EXPERIMENT 4
ROTARY VACUUM-DRUM FILTER
(High pressure filters)

I. Introduction

Filtration is the process of separating the suspension into filtered water and residue. During the filtration process, it is necessary to create a pressure difference on the sides of the filter surface baffle. Currently, the following methods are used to create pressure differences on both sides of the filter surface baffle (the baffle consists of the filter fabric and the residue is created on the filter fabric surface):

- Vacuum on one side of the filter surface
- Compress the suspension by pressure generated by a pump
- Use a liquid column to create a pressure difference.

The productivity of any filter depends on the filter operation (pressure, temperature) on the characteristics of the filter fabric and on the physical and chemical properties of the residue. The liquid moves through the residue layer, the filter cloth at a very small speed and according to Poa-zen, the filtration process can follow the following equation:

$$\Delta P = \frac{32.\mu.l.v}{d^2} \qquad (1)$$

ΔP - pressure difference (dynamic) of the filtration process, N/m^2;

μ - liquid viscosity, $N.s/m^2$;

l - capillary tube length, m;

d - capillary tube diameter, m;

v - velocity in the capillary tube, m/s.

The amount of filtered water collected during the working time τ of the filter by:

$$V_1 = V.F.\tau \qquad (2)$$

F: filter surface

For simplicity in the calculation process, people often use the filter capacity of one square meter of filter surface V and we can represent the filter equation according to the equation:

$$\frac{dV}{d\tau} = \frac{\Delta P}{R_1} \qquad (3)$$

R_1 The resistance of the filter including resistance of residue R_b and fabric resistance R_v :

$$R_1 = R_b + R_V \qquad (4)$$

The resistance of the residue layer is proportional to the amount of clean filtered water passing through that layer:

$$R_b = K^{'}.V$$

The resistance of the filter fabric is considered as the resistance of the filter. If to form a residue layer with resistance equivalent to R0, there must be V0 of filtered water to pass through:

$$R_v = K^{'}.V_0$$

K - Ratio coefficient

$$R_1 = K.(V + V_0) \qquad (5)$$

From equations (3) and (5) we can write the following filter equation:

$$V^2 + 2.V.V_0 = K.\tau \qquad (6)$$

$K = \dfrac{2\Delta P}{K'}$ - filtration constant characterizing the resistance of the residue layer

τ - Filtering time, minutes

If we know K and V0, we can determine the required filter surface when given filter capacity. The above filter constants are very complex and can only be determined by experimental way.

After differentiating the equation (6) according to V we have the form:

$$\frac{d\tau}{dV} = \frac{2V}{K} + \frac{2V_0}{K}$$

Or $\dfrac{\Delta\tau}{\Delta V} = \dfrac{2V}{K} + \dfrac{2V_0}{K} = AV + B$ (7)

Equation (7) is a straight line equation whose angle is inclined to the horizontal α with $tg\alpha = \dfrac{2}{K}$ and intersects the vertical axis at a point of intersection $B = \dfrac{2.V_0}{K}$

Δτ and ΔV are the increment of filtration time and the volume of purified water.

To determine filtration constants K and V0 we conduct filtration experiments with constant pressure.

During filtration, after working time τ_1, τ_2, τ_3..., τ_n, We get the corresponding amount of filtered water: V_1, V_2, V_3,..., Vn. Gia số của $\Delta\tau_1 = \tau_1$, $\Delta\tau_2$, $= \tau_2 - \tau_1$,

$\Delta\tau_3 = \tau_3 - \tau_2$..., $\Delta\tau_n = \tau_n - \tau_{n-1}$ and $\Delta V_1 = V_1$, $\Delta V_2 = V_2 - V_1$, $\Delta V_3 = V_3 - V_2$,...., $\Delta V_n = V_n – V_{n-1}$.

Calculate the ratio:

$$\frac{\Delta\tau_1}{\Delta V_1}, \frac{\Delta\tau_2}{\Delta V_2}, ..., \frac{\Delta\tau_n}{\Delta V_n}$$

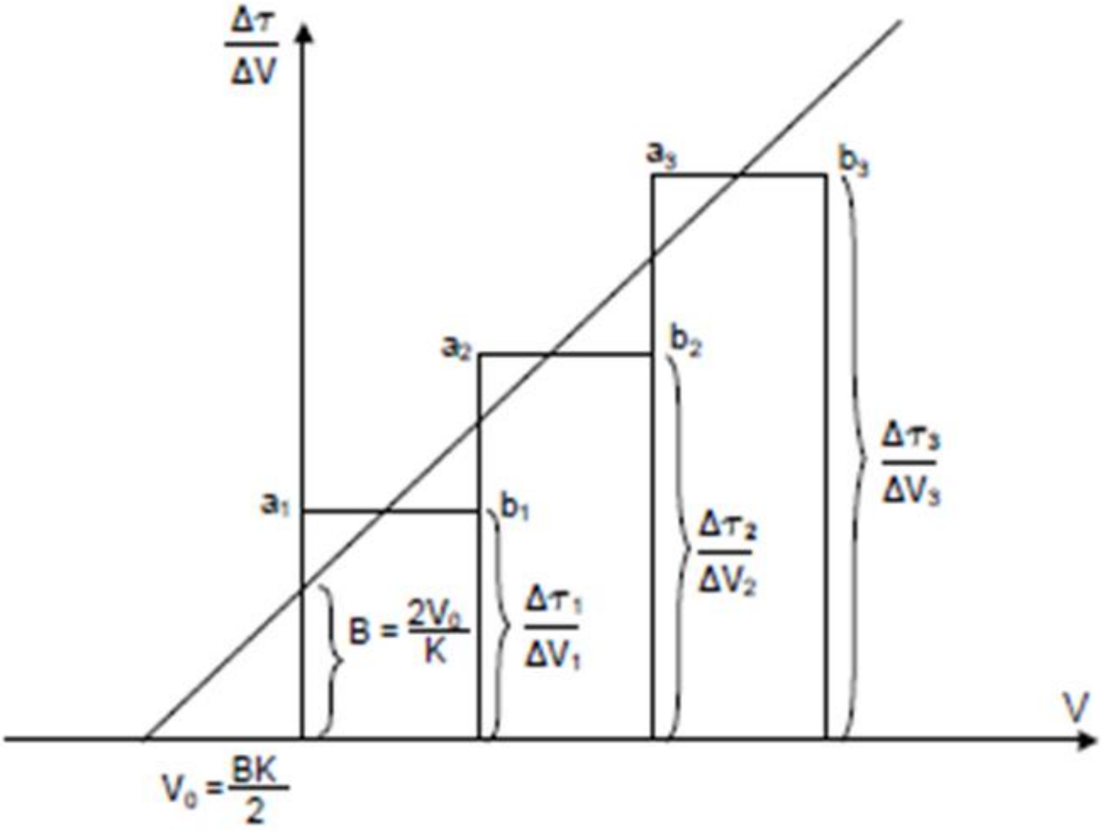

Figure 1. *The chart for determining the filter constants*

II. EXPERIMENT PURPOSE:

1. Learn how rotary barrel vacuum filters and high-pressure filters work.
2. Determination of filtration constants K and Vo and productivity of high-pressure filters.

III. EXPERIMENT DIAGRAM:

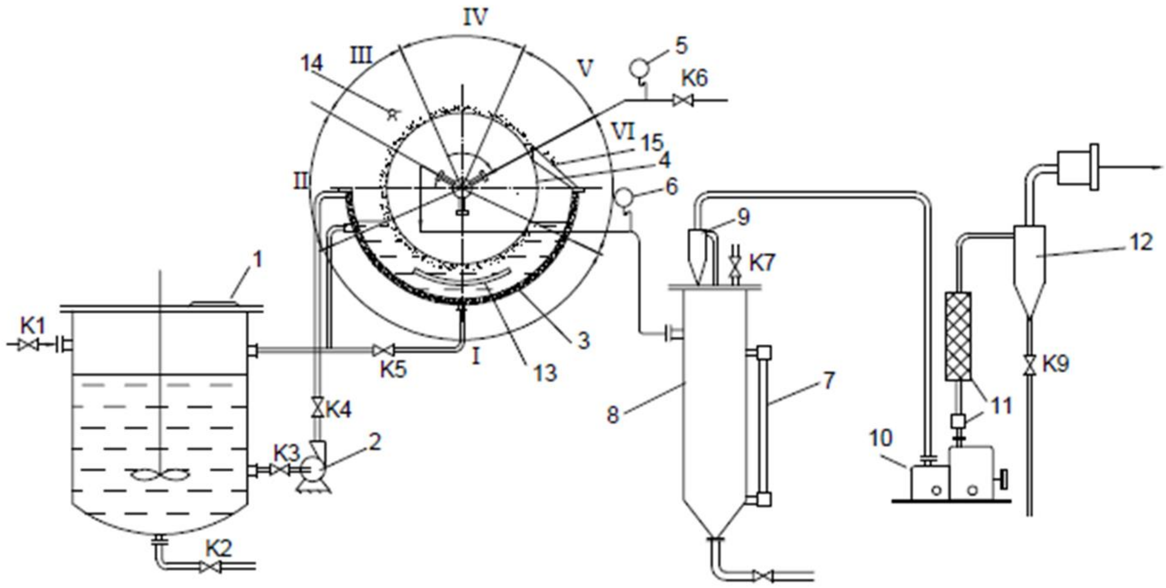

Figure 2. *Diagram of rotary barrel vacuum filter*

Figure 3. Diagram of high-pressure filter

The filter surface area of the high-pressure filter is 0.1 m2

III. Experiment steps:

1) Check the experiment system, state of the valves and suspension tank
2) Supply water and suspension to the suspension tank
3) Turn on the paddle of the suspension tank
4) Open the vent valves from the suspension tank to the filter tank, the clear water valve after the filter, close the bottom drain valve from the filter tank to the suspension tank.
5) Open the air release valve of the filter tank
6) Turn on the pump to transfer the suspension to the filter tank, wait until there is water overflowing from the filter tank to the suspension tank, then close the pressure valve.

7) Adjust the filter pressure with the overflow valve, and the connection valve from the suspension tank and the filter tank

8) Determine the amount of filtered water obtained (1 liter or 2 liters), and measure the time it takes to obtain that filtered water. During the measurement, it is necessary to control the constant filter pressure

9) After filtration, it is necessary to wash the filter surface by pumping clean water in the opposite direction from the filter direction.

10) Proceed with further filtration (if necessary), and the corresponding filter fabric washing process.

VI. ANALYSIS AND CALCULATION OF EXPERIMENT DATA

1. The amount of filtered water per unit of filter surface:

$$V_i = \frac{Q_i}{F} \quad , \quad l/m^2 \quad (8)$$

Where :

V_i - the amount of filtered water obtained per unit of filter surface in experiment i.

Q_i - The amount of filtered water obtained in the "i" experiment corresponds to time "i".

"i" - is the experimental number, i = 1 - 10.

F - filter surface.

So the differential of the volume of filtered water is: $\Delta V = V_{(i+1)} - V_i$

2. Filtering time is determined by the equation:

$$\tau'_i = a.\tau_i \qquad (9)$$

Where:

a - coefficient of using the filter surface; is equal to the ratio between the filter surface and the general surface of the tank; for high pressure filters a=1.

τ'_i - filtration time of experiment " i' "

τ_i - time experiment "i".

So the variation of time is: $\Delta\tau' = \tau_{i+1}' - \tau_i'$

No.	The amount of filtered water Q (l)	Time (minute)	Time (minute) $\tau' = a.\tau$	$\Delta\tau'$	The amount of filtered water with one unit of filtration surface V (l/m^2)	ΔV	$\frac{\Delta\tau'}{\Delta V}$
1							
2							
3							
4							
5							

From the data in the table above, we draw graphs to determine K and V0 as well as filter capacity (draw separately and attached).

3. Conclusion