature changes of large magnitude.

Quaternary ammonium has wide practical application in practice. Quat-s are widely used as ingredients in industrial applications and find widespread use in household products, including fabric softeners, detergents, disinfectants, preservatives, and a range of personal care products [1]. Due to these advantages Quats are also used against microbial growth, because of their relatively low toxicity, broad antimicrobial spectrum, non-volatility and chemical stability [2,3].

In order to create a substance capable of killing bacteria, it is necessary to give it three properties:

1. The first is the ability to attach to the bacterial wall;

2. The second is the ability to penetrate the wall;

3. The third is the ability to destroy the vital components of a bacterial cell or inhibit the reproduction of a bacterium

Quaternary ammonium salt satisfy is the first of the above properties of effective bactericide due to the positive charge carried by their molecules, due to which they are attracted to the outer surface of a bacterial membrane charged negatively. And although the substitution effect of quaternary ammonium salt from other positively charged ions is not so great, it is sufficient to destabilize the microbe. In the place where the ammonium salt binds to the bacterium, a rupture of the membrane takes place, through which a fatal leakage of cellular contents occurs [4].

The goal of this study is to determine the usefulness of biocides based on quaternary ammonium salts for the protection of agricultural products in warehouses and woody containers against microbial growth. The properties of quaternary ammonium compounds vary with the length of the alkyl group, while the solubility in water decreases, while the adsorption increases. This property is very useful when using such compounds as disinfectants [3].

2. Materials & methods

Samples of materials from tare were sterilized twice at 115-120 ° C for 15 minutes, and then stabilized in a chamber at 30 ° C and 70% humidity for a week. Disinfection of agricultural products warehouses and woody containers can be carried out by three applications of 6% v/v solutions of Katamin AB (biocide A) and Katamin AB (biocide B) impregnated on natural Armenian zeolite-clinoptilolite Effective protection against microbial growth for a period of seven days can be achieved by the application of biocide A (30% v/v) on the wood surface and biocide B (6% v/v) on the container surface.

The antimicrobial properties of the samples were studied in vitro experiments by serial dilution in a liquid nutrient medium.

As indicator microorganisms used:

a / *Staphyloccocus aureus* strain number 209 P as the most stable species from the coccus group of bacteria;

b / *Esherichia coli*seropathy OB: 4 as the most resistant species from the gram-negative microorganisms of the family of intestinal bacteria. In the process of studying antimicrobial properties, it has been established that they possess antimicrobial properties. These substances are of considerable interest for the preparation of disinfectants.

The efficiency of antimicrobial activity of dimethylbenzylalkyl (C_{10}-C_{17}) ammonium chloride compared to the same compound on zeolite surface. These two samples cause death of *Staphyloccocus aureus* strain at a concentration of 0.12 and 0.15 μg / ml, respectively. Consequently, they can serve as a disinfectant for the intended purpose.

3. The results and discussion

Since it is known by us and also by the studies of other authors that with increasing length of the alkyl chain in Quat-s, the solubility in water decreases and the adsorption capacity of the surface increases, as well as the antimicrobial activity, specifically the industrial Katamin AB has been studied [5].

Disinfection by Quat can be carried out with a 10% aqueous solution in a mixture with ethanolamine derivatives also known for their antimicrobial properties [6]. Effective protection of storage facilities and containers for agricultural products from microbial growth during the week is achieved by applying the proposed mixture.

The study determined the activity of mentioned against bacteria and showed high sensitivity.

The two quaternary ammonium biocides showed the same activity. Only Katamin AB on clinoptilolite has technical useful for applications. Given the high inhibitory activity of the investigated salts can offer them as bio-anticorrosion drugs [5].

For zeolites with impregnated Katamin AB appear also zeolitean possibilities to serve as absorbents of moisture. This possibility is more important for the mentioned aims for Quat application.

Conclusions

Thus, it was found that industrial mixture of quaternary ammonium salts – Katamin AB can be used as disinfectants. The same activity has also Katamin AB on zeolite sample which is easier for practical application for mention goals.

The zeolites with Katamin AB on the surface impregnated also serve as a desiccant / moisturizer / and when removing the dried sorbent will not have allowed to enter Quat-s the space.

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EFFECT OF TEMPERATURE ON THE COEFFICIENT OF FRICTION IN PAIRS "POLYMER FILM - STEEL"

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Abstract. *The results of the analysis on the specifics of film materials and their friction pairs metal structures machine li-food packaging. The attention is paid to the importance of influence of the temperature on friction indexes and information on the results of laboratory tests is given. It is shown that the temperature of the interacting surfaces influens the value of the coefficient of friction and this effect is noticeably different for different types of polymer materials.*

Key Words: polymer film, coefficient of friction, resistance, displacement, temperature.

II. Introduction.

One of the priority directions of the study of the properties of packaging materials is to determine the influence of their physical and mechanical parameters on the processes of packaging formation and the operation of the packaging is equipped in general.

The topicality of the problems is indicate by the fact that over the past decade, the study of physical properties of surfaces of materials spent more than on research on nuclear energy [1]. This is because the physical and mechanical properties of the packaging materials and the properties of the surfaces of the working equipment of the packaging equipment depend on the quality of the packaging and the quality of the operation of the packaging equipment and its performance.

Physical and mechanical properties of packaging materials determine their interaction with the working bodies of packaging equipment for technological processes under the influence of mechanical loads.

The basic physical and mechanical properties of the packaging materials that can significantly influents the technological parameters of the package include stiffness, strength, flexibility, relative elongation, yield strength, elastic modulus, hardness, impact strength, surface roughness and coefficient of friction. Each of the above listed parameters can radically influence the work of the packaging equipment. For example, the stiffness of a material depends on it behavior on the nodes of filing and cutting a particular packaging equipment, and when the sheet passes through the tracks of the packaging equipment, the material can flex, sag under its own weight or dynamics components from the side of the work nodes. The magnitude of this deformation can also depend on the type of guide supports hardware, the distance between them, thickness of packaging material and it deformation-strength characteristics.

Flexible packaging material is defined as the property of its bending under the property of own weight. The stiffness of the material at the bend is inverse to the flexibility and determines the property of the resistance of elastic bending deformation, which arises under the influence of external forces. It is obvious that flexibility and rigidity are characterize by such a tension and deformations, by which the material can recover its shape and size after eliminating the applied effort.

If we consider the different types of packaging equipment, for the equipment of discrete steps necessary to use packaging with a high yield point, because periodic stops and start during operation of such equipment can lead to irreversible deformation of the material, which entails failure or stop. The packaging material can be exposed to the effects of the machine's working bodies, such as breakthroughs and break. Moreover, even despite the fact that today there are many technical solutions that can offset the negative effects of dynamic loads on the packaging material, in order to prevent the above defects occurring, it is recommended to use materials with high resistance to shock loads, punctures and breach.

The purpose of the research is to analyze the peculiarities of the interactions of packaging film materials with supporting surfaces and working organs of technological equipment and to obtain data on temperature influences on power friction coefficients.

II. Materials and methods

Significant influence on the operation of the packaging equipment has the surface characteristics of the packaging material. These include friction, surface roughness and stickiness of packaging material. The most difficult controlled parameter is the coefficient of friction of the packaging material with the surfaces of the robotic bodies. Among the factors that may change in the process of work, include temperature, speed, pressure, etc. [2, 3].

Regarding the coefficients of friction, it is divided into static and kinematic. They are determined by standard techniques, such as ASTM D1894, ASTM D4918, DIN 53375 or ISO 468, using devices (Figure 1) that capture the strength of the friction resistance between the interacting surfaces. The resistance force that occurs when the two surfaces are interacting is fixe with the help of a special dynamometer, and the coefficient of friction is determine by the known value of the resistance of the friction.

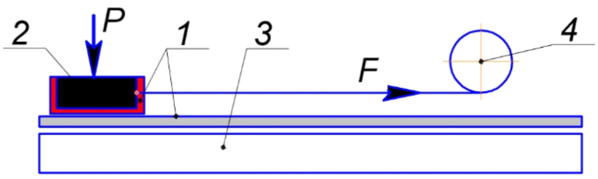

Figure 1. *Scheme of the installation for determination of friction force: 1 – materials of friction pair; 2 – the load fixed on the guides; 3 – plate; 4 – instrument for determining effort*

III. Results and discussion

The value of static coefficient of friction (SCOF) packaging has a significant impact on the processes of packaging. For example, for small values of SCOF, deposition of roll layers may occur, which results in telescopicity, loss of form, and this entails reweaving the material during the passage of guiding supports, shafts, and the like. Besides low value SCOF of packaging material leads to failures in storage and transport of equipment does not ensure the maintenance of finished products packed in stacks. For high values of the SCOF, the roll may degrade when humidity or temperature changes, as these parameters often fluctuate when storing and transporting the packaging material. The kinematic coefficient of friction (KCOF), compliance with a certain range of its values, ensures the stable and efficient operation of the packaging equipment, the free passage of the packaging material on the surface of the working bodies without jerks and stretching. The high values KCOF increases the likelihood jam packaging material, especially when there is bending, folding or pressing it tightly to the working surfaces of equipment [4]. The small values of the CKT increase the probability of slipping the passage over the packing material, or slipping the material from the guides or forming gate. It is known that the coefficient of friction between the surface of the working body and the packaging material is influenced by various external factors, and most of them are difficult or impossible to control during the work process. Therefore, in most cases, the packaging material is select with the necessary values of the coefficient of friction. However, there are cases when, at some stage of packing formation, a material with a low friction coefficient is working fine, and on the other - there are failures in the work of the same equipment. For example, on vertical packaging equipment for the formation of packaging of the type "pillow" when passing the packaging material on the molding gate it is desirable to have a low coefficient of friction, which will ensure easy passage of the material and eliminate the possibility of creating clamps on the sleeve and less effort to pull material. But, at the same time, because of the low value of the coefficient of friction of the packaging material, there is a slip of the stroke passes on the material, and therefore have to either increase the force of pressing the pass, or use a special system of vacuum passes. Therefore, choose the value of the coefficient of friction, based on the design features of the packaging equipment and the requirements for the final packaging.

Contrary to the laws of friction of Amonton-Coulon, the friction coefficients influence not only the frictional properties of the interacting bodies but also factors such as the contact area, the pressing force, the temperature of the interacting surfaces, and so on.

If the forces of pressing the two interacting surfaces can be adjusted, the temperature of the contacting surfaces during the operation may change, the contact area is practically constant. In this regard, it was decided to conduct a study and determine the influence of the temperature of the contact surfaces to change the coefficient of friction between them.

Two samples were selected for the study. The first sample is a multi-layer sheet material consisting of paper, aluminum foil and polyethylene; the second sample was a transparent polyethylene film. The coefficient of friction between the polyethylene film, which was the wrapped cargo, and the metal plate imitating the working surfaces of the packaging equipment was investigated. Proceeding from the fact that in the packing-equipped working bodies are in constant contact with the packaging material, and the packaging material is constantly moving and has room temperature, only a metal simulated plate is heated.

The coefficient of friction is measured according to the widely used standard D 1894-01 "Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting", which describes the method of conducting research and laboratory equipment. But given the fact that for our research it is necessary to heat the metal surface on which the material slips, it was decided to make a laboratory installation such as "inclined plane" (Figure 2). The design of the developed installation allows precisely to adjust the angle of inclination, and to warm the metal plate on which the research will be conduct. The plate heating was performed from the underside with help hot air. The plate temperature was controlled at five points using a contactless pyrometer. The test is carried out only when the plate is heated up uniformly to the required temperature.

Determination of the coefficients of friction of the interacting surfaces was carried out in the range of temperature values, ranging from room temperature (20°C) to 80°C with a step of 10°C. The final temperature of 80 ° C was chosen because some of the packaging materials at the given temperature begin to change the physical state: they are shrinking or adhered to the metal, so overheating is undesirable.

The calculation of the coefficient of friction of the interacting surfaces was carried out in accordance with the law of Amonton-Coulon, which describes the relationship between the surface frictional force and the normal reaction of the metal plate.

With self-braking load conditions on an inclined plane in the form

$$mg\sin\alpha = \mu mg\cos\alpha, \qquad (1)$$

Where m – mass of cargo, kg; g – acceleration of free fall of cargo, m/s^2; α – angle of inclination of the plate to the horizon line; μ – coefficient of friction on this basis:

$$\mu = \mathrm{tg}\,\alpha\,. \qquad (2)$$

The friction angle α correspond to the angle of installation of the plate to the horizon line, at which the movement of the load began.

Since the plate, which interacts with the test sample, is made of stainless steel of the brand 12X18H10T, then the value of the coefficient of friction was determined according to the pair of bodies "film - metal". The determination of the friction coefficient at each temperature value for each sample from the two selected materials was carried out five times. The data received are listed in the Table 1.

After statistical data processing of the table, a plot of the dependence of the coefficient of friction of the prototype samples on temperature was constructed (Figure 3).

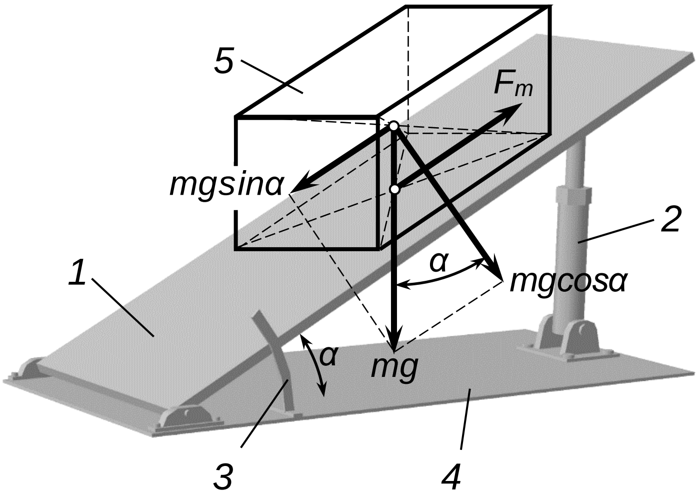

Figure 2. *Laboratory installation of "inclined plane" type: 1 - metal plate; 2 - screw pair to change the angle of the plate; 3 - protractor; 4 - basis; 5 - load, wrapped in a film*

Table 1. *Results of experimental studies*

№	Temperature, °C	Material	Obtained values					Average value
1	25	film	0,21	0,23	0,21	0,22	0,23	0,218
		laminate	0,38	0,38	0,39	0,37	0,39	0,382
2	35	film	0,23	0,21	0,21	0,23	0,22	0,22
		laminate	0,39	0,38	0,37	0,37	0,36	0,374
3	45	film	0,25	0,26	0,23	0,24	0,24	0,244
		laminate	0,39	0,38	0,40	0,40	0,38	0,39
4	55	film	0,25	0,26	0,27	0,24	0,23	0,25
		Laminate	0,44	0,43	0,45	0,42	0,43	0,434
5	65	film	0,27	0,26	0,28	0,29	0,25	0,27
		laminate	0,5	0,49	0,49	0,5	0,47	0,49
6	75	film	0,29	0,31	0,30	0,30	0,31	0,302
		laminate	0,54	0,55	0,56	0,55	0,56	0,552
7	80	film	0,38	0,37	0,37	0,36	0,38	0,372
		laminate	0,59	0,58	0,58	0,57	0,59	0,582

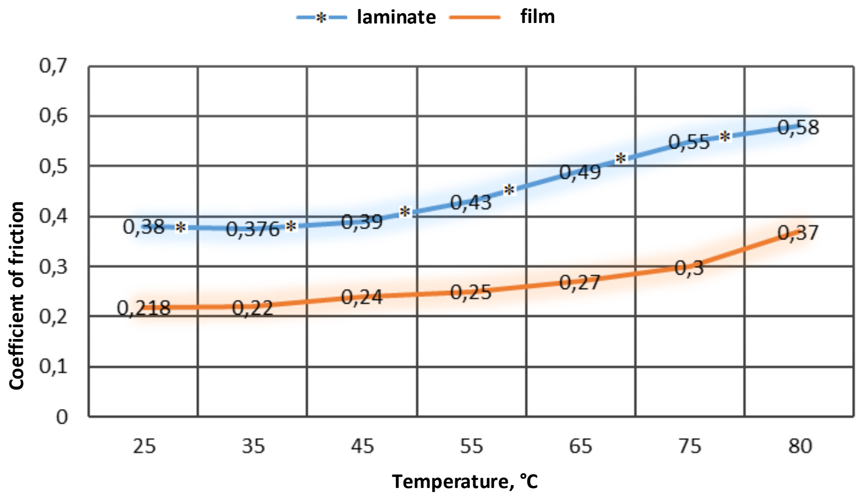

Figure 3. *Dependence of the coefficient of friction between the packing material and the metal plate*

IV. Conclusion

From the data obtained, the following conclusions can be drawn:

- the temperature of the interacting surfaces affects the value of the coefficient of friction, but this effect is most pronounced at a temperature close to the plasticisation temperature of the polymer material;
- for each individual material, the effect of one and the same temperature will be noticeably different;
- analyzing the polymeric packaging materials used in the world market, it can be argued that temperature changes in the range from 25 to 60 ° C will not have a critical impact on the processes of packaging formation.

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RESEARCH OF MECHATRONIC MODULES OF DOSING WEIGHING DEVICES FOR LIQUID PRODUCTS

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Abstract. *The creation of new packaging equipment for dosing of liquid products that has a flexible structure and is universal while changing material's dose or package is a main task today. Its solving needs a systematic approach, starting from the development of the design concept of dosing devices and finishing with the constructions of executive mechanisms. This concept can be the one of use of mechatronic principle of design. The construction of mechatronic dosing weighing devices has been represented in this work and also the function of its closing element in terms of its form, sizes and motion character of liquid food product has been researched.*

Key Words: dosing weighing device, mechatronic module, packaging equipment, conical closing valve, electronic control system.

I. Introduction

The development of dosing ways of food products is immediately connected with the improvement of production technology, growing of requirements for accuracy of dosing, reliability and operation speed of dosing units. The main requirements to new samples of dosing devices are to provide both traditional parameters: productivity, economy (minimal cost), reliability, and technological ones: stabilization of instant and average expenses at the specified value; expenses change at the specified law (in software) depending on the parameters change of technological process or dosing object.

Any way of expenses regulation and forming of unitary dose can have a lot of structural and constructive types of dosing devices which represent the specificity of technological process, the qualities of dosed media etc. [1].

The most perspective systems among the variety of known ones of automatic dosing of liquid food products are weighing ones whose interest has substantially grown recently and is connected with scientific achievements in the sphere of micro- and nanotechnologies. The classification of weighing systems of automatic dosing that involves the main spheres of use of dosing devices of closure and closure-free principle of liquid motion, is based on the technological requirements of production processes and is shown in Fig. 1 [2].

While dosing liquid food products the most important section of dosing weighing system is an operating device (a closing valve) that is in the immediate contact with dosing liquid (Fig. 2).

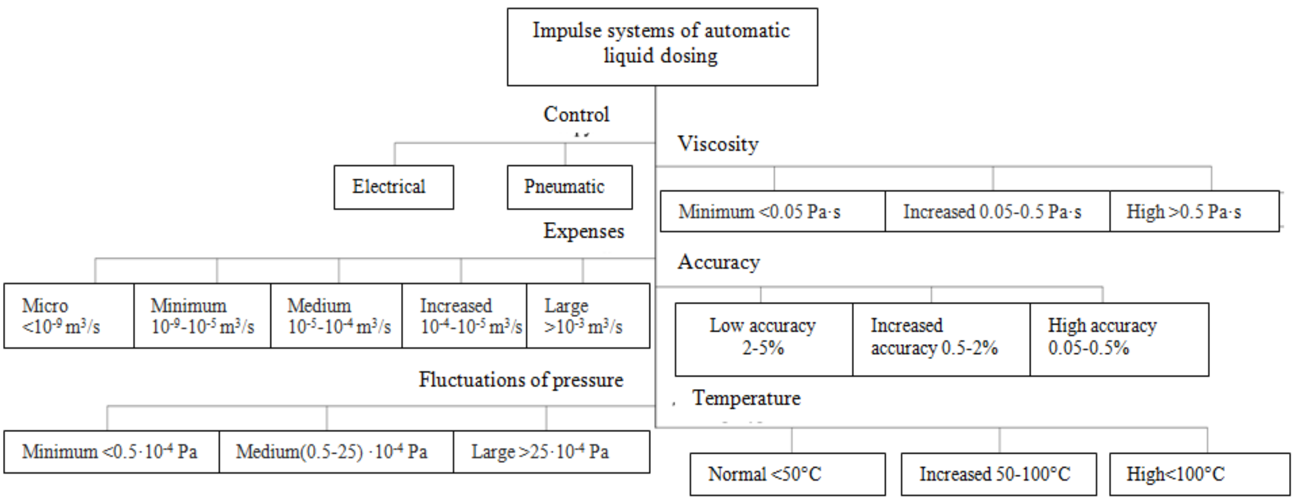


Fig. 1. *Classification of dosing weighing systems of automatic dosing for liquid food products*

II. Problem statement.

To develop mechatronic modules of dosing weighing devices for liquid food products it is necessary to define and set the regularities of functioning and creation of instrumental means of calculation of controlled non-stationary modes of motion of operating device taking into account physical and mechanical characteristics of liquid food products on the basis of use of different geometrical sizes and forms of closing valves. According to the terminological definition "the mechatronic module of dosing weighing device" is an integral technical system that is constructively and functionally complete independent product, has an automatic control system of the work of operating devices with a flexible software change of technological process and feedback in the form of use of different types of sensors which guarantee the possibility of information reception about characteristics change of external medium; is characterized by constructively specified unified channels of mechanical, energetic and informational connection for synergetic connection with other mechatronic modules. It is foreseen that packaging and dosing equipment of the fifth and sixth generation will be created on the basis of mechatronic modules use.

III. Problem solving

Usually dosing devices for liquid food products consist of three main elements: a housing (1), a valve (2) and a nozzle (3) (Fig. 2).

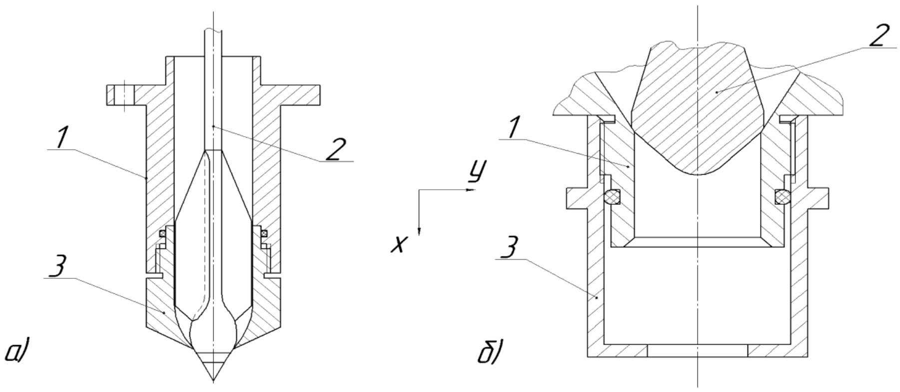


Fig. 2. *Construction of the operating device in dosing weighing devices: a) conical; b) cylindrical: 1 – housing; 2- valve; 3 – nozzle.*

So a modern electronic control system of the movement of the operating device (by closing valve) of the dosing weighing device for liquid food products includes a set of position sensors and devices for information reception and processing, executive mechanisms, operating devices and auxiliary devices. (Fig. 3) [3].

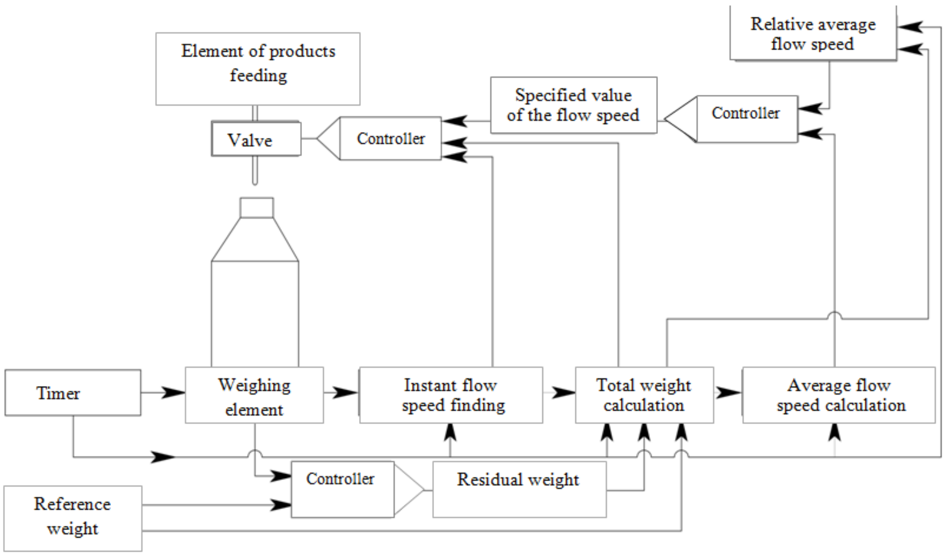


Fig. 3. *Structural scheme of control system of operating device (valve) movement of precision dosing unit.*

The accuracy of dosing in such control system is provided by the presence of the feedback on mass taking into account liquid flow speed and its physical and chemical characteristics and comparison of the obtained result with the reference value at each measurement stage.

The most important system section of weighing dosing is an operating device that is a closing valve which is in the immediate contact with a dosing liquid. It was found out that the most used is the closing valve of conical form. Automatic control systems by the closing valve are adaptive and they provide a necessary level of the reliable work of the precision dosing unit at the conditions of fast change of surrounding characteristics by means of calculating and feeding of electrical signal that influence on the position of the system operating device [4].

At present the method of two-stage dosing is widespread (fig.4), it can be illustrated by a broken line consisted of two straight lines. The first line corresponds to the mode of rough dosing, the second one – to the accurate one, the transition from one to another is represented by the conditional point A. The disadvantage is substantial dose forming time. To eliminate this disadvantage, it is suggested to use more complicated “optimal” modes, they represent a curve that doesn't have distinctively highlighted points of change of dose forming modes and is fulfilled with the help of change of effective area of cross section of the packaging device.

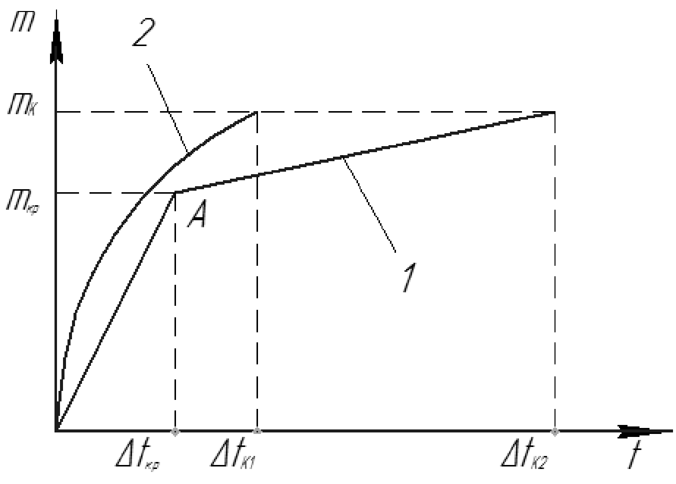


Fig. 4. *Forming dose modes: 1- two-stage 2-optimal.*

As the effective area of the cross section between the valve and the saddle directly depends on the valve position, it is advisable to calculate this change according to the geometric sizes of the valve (Fig.5).

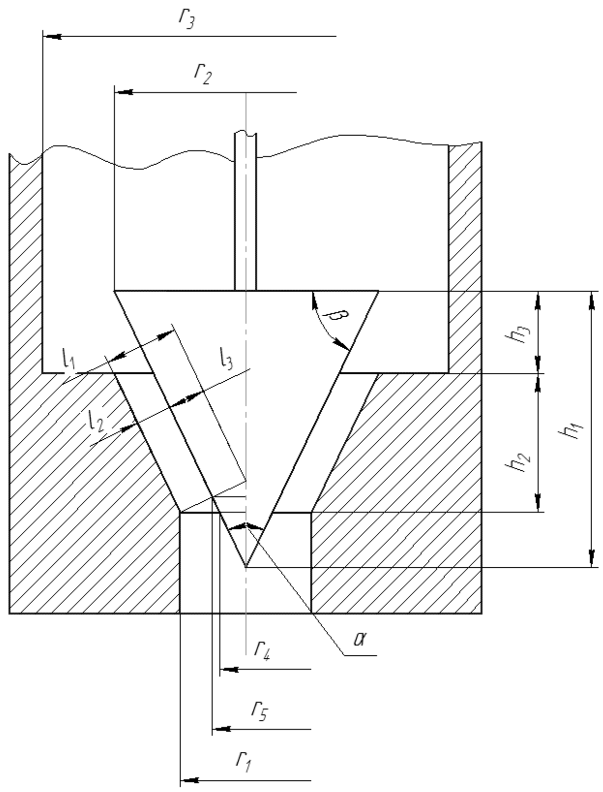


Fig. 5. *Calculation scheme of the valve of the conical form*

The value of the angle β at the top of the conical valve is defined from the equation:

$$\beta = \frac{\pi - \alpha}{2} \quad (1)$$

Herewith the total length of the conical part of the valve h1 is:

$$h_1 = \frac{r_1 \cdot \sin\beta}{\sin\frac{\alpha}{2}} + h_2 \quad (2)$$

The radius of the valve base is defined from the formula:

$$r_2 = \frac{h_1 \cdot \sin\frac{\alpha}{2}}{\sin\beta} \quad (3)$$

The length of the lateral surface of the valve cone that provides the change of effective area of the cross section during its movement l_1 is

$$l_1 = \frac{r_1}{\sin\beta} \quad (4)$$

The radius of the closed part of the drain nozzle r_4 is:

$$r_4 = \frac{r_1 \cdot (-h_3 + h_1 - h_2)}{h_1 - h_2} \quad (5)$$

The length of the closed lateral surface of the cone l3 is:

$$l_2 = (r_1 - r_4) \cdot sin\beta \ ; \qquad (6)$$
$$l_3 = l_1 - l_2$$

Considering the defined geometrical sizes of the conical valve, the radius of the valve in the point of closing of the cross section effective area r_5 equals:

$$r_5 = l_3 \cdot sin\beta, \qquad (7)$$

and the effective area of the cross section $S1$ is:

$$S1 = \pi \cdot l_2 (r_1 + r_5) \qquad (8)$$

The movement of the conical valve during the opening of the hole will be stopped if the value of the cross section effective area of the passage channel equals the value of the area of the cross section of the drainage path:

$$Sm = r_1^2 \cdot \pi \qquad (9)$$

The maximum value of the expenses of the liquid food products at such conditions is defined from the formula:

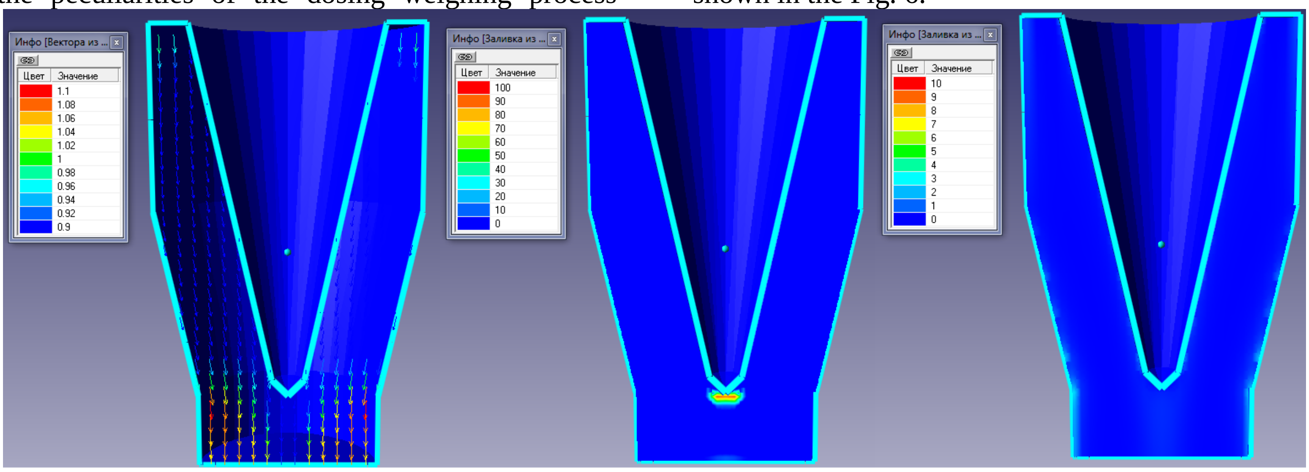
$$Q1 = \mu \cdot S1 \cdot v \qquad (10)$$

where, v is a liquid outflow speed, $v = \sqrt{2 \cdot g \cdot H}$; H – the height of the liquid pillar; μ – expenses coefficient (Table1).

Table 1. *Expenses coefficient for different valve forms*

Forms of holes and nozzles	Expenses coefficient μ
Round hole in the thin wall	0.62
External cylindrical nozzle	0.82
Internal cylindrical nozzle	0.71
Conical nozzle that converges with the angle of taper 140º	0.95
Conoidal nozzle	0.98
Conical nozzle that diverges with the angle of taper 50º	0.48

The research of the motion character of the liquid food product with known geometrical sizes of the valves was carried out with help of software FlowVision. It has been found out that because of the peculiarities of the dosing weighing process there is a risk of product lateness in the container that has negative outcomes. To avoid this phenomenon it is necessary to provide the laminar mode of motion. The results of the research are shown in the Fig. 6.



I II III

Fig.6. *Results of liquid food product motion through the hole between the conical valve and the housing: I- speed vector change; II- pressure change; III- dissipation.*

The calculation results of the change of the cross section effective area and the corresponding changes of expenses depending on the valve position are shown in Fig.7 and Fig.8.

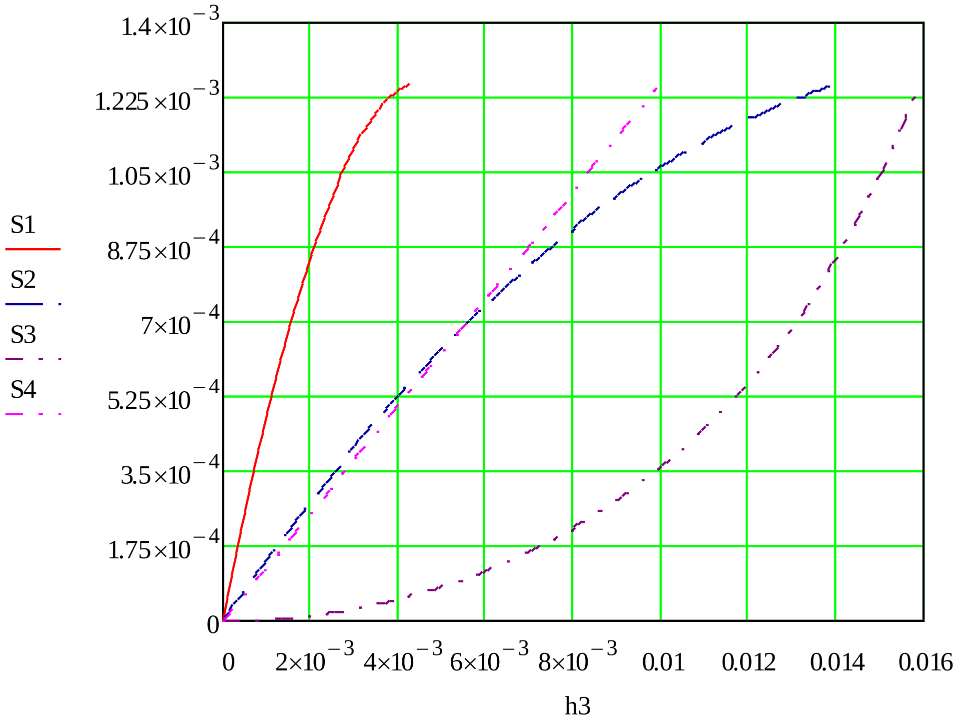


Fig. 7. *Diagram of the change the cross section effective area depending on the valve position. S1 – a conical valve shape, S2 – a spherical valve shape with the saddle that does not follow the valve shape, S3 – a spherical valve shape with the saddle that follows the valve shape, S4 – cylindrical valve shape.*

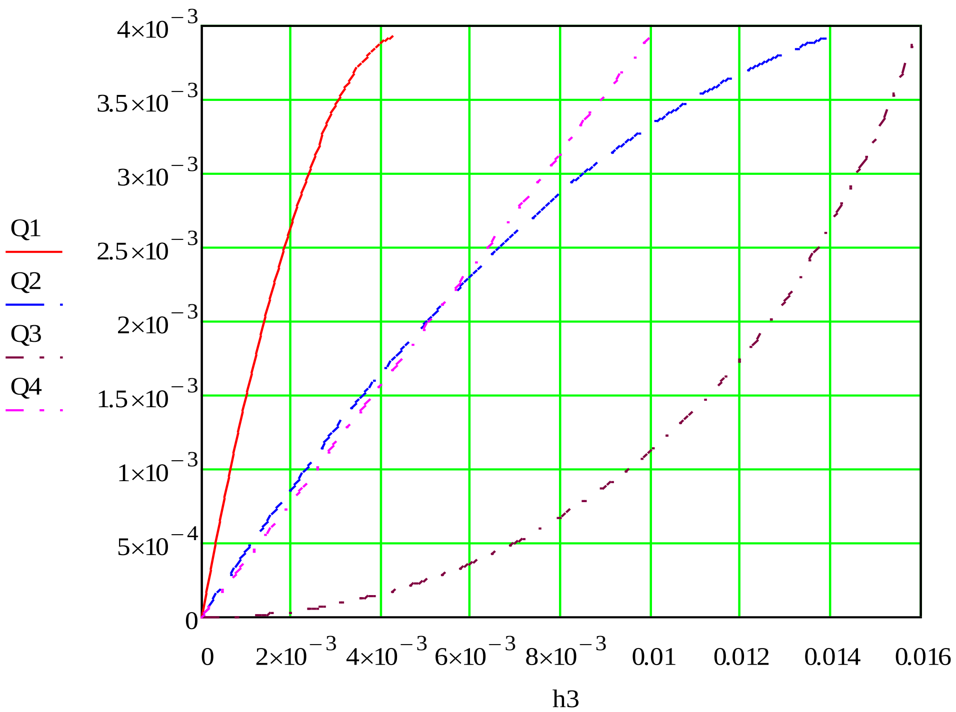


Fig. 8. *Diagram of expenses change depending on the valve position. Q1 – a conical valve shape, Q2 – a spherical valve shape with the saddle that does not follow the valve shape, Q3 – a spherical valve shape with the saddle that follows the valve shape, Q4 – cylindrical valve shape.*

IV. Conclusions

The analysis of the obtained results of modeling has shown that the speed of the liquid products passing through the valve reduces as a result of increase of effective cross area that allows to avoid the increase of dissipation values and so to keep the laminar mode motion of the liquid products. The increase of the pressure is observed at the top of the valve and the main motion resistance – on the walls of the housing during its flow direction change.

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