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FEATURES OF THE CHANGE IN THE PHYSICAL PROPERTIES OF QUARTZ IN ALTERNATING ELECTRIC FIELDS

Abstract. The paper presents the results of experimental work on mechano-chemical activation (MCA) of quartz. MCA was carried out with different duration from 3 to 20 minutes. Polyhydric alcohols were used as catalysts. The magnetic properties of dispersed compositions were measured. It is shown that new properties of quartz with MCA arise due to the processes of the nanoscale of analysis.

Key words: quartz, mechanochemical activation, properties, magnetic permeability, electric effect.

Crystalline quartz has a hexagonal close-packed lattice with parameters a = 4.913A┴ ° and c = 5.405A┴ ° [1-4]. The pronounced anisotropy of properties in different crystallographic planes is used in the electrical industry: piezoelectric element, frequency stabilizers, ultrasonic equipment, etc. When dispersing quartz in conditions of mechanochemical activation (MCA), powders with magnetic properties of [5-8] were obtained. Moreover, the magnetic properties varied depending on the duration of activation, the time of aging. Therefore, it became necessary to study these properties when changing external conditions in order to reveal the mechanism of interaction with the environment [9-15]. Electric fields superimposed on the test sample are selected as external changing factors in static (0.05 V - 5 V) and dynamic modes (frequency 5-5000 Hz). According to N.N. Mofa and V.P. Ryabikin [16-20] In activated quartz, the number of paramagnetic centers varies depending on the milling time, i.e. the duration of the MCA promotes an increase in the magnetic susceptibility of small quartz particles. Therefore, the behavior of these particles, structured by surface-active substances (surfactants) of one nature, but with different structure and density, is of interest. Alcohols are selected as surfactants: one, two and three-atom, i.e. ethanol, ethylene glycol and glycerin.

Methods of research. The actuality of the work is conditioned by a large number of contaminants arising during the production and transportation of oils. For elimination of large volumes of oil waste, appropriate devices have been developed and used, the operation of which is cost-effective at specified volumes. For small-scale contamination, such devices are not available. Hence, there is a need to search for new cost-cutting ways to solve problems associated with the restoration of disturbed soils. In this work we investigate the properties of quartz subjected to MCA.

Figures 1 and 2 show the experimental data on the change in the magnetic permeability of quartz milled during 20 min placed in a variable field of different voltages (0.5, 5 V). For low-energy action (u = = 0.5 V), a change in the magnetic permeability μ was observed as a function of the frequency of the action with maximum values near 30, 50, and 500 Hz, where the amplitude of μ increases with respect to

EXPERIMENTAL PROCEDURE

Quartz activation 20 min

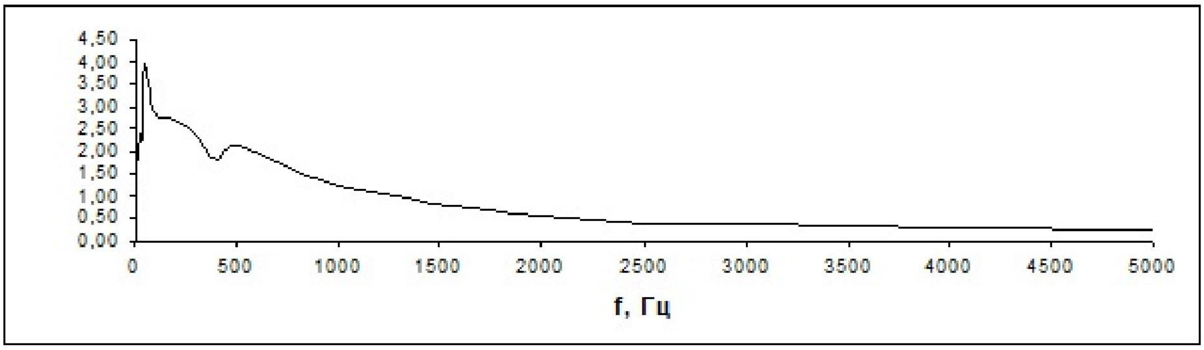


Figure 1 – Change in the magnetic permeability of quartz in variable fields (u = 0,5 V)

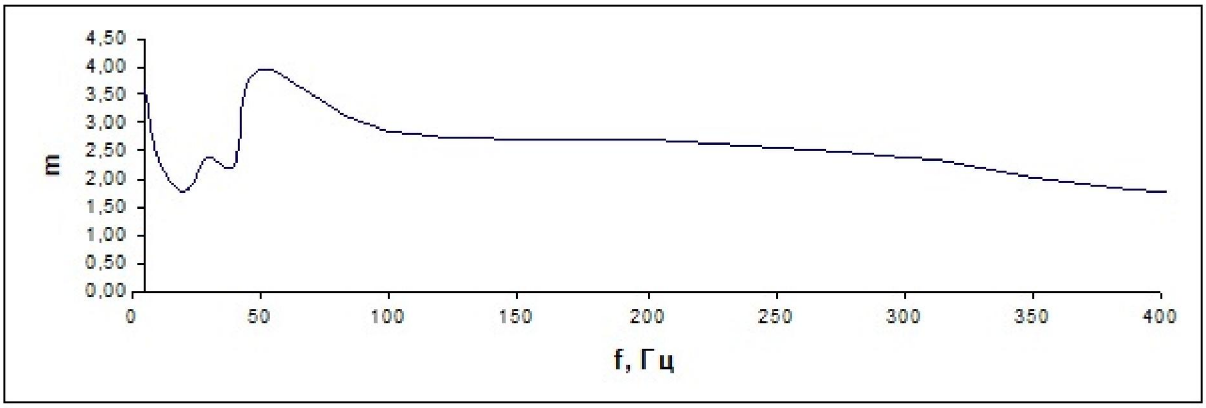


Figure 2 – Change in the magnetic permeability of quartz in variable fields (u = 5 V)

the background to 500-800%. The increase in the impact potential by 10 times (5 V) at the same frequencies showed the reverse effects, i.e. the magnetic permeability decreased sharply at all frequencies, and its maximums were detected near 36, 100 and 300 Hz. These facts indicate a shift in the balance between the electrical and magnetic components of the milled quartz structure.

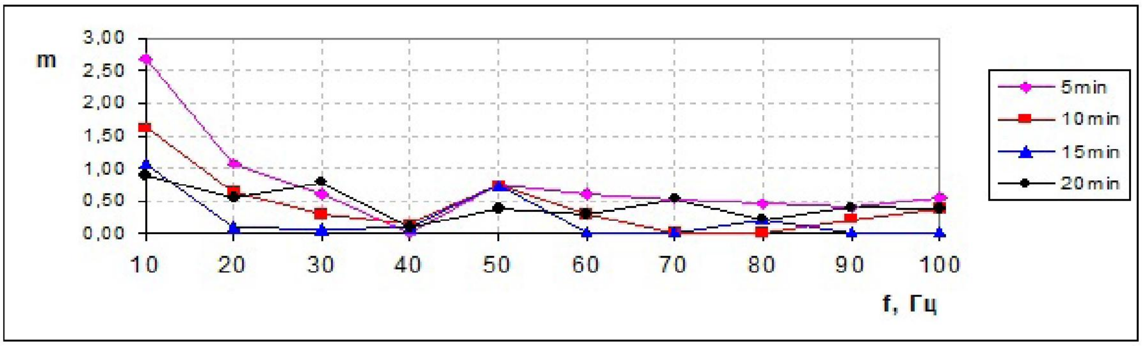
Milling with surfactants (figure 3) leads to an acceleration of MCA and the samples show the maximum values of μ after a 5-minute milling, increase in the milling time leads to a sharp decrease in magnetic activity. All samples have maximum near 10 Hz and 50 Hz, and samples with a minimum MCA time (5 min) show a sharp increase in μ at 400 and 800 Hz. The absolute values of μ range between 0 and 2.7. An increase in voltage in the same experimental conditions up to 5 V (figure 4) leads to a redistribution of the maximums on the frequency scale and a decrease in the absolute values of $0 \leq \mu \leq 0.78$. Here the samples with the maximum MCA time (20 min), which showed maximum at 50, 70, 300÷200, 900 Hz are most active.

A change in the form of surfactant (ethylene glycol) leads to an increase in the absolute values of μ at the extreme points, which are distributed for low-energy effects near 10, 50 Hz. There is also a special maximum near 500 Hz for a sample with T_{MCA}=15 min. The increase in voltage helps to reduce the absolute values of μ, and the maximums arise for samples with a higher activation time near 50, 200 and 900 Hz.

Quartz activated with glycerin shows the highest values of μ, which for a low-energy variable effect are $0 \leq \mu \leq 0.32$, and for u = 5 V $0 \leq \mu \leq 5.4$. Frequency maximums in the first case occur near 10, 50 Hz, and for u = 5 V - near 500 Hz.

Due to the fact that all quartz samples activated in different conditions show maximums near the frequency - 50 Hz, we conducted an additional experiment in which the external action was performed at a frequency of 50 Hz, and the voltage in the range of $0.05 \leq u \leq 5$ V varied. The results of this experiment

Quartz activation 20 min.
Quartz + ethanol 0,5 V



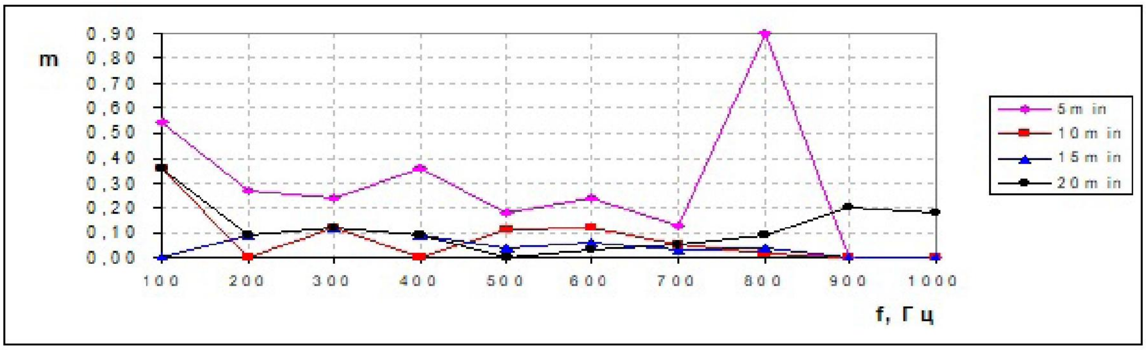
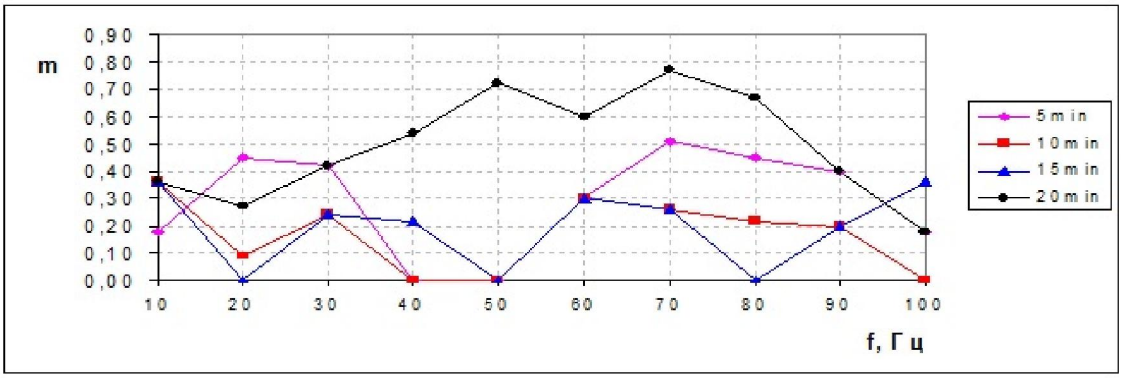
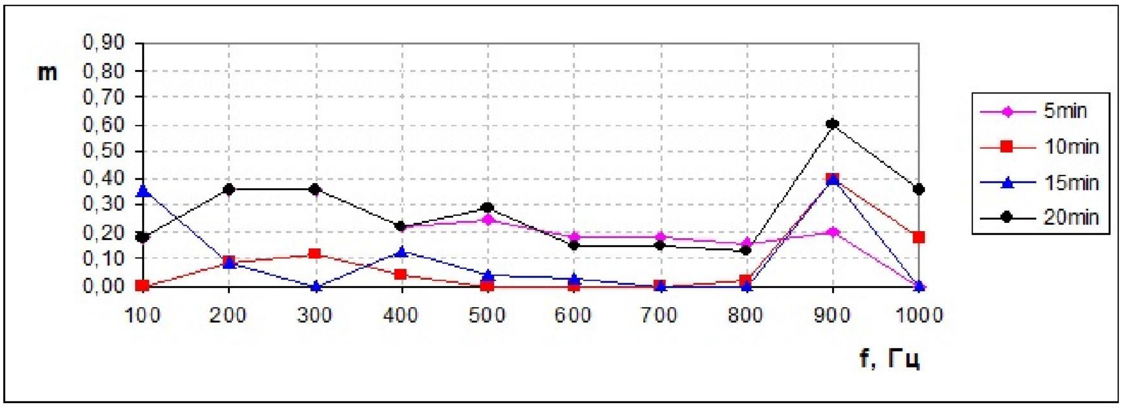


Figure 3 – Magnetic permeability of quartz + ethanol in a low-energy variable field (u = 0,5 V)

Quartz + ethanol





Activation time
Figure 4 – Magnetic permeability of quartz + ethanol in a variable field (u = 5 V)

showed that the highest values of μ correspond to the minimum voltage u = 0.05 V, here: 3.59≤μ≤ 17.93. As voltage increases it can be observed that at this frequency there are abrupt readings near 0.5; 1.0; 3.0 V for samples with surfactant - ethanol. Zero values are observed for samples with 5-minute activation near 5 V, with 15 minutes - near 4.5 V, and 20 minutes - 0.15; 0.25; 0.4 V.

In the same conditions, but with surfactant-ethylene glycol, quartz samples showed the highest μ = 17.93 with a 5-minute MCA. As voltage increases, μ falls as in the previous case, showing jumps near 0.45; 2.5; 3.5 and 4.5 V. Zero values were shown in samples with T_{MCA}=10 min at 0.1; 0.25; 0.3; 0.4 - 1.0 V, with T_{MCA}=15 min: at 0,1 – 0,15; 0,25 – 0,3 V.

The highest magnetic properties showed quartz samples activated with glycerin, here 7.17≤μ≤39.45. With an activation time of 15 minutes, it reaches its limit value and then, as the duration of the MCA increases, begins to decrease. Here we also see jumps in properties near u = 0.5; 1.5-4.5 V. Zero values are only shown by samples with T_{MAX} = 5 min near 0.1; 0.25-0.35, 3-3.5 V.

The presented experimental facts altogether indicate that the behavior of quartz in alternating fields depends both on the frequency and the magnitude of the applied voltage. In order to identify the mechanism of interaction in these conditions, it is necessary to know the algorithm for the correspondence of dynamic attributes of the external field and the form of the dynamic response to this effect. For this purpose, it is necessary to develop a compliance matrix for quartz and the surfactants used.

The obtained experimental data make it possible to make the following conclusions:

1. It is shown that in the MCA process quartz acquires the ability to attract oppositely charged particles, especially of organic origin. This effect is proposed to be used in the liquidation of small-scale oil waste.

2. Mechano-chemical activation of quartz with different milling duration has shown that the achievement of maximum dispersion depends both on the milling time and on the selection of the quality of the catalytic active substances. The optimal mode for conducting an MCA shall be determined experimentally.

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АУЫСПАЛЫ ЭЛЕКТР ӨРІСІНДЕ КВАРЦТЫҢ ФИЗИКАЛЫҚ ҚАСИЕТТЕРІНІҢ ӨЗГЕРУ ЕРЕКШЕЛІКТЕРІ

Аннотация. Жұмыста кварцты механохимиалық белсендіру (МХБ) бойынша жүргізілген эксперименталды жұмыстардың нәтижелері ұсынылды. МХБ әртүрлі ұзақтыпен 3-тен 20 мин аралығында жүргізілді. Катализатор ретінде көп атомды спирттер қолданылды. Ұсақталған композициялардың магниттік қасиеттері өлшенді. Көрсетілгендей, МХБ кезінде кварцтың жаңа қасиеттері нанодеңгейлік процестік қарау есебінен пайда болды.

Түйін сөздер: кварц, механохимиалық белсендіру, қасиеттері, магниттік өтімділік, электр әсері.

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ОСОБЕННОСТИ ИЗМЕНЕНИЯ ФИЗИЧЕСКИХ СВОЙСТВ КВАРЦА В ПЕРЕМЕННЫХ ЭЛЕКТРИЧЕСКИХ ПОЛЯХ

Аннотация. В работе представлены результаты экспериментальных работ по механо-химической активации (МХА) кварца. МХА проводили с разной продолжительностью от 3 до 20 мин. В качестве катализаторов использовали многоатомные спирты. Измерены магнитные свойства диспегированных композиций. Показано, что новые свойства кварца при МХА возникают за счет процессов наноуровня рассмотрения.

Ключевые слова: кварц, механо-химическая активация, свойства, магнитная проницаемость, электрическое воздействие.

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