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RESULTS OF STUDIES OF THE INFLUENCE OF THE DENSITY AND VIBRATIONAL DISTURBANCE IN THE PROCESS OF HYDROMECHANICAL AMBER MINING

The article presents the laboratory stand and the results of experimental studies to determine the influence of the density of the medium, as well as vibration and bubbling factors, in the process of amber extraction. As a result of the research, the density of the medium, C = 105-150 g / l, necessary for curing amber is established. The positive effect of the use of bubbling and vibration was also confirmed, which allowed to reduce the density necessary for amber extraction from 1.5 to 3.2 times. There is established the possibility of effective replacement of expensive salt, used for increasing the density, with "blue clay", lying in the places of amber mining.

Key words: *amber, density, bubbling, vibration, salt, clay.*

Formulation of the problem. At present, the demand for amber has increased substantially, which, apart from the jewelry industry, has been widely used in the pharmaceutical industry as well as in the production of high-quality varnishes. Therefore, the improvement of the technology of its extraction by determining the significant factors affecting the process is topical [1-4].

Analysis of recent research and publications. In Ukraine, intensive development of amber deposits is under way. However, the complex and diverse mining and geological conditions of deposits, the imperfection of technological methods of extraction, the lack of special equipment lead to large losses of amber, especially of small fractions, as well as to disruption of the ecological situation in the mining areas. The search and implementation of new development methods will significantly expand the capabilities of traditional technologies.

The work deals with the conditions of amber extraction in the deposits of the Rivne-Volyn region, in which a large number of industrially significant sandy and sandy-clay deposits of amber are concentrated. In this region, only selected sections of the field are developed that are available for simple hydraulic well production using a hydro pump. This method is inefficient: it requires a large amount of water, amber is extracted without subsequent reclamation of the destroyed layer, with large losses in the dump of fine amber particles [5].

The developed hydromechanical production method for these conditions is promising, since it is carried out without destruction of the rock bed during amber mining and does not require subsequent reclamation of the surface in the area. At the same time, the high water consumption, the sources of which are limited in these areas, is a deterrent to its widespread use in sandy and sandy-argillaceous deposits. At the same time, the use of this method has shown that the effectiveness of amber extraction depends significantly on the rate of its ascent from the well, and this requires a large flow of water [6]. However, at present there are no studies to rationally limit the use of water without reducing production efficiency. One of the important factors is the density of the slurry, which significantly affects the rate of ascent of amber particles and the efficiency of the extraction process, but the nature of this effect has not been sufficiently investigated.

The complex effect of several mechanisms at amber extraction, for example, the creation of conditions for the ascent of amber particles of

various masses with additional air flow (flotation or bubbling) and vibrational action in the working zone, deserves the attention of researchers. The effectiveness of this mining technology can be increased by selecting the dominant process factors and their rational parameters [2, 3, 7,8].

The aim of the study is to determine the density of the medium necessary for the ascent of amber of different sizes, as well as to determine the influence of vibration and bubbling factors on the process of ascent of amber.

Main results of the research. To carry out experimental studies, a laboratory stand was created, shown in Fig. 1. The stand consists of the base 1, on which the body 3 is mounted on the elastic supports 2 with a cylindrical tank 4 filled with water, a perforated surface 5 is installed at a distance from it, which forms a cavity with the bottom and walls of the tank, compressor 6 with a capacity of 20 l / min. The electric vibration exciter 7 of the brand EV63-4U3, 1420 rpm, an engine power of 0.18 kW, a maximum disturbing force of 1755 H, to create circular vibrational oscillations was attached to the body of the stand, experiments were conducted with the disturbing force of 800 H.

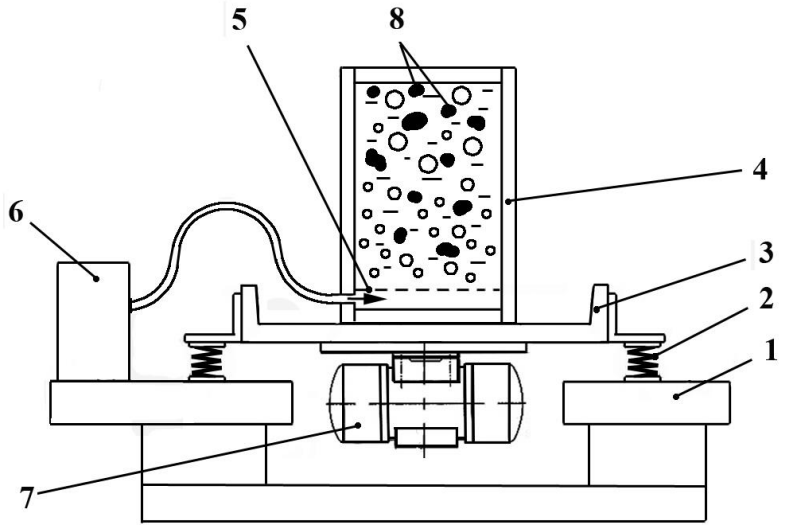


Fig. 1 Scheme of the laboratory stand

The principle of the stand is as follows: in the tank 4 filled with water, pieces of amber 8 of different mass were immersed, and salt or "blue clay" was added to increase the density of the liquid until the amber ascent ascertained, this process is also carried out with air supply (bubbling) and the action of circular vibrational oscillations separately from each other and together. The data of the conducted experiments on determining the concentration of salt C (gram per liter, g / l) necessary for the ascent of amber, for various conditions, are presented in Tab. 1.

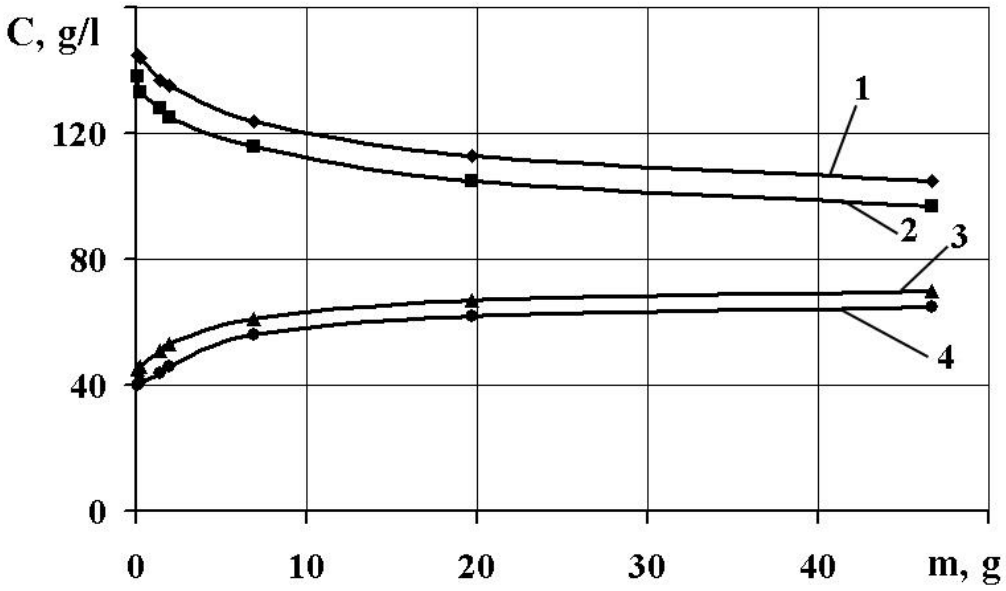
Table 1

The concentration of salt C (g / l), necessary for the ascent of amber

№	Type of additional effect	m, amber mass, g						
		0,1	0,2	1,4	1,9	6,9	19,7	46,7
1	without vibration and bubbling	145	144	137	135	124	113	105
2	with vibration	138	133	128	125	116	105	97
3	with bubbling	45	46	51	53	61	67	70
4	with vibration and bubbling	40	41	44	46	56	62	65

From Table. 1 it is established that the use of bubbling has a significant effect on improving the ascent of amber, with a lower salt concentration in water. To determine the nature of the dependences obtained, the graphs, shown in Fig. 2, of the required concentration of salt C for

the ascent of amber from the mass of pieces of amber m when air is supplied (bubbling) and the effect of circular vibrational oscillations separately from each other and together.



1 - without vibration and bubbling; 2 - with vibration;
3 - with bubbling; 4 - with vibration and bubbling
Fig. 2. Dependence of the necessary concentration of salt C for the ascent of amber on the mass of pieces of amber m

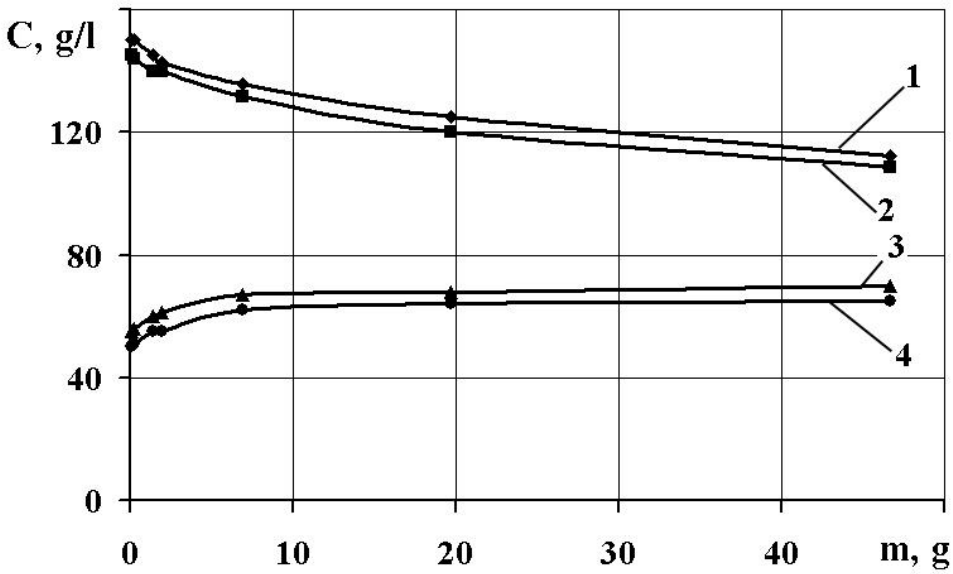
Since salt is a relatively expensive way to increase the density of the solution, and the use of salt in industrial conditions can lead to increased salinity of the environment, salt substitutes have been searched for in the area where amber mining is expected. The material found is "blue clay", the deposits of which are in close proximity to the places of extraction and processing of amber. As a result of studies of this "blue clay" it was found that it contains 25% of clay, and the remaining 75% is sand. Since the influence on the increase in the density of the solution is provided by clay, the data on the change in the concentration of relatively pure clay, rather than the sandy-argillaceous mixture, will be given further. The data of the conducted experiments on determining the concentration of clay Cg necessary for the ascent of amber, for various conditions, are presented in Table. 2.

Table 2

Concentration of pure clay Cg (g / l), necessary for the ascent of amber

№	Type of additional effect	m, amber mass, g						
		0,1	0,2	1,4	1,9	6,9	19,7	46,7
1	without vibration and bubbling	150	150	145	142,9	135,6	125	112,2
2	with vibration	145	144	140	140	131,7	120	108,7
3	with bubbling	55	56	60	61,3	67	68	70
4	with vibration and bubbling	50	51	55	55	62	64	65

As a result of the analysis of the obtained data it was established that the replacement of salt with pure clay does not significantly affect the concentration of the solution necessary for the ascent of amber, only clays need 10-15% more. To determine the nature of the dependences obtained, plots of the necessary concentration of pure clay Cg were constructed for the ascent of amber from the mass of pieces of amber m with air supply (bubbling) and the action of circular vibrational oscillations separately from each other and together shown in Fig. 3.



1 - without vibration and bubbling; 2 - with vibration;
3 - with bubbling; 4 - with vibration and bubbling

Fig. 3. Dependence of the necessary concentration of pure clay Cg for the ascent of amber on the mass of pieces of amber m

Taking into account the positive influence of vibration during the implementation of technology of amber extraction in sand deposits, a special design of the vibratory classifier [9] has been developed, which makes it possible to extract the amber even of small size classes with the least technological losses. Subsequent improvement of this design [10] allowed to create a complex action classifier in which the intensification of the process of ascent of amber particles due to air bubbles is provided.

Conclusions

1. With the hydromechanical method of extraction and extraction of amber from sandy and sandy-argillaceous rock mass, the use of a suspension medium in the form of a liquid of increased density, vibration and air in the form of bubbles makes it possible to increase the rate of ascent of pieces of amber of various sizes, which contributes to its maximum extraction.

2. When using table salt to increase the density of the suspension medium, its concentration is in the range of 105 ÷ 150 g / l, and when using clay for this purpose, its concentration increases by another 10%.

3. The use of vibration allows you to reduce the concentration of the suspension by 10%, bubbling - in 1,5-3 times, and also contributes to the segregation of pieces of amber when they are separated from sand and clay. During the experiments it was proved the possibility of replacing the expensive and polluting salt with the "blue clay" with the increase in the concentration of pure clay in comparison with the salt by 5 ÷ 10%.

4. In general, as a result of the studies carried out, it has been shown that the complex effect on the rock mass can be effectively used in the form of a liquid medium of increased density, vibration and air flows in the form of bubbles. At the same time, a closed cycle is performed on the liquid phase of the impact, which allows us to justify the new technology of amber extraction.

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РЕЗУЛЬТАТИ ДОСЛІДЖЕНЬ ВПЛИВУ ЩІЛЬНОСТІ СЕРЕДОВИЩА І ВІБРАЦІЙНОГО ЗБУДЖЕННЯ ПРИ ГІДРОМЕХАНІЧНОМУ СПОСОБІ ВИДОБУТКУ БУРШТИНУ

Анотація. *У статті представлені лабораторний стенд і результати експериментальних досліджень по визначенню впливу щільності середовища, а також факторів вібрації і барботажа, в процесі вилучення бурштину. В результаті досліджень встановлена необхідна для видобутку бурштину щільність середовища С = 105-150 гр/л. Також підтверджений позитивний вплив використання барботажа і вібрації, що дозволило знизити необхідну для вилучення бурштину щільність від 1,5 до 3,2 разів. Встановлена можливість ефективної заміни дорогої солі для підвищення щільності на «блакитну глину», що залягає в місцях видобутку бурштину.*

Ключові слова: *бурштин, щільність, барботаж, вібрація, сіль, глина.*

РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ ВЛИЯНИЯ ПЛОТНОСТИ СРЕДЫ И ВИБРАЦИОННОГО ВОЗМУЩЕНИЯ ПРИ ГИДРОМЕХАНИЧЕСКОМ СПОСОБЕ ДОБЫЧИ ЯНТАРЯ

Аннотация. *В статье представлены лабораторный стенд и результаты экспериментальных исследований по определению влияния плотности среды, а также факторов вибрации и барботажа, в процессе извлечения янтаря. В результате исследований установлена необходимая для излечения янтаря плотность среды С = 105-150 гр/л. Также подтверждено положительное влияние использования барботажа и вибрации, что позволило снизить необходимую для извлечения янтаря плотность от 1,5 до 3,2 раз. Установлена возможность эффективной замены дорогостоящей соли для повышения плотности на «голубую глину», залегающую в местах добычи янтаря.*

Ключевые слова: *янтарь, плотность, барботаж, вибрация, соль, глина.*