Section 14. Chemistry

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TESTING BASALT FILTER IN LABORATORY AND INDUSTRIAL CONDITIONS

Abstract. In recent years, requirements for cheap and demanded products from basalt raw materials have been growing. It is directly related to basalt processing industry development, activity and problem solution. In such circumstances, to solve the problem of production, especially those related to the study of the influence of various forces on basalt materials, is very important. This creates conditions for increasing the number of industrial enterprises producing environmentally friendly, high-quality products that will last longer than the existing ones.

Keywords: filter, material, hardness, aerosols, solid residues, basalt materials, filter partition, measures, surface bending, rigidity, separation, weight, residue, basalt filter, raw minerals, container, filtration rate, wet residue, quality ecology.

Water permeability is one of the main properties of basalt fiber material used for the manufacture of filter materials. The coefficient of water permeability ($\text{dm}^3/(\text{m}^2\text{s})$), shows how much water passes through a unit of material area per unit of time with a constant pressure drop on both sides of the basalt fiber filter [1].

Practical permeability is determined experimentally using basalt wool ambassadors stuffing. Pressed basalt crystal-line fibers are commonly called “Basalt wool”. We developed a technique (МВИ ГТМК Л-34.20–39:2010 (Measurement procedures of Navoi Mining and Metallurgy Combinat

Ts-34.20–39: 2010) to determine the filtration rate of pulp (non-homogeneous media) using a filter made of basalt fibers. The features of the filter object are [2–5]:

- comparative high bending stiffness of basalt fiber in comparison with other mineral fibers. Its crystal structure contributes to the creation of mechanical strength, as well as a high coefficient of resilience, the absence of a coefficient of stretching, which favors the formation of an artificial lattice – a type of light mesh that prevents the filter from deflection and thus accelerates the filtering process while trapping large particles;

– in the manufacture of a filtering material from basalt, indiscriminate deposition of fibers is formed on each other,

as a result of which free space is formed between them for the flow of fluid;

Table 1. – Experimental calculated indicators of basalt fiber bending during liquid filtration

Parameters	Theoretical results				Experimental results			
	I	II	III	IV	I	II	III	IV
Fluid pressure, kg/mm ²	30	60	90	120	30	60	90	120
Average diameter of the filter, mm	120	120	120	120	120	120	120	120
Average filter thickness, mm	10	10	10	10	10	10	10	10
Average bend, mm	1.43	3.4	5.76	10	1.51	3.8	6.1	10.5
Average pressing force of basalt fibers for filters, kN	18	18	18	18	18	18	18	18

– lack of hygroscopicity and swelling, as well as maintaining a constant porosity of basalt fibers, counteracts the formation of precipitates in the path of flow of the liquid mass through the filter, at any filtration rate, thereby ensuring high performance;

– the pulp precipitates (inhomogeneous media) remaining on the filter surface are easily removed by washing from the filter surface, which creates conditions for filter reuse in subsequent filtration. In fig. 1 and in table. 1 shows laboratory experimental installations for filtering slurries using single and multiple filter materials.

Depending on the purpose, various types of filtering materials can be produced that best suit the needs of the mining and metallurgical industry in the best way. When pressing in and making filtering materials, various pressing forces can be used. They vary depending on specific technical needs: hardening, stabilization, etc. Good chemical resistance of filter materials expands the scope of this material.

Filtration is carried out under vacuum on a Buchner funnel, where an arbitrarily selected volume of the non-homogeneous

medium is equal to 5 l. The pulp is passed in one case through the “Traditional filter”, in the other case through the “Traditional filter” with the “Basalt Wool” filter placed on top (with the layers of planes slightly shifted, $h = 5$ mm).

Measurements are performed in accordance with the instructions for the technical operation of filtration materials and under normal climatic conditions (GOST 15150–69): ambient temperature $t = 25(\pm 10)$ °C, relative humidity $45 \div 80\%$ and atmospheric pressure $630 \div 740$ mmHg and regulatory documents [6–7].

The results are presented in (Table 2). Filtration is carried out at a constant vacuum, using the “Basalt wool” filter, while the filtration rate is accelerated by 1.8 times. Processing the measurement results consists in registering the time on the stopwatch and comparing the result with filtering results and through a paper filter with an estimate of measurement uncertainty, as shown in the (table 3).

In developing this methodology, we followed the Regulatory Documents [7–8].

Figure 1. Experimental plant for the combined filtration: a) filtration using a paper filter – “traditional filtering material”; b) combined filtration using “Basalt wool + traditional filtering material” filters; 1 – Basalt wool filter; 2 – “traditional filtering material” filter

Table 2. – Experiment results

Filter name	Filtration time, τ , min			Mean time, min
“Traditional filter”	47	45	43	45
“Basalt wool” + “traditional filter”	25	27	23	25

One of the important areas for solving problems of filtering gold-bearing pulp in the mining and metallurgical industry and solving environmental problems is the use of filters to improve labor productivity, reduce process costs, and also to eliminate harmful emissions to the atmosphere and the aquatic environment as much as possible.

This direction is of great interest for the manufacture of filters from natural basalt fiber (NBF), obtained from raw materials of domestic basalt deposits. This choice is explained by the fact that basalt is an environmentally friendly product of nature, it has a high natural chemical and thermal resistance.

As one of the most important functions of a basalt filter, one can note the high thermal resistance of its material, i.e. basalt fibers that open up unlimited possibilities of this breed.

Thus, the fundamental proof of the filtering ability of basalt materials are the results of a preliminary check of the basalt filter when filtering the gold-containing pulp of the metal-mining plant Mining and Metallurgy Factory-1 of the State Enterprise Navoi Mining and Metallurgy Combinat.

A preliminary study of the filtering capabilities of basalt materials made of basalt fibers showed their relatively high stability when filtering gold-bearing pulp for a long time (stability during repeated alternate freezing and thawing, wetting and drying, as well as resistance to long-term atmospheric effects were not tested). Filtration of gold-containing pulp was checked on the existing filters "traditional filter material" and on the filter material "Basalt wool".

The study was conducted according to the following scheme:

- preparations;
- conducting an experiment to test the performance of each type of filter;
- conducting an experiment to test the performance of the combined filter;
- accounting of the results of the experiment;

At the first stage of the study, three samples of each filter were prepared: three filters – "traditional filtering material" and three filters from the material "Basalt wool".

Three vessels of volume 1, 3 and 5 l. Gold-bearing pulp was also prepared in the appropriate volume, which contained crushed ore mixed with water, acid and cyanides. Checked the operation of the stopwatch. In this case, the density $\rho = 2.65 \text{ g/sm}^3$ and solid to liquid ratio – 1:2.83. During the experiment, the allowable temperature, pressure, humidity of the room air and illumination were provided.

The performed experiment was conducted in accordance with GOST 7076–79. At the second stage of the experiment, one filter was installed in the throat of vessels with a capacity of 1 l, as shown in fig. 1 a and b. The duration of the whole filtration process for pulp of 1 l. was recorded. At the end of the filtration, the data were recorded in the log. Similarly, the experiment was carried out on 3 and 5 liter vessels.

All indicators of the experimental study on the filtration of gold-bearing pulp on the existing filters "Traditional filter material" and on the filter material "Basalt wool" were recorded in a journal.

As a result of an experimental study on the filtration of gold-containing pulp using the filters "Traditional filter material" and "Basalt wool" it has been established:

- in contrast to the filter made from the material "Basalt wool" in the filtering process of gold-bearing pulp on the filter "Traditional filter material" external intervention is required, which is due to the fact that when the accumulation of pulp particles on the surface of the filter material is necessary to mix them, in order to accelerate the passage liquid medium;
- found a very low mechanical strength "Traditional filter material" compared to basalt material, the strength of which is created as a result of pressing basalt fibers and the formation of wool due to indiscriminate occurrence of crystalline fibers on each other in the process of forming an artificial lattice;
- the technology of using the filter "Traditional filter material" includes the treatment consisting of soaking and processing the filter material with distilled water, which is not necessary when using the material "Basalt wool".

Table 3. – The results of the experiment on filtration of the pulp using filter materials "traditional filter materials" and "basalt wool"

Parameters of sample filters	Filter material name								
	Traditional filter material			Basalt wool			Combined		
	I	II	III	I	II	III	I	II	III
Diameter and thickness of filter, D × B, sm	12.5–0.4	12.5–0.4	12.5–0.4	13–1.5	13–1.5	13–1.5	13–1.5 12.5–0.4	13–1.5 12.5–0.4	13–1.5 12.5–0.4
Volume of gold-bearing pulp, l	1	3	5	1	3	5	1	3	5
Filtration time, min	10	35.4	55	5,3	25.8	39.7	9	18	27
Price of 1 filter (at the price of 2014)	60	60	60	40	40	40	100	100	100

At the third stage, the operability of the combined filter was studied, including filters from the materials “Basalt wool” and “Traditional filtering materials”. The installation of the combined filter in the vessel was illustrated.

1, b. Recorded filtration time on each vessel volumes of 1, 3 and 5 l. As in the previous stages of the experiment, all significant indicators of the study were recorded in a journal. All data obtained as a result of studying the process of filtering inhomogeneous media in laboratory and industrial conditions were merged and listed in (Table 3). In the experiment, the used filter materials “Basalt wool” were pre-dried with the preservation of the corresponding geometric parameters.

Under laboratory conditions, it was established experimentally that the use of a basalt filter when filtering inhomogeneous media with a volume of 1 l, compared with the “traditional filtering material”, reduced the filtration time by 1.1 times, the volume of 3 l – by 1.9 times and the volume of 5 l – by 2 times. Curves of changes in filtration time when using different types of filter materials are shown in (Fig. 2)

Throughout the experimental investigation of filtration through the samples under study, the vacuum remained constant. The use of a filter consisting of the following was effective: “Traditional filter media” + “Basalt wool” while maintaining the existing degree of purification of the liquid medium, where the filtration rate of non-homogeneous media is accelerated by about 1.8 times. The use of the “Basalt wool” filtering mate-

rial up to the “Traditional filtering material” filter layer made it possible to eliminate accumulations of large particles of impurities on the surface of the current filter, which previously delayed cleaning the liquid phase from precipitation. From the data table. 1 shows that the filter made of natural basalt fiber is cheaper. High efficiency of application as a filtering material “Basalt wool” and in the combined method “Traditional filtering material” + “Basalt wool” proved that basalt fiber material has good prospects. Particularly noteworthy are the positive filtering indicators of such materials, which are far superior to the materials of existing filters used to filter gold-bearing pulp. The latest indicators give good recommendations for using the Basalt wool filter material for filtering inhomogeneous media.

In the process of researching the performance of basalt filter material, the priority application of the Basalt wool filter has been proved, which has the following properties:

- well retains solid particles of the suspension;
- has sufficient hydraulic resistance to filtrate flow;
- easily separated from the sediment suspension;
- resistant to chemical effects of the substances to be separated;
- does not swell in contact with the liquid phase of the suspension and leaching fluid;
- has sufficient mechanical strength;
- heat resistant at filtration temperature.

Figure 2. Diagram of filtering time when using different types of filter materials

Thus, as a result of analyzing the filtering ability of gold-bearing pulp on the existing “Traditional filtering material” filter and using it in combination with the Basalt wool filter, the expediency of using the latter for filtering inhomogeneous media was revealed. When using “Basalt wool” as a filtering material for filtering inhomogeneous media, the use of local raw materials is expanded and the cost of filtering is reduced.

Based on the results of the study of the technical feasibility of the Basalt Cotton filters, their use in hydro-metallurgy for pulp dehydration can be recommended, as well as the possibility of using recycled water (filtrate) in a closed cycle of the technological process.

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