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STUDYING THE FILTRATION CHARACTERISTICS OF THE WHITE EARTH

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The spent bleaching earths are separated from the bleached oil by filtration, most often on lamellar filters [1]. In this case, filtration is carried out through a layer of sediment, which is washed onto filter elements (plates), the working surface of which is a fine mesh. The filtration characteristics of the adsorbent, when filtering liquids through a layer of sediment, are determined by the dispersion, porosity, shape and compressibility of the particles [2].

During the filtration process, as a result of layer compaction in the presence of small fractions in it, the resistance of the sediment layer can increase several times. The magnitude of the increase in resistance depends on the mechanical properties of the adsorbents, as well as on the design of the filter and its operation modes [3,4].

It is known that the filtration rate depends on a number of factors:
- the driving force of the filtration process, that is, the pressure difference across the partition;
- thickness of the sediment layer on the filter;
- structure of the filtering partition;
- sediment structure;
- viscosity of the filtrate.

The relationship between the parameters that affect the filtration process, the filtration equation will have the form

$$\frac{\Delta V}{\Delta \tau} = \frac{\Delta P}{R} \qquad (1)$$

Where ΔV - is the volume of the filtrate passing through 1 m^2 of the filter surface, (m^3/m^2);
$\Delta \tau$ - is the duration of the process, s;
ΔP - pressure difference, Pa;
R - is the filtration resistance, Pa (s/m).

Filtration resistance R is the sum of the sediment resistance $R_{s.r}$ and the filtering baffle resistance $R_{f.r.}$, i.e.

$$R = R_{s.r} + R_{f.r} \qquad (2)$$

Since the sediment resistance is proportional to the amount of sediment deposited, and therefore proportional to the amount of filtrate, then

$$R_{s.r} = K' \cdot V \qquad (3)$$

where K' - is the coefficient of proportionality.

The resistance of the filtering baffle can be replaced by the resistance of the sediment layer, which has the same resistance to filtration as the baffle, and expressed by the corresponding amount of filtrate C, (m^3/m^2), i.e.

$$R_{f.r.} = K' \cdot C \qquad (4)$$

Then

$$R = K' \cdot (V + C) \qquad (5)$$

After substituting the obtained value of R into the equation, separating the variables and integrating it, the equation becomes

$$V^2 + 2 \cdot V \cdot C = K \cdot \tau \qquad (6)$$

where K and C are filtering constants.

Filtration constants were determined experimentally by separating the studied model suspension of bleaching earths on a filter at a constant pressure drop Δp.

The constant K characterizes the mode of the filtration process (at Δp = const), as well as the physical properties of the sediment and liquid, and the constant C is the hydraulic resistance of the filtering partition.

To determine the resistivity of the sediment, the thickness of the sediment layer on the filter wall, as well as the ratio of the volume of sediment to the volume of the filtrate, an experiment was carried out, the purpose of which was to determine the comparative characteristics of bentonite and diatomite bleaching earths

Therefore, in order to avoid the influence of sorbed substances on the filtration characteristics of bleaching earths, suspensions of bleaching earths in cotton refined deodorized oil with a concentration of 0.5% were used as a model, which corresponds to the average value of the adsorbent concentration in bleached cotton oil.

The filtration process was carried out at a constant pressure drop of 970 mbar and a constant temperature of 80°C through a filter mesh with a mesh size of 10 μm. Thus, from the quantities included in equation 1, the variables were the volume of the filtrate and the filtration time.

During the experiment, the volume of the filtrate obtained over a certain period of time was determined. The research results are shown in table 1.

Table 1 - Filtration time (τ_c) and filtrate volume (V_c) for one cycle

Characteristic name	Characteristic value for bleaching earth			
	Diatomite	Bentonite:		
		Sample 1	Sample 2	Sample 3
Filtrate volume per cycle filtration, m^3/m^2	0,19	0,20	0,18	0,17
Duration filtering, with	1800	1800	2000	1945

The value of the coefficient C, which characterizes the hydraulic resistance of the partition, was calculated by the formula

$$C = \frac{В \times К}{2} \qquad (7)$$

The filtering constants obtained experimentally and calculated are presented in Table 2.

Table 2 - Filtering constant

Constant notation	Value of filtration constant for bleaching earth			
	Diatomite	Bentonite:		
		Sample 1	Sample 2	Sample 3
К	3,0	3,2	2,8	2,6
C	1600	1920	1680	1560

As follows from the data in Tables 1 and 2, diatomite bleaching earth is comparable in its filtration characteristics to bentonite bleaching earths.

As mentioned above, the separation of the bleaching earth is carried out by filtration on vertical sheet (plate) filters. The distance between the plates, depending on the design of the filter, is from 50 to 70 mm. The sediment is thrown off the plates with a vibrator and removed from the filter housing through the bottom hopper. In this regard, for unhindered removal of sediment, its thickness on the plate at the end of the filtration cycle should not exceed 20 mm.

Since the bulk density of diatomite bleaching earth is from 350 to 370 kg/m^3, which is less than the bulk density of bentonite bleaching earth (500-600 kg/m^3), it is logical to assume that the height of the sediment layer of diatomite bleaching earth when filtering the same volumes of filtrate can be greater than the height of the bentonite bleaching earth sediment layer, which can lead to a decrease in the calculated leachate volume per cycle

To compare the height of the sediment layer formed on the filter during the filtration of bentonite and diatomite bleaching earths, the following experiment was carried out.

A suspension of adsorbents in deodorized oil with a concentration of 5% was filtered in an amount of 0.2 m^3/m^2 at a pressure drop of 970 mbar and a temperature of 80°C. At the end of the filtration cycle, the height of the sediment layer was measured. The results of the experiment are presented in table 3.

Table 3 - The height of the sediment layer during filtration 23.8 m^3/m^2

Sample name	Indicator value
	Sediment layer height ($h_{s.r}$), mm
Diatomite bleaching earth	8,3
Bentonite bleaching earth:	
Sample 1	7,1
Sample 2	6,8
Sample 3	6,9

As can be seen from the presented data, the height of the sediment layer $h_{s.r}$, diatomite bleaching earth exceeds the height of the sediment layer of bentonite bleaching earths by no more than 15%, which will not affect the previously calculated time of one filtration cycle.

Thus, from the data obtained, it can be seen that the duration of one filtration cycle using diatomite bleaching earth is similar to the duration of the process using bentonite bleaching earth. The volume of the filtrate after separation from the diatomite bleaching earth will correspond to the previously theoretically calculated value and will be 0.19 m^3/m^2. In this case, the height of the sediment layer on the plate at the end of the filtration cycle will not exceed the maximum allowable value (20 mm).

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