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DETERMINING THE DEPENDENCE OF THE VALUE OF THE EXCHANGE CAPACIT--ETC(U)
AUG 78 A A GROMOGLASOV, Z P KOLPAKCHIYEV

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FOREIGN TECHNOLOGY DIVISION

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By

A. A. Gromoglasov, and Z. P. Kolpakchiyev

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В в	*В в*	V, v	Т т	*Т т*	T, t
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Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
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И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
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К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

1251

DETERMINING THE DEPENDENCE OF THE VALUE OF THE EXCHANGE CAPACITY OF ION-EXCHANGE FILTERS ON THE GRAIN DIAMETER OF THE ION EXCHANGERS

A. A. Gromoglasov, Cand. Tech. Sci., Docent, and Z. P. Kolpakchiyev, Grad. Stud.

The effect of the ion exchanger grain diameter on the form of the output curve of the ion-exchange filter is of interest in certain water treatment situations. The process of ionization in combined-action filters, which are comprised of a specific fraction of ion exchangers, is an example of such a case. The problem of the effect of the ion exchanger grain diameter on the form of the output curve can be solved by the method described in [1].

When ion-exchange filters are used for treating auxiliary water for steam generators or for cleaning turbine condensers, the content

of impurities in the water is insignificant, and the ion exchange isotherms are convex. These conditions make it possible to assume that the parallel transfer of the filtering front takes place in the ionization process, while the kinetics of the process are determined by the kinetics of external diffusion.

In this case, the solution of the system of differential equations describing the ion exchange process leads to the expression [1]:

$$T_0 = A \cdot t_0 = -\left(\ln \frac{C}{C_0} + 1\right), \qquad (1)$$

where T_0 is a dimensionless value which determines the ionization process. This value can be represented in the form of an exponential dependence on the conditions under which the process is carried out

$$T_0 = \gamma \cdot u^{\nu} d^{\varepsilon} C_0^{\delta} \cdot t_0, \qquad (2)$$

where u is the filtration rate, d is the ion exchanger grain diameter, C_0 is the initial concentration of the solution, γ is the coefficient which determines the properties of the ion exchanger-solution system, and ν, ε, α and δ are the exponents which reflect the effect of the change in the corresponding conditions of carrying out the process.

If two ionization processes are carried out under conditions which differ only by one parameter, e.g., d, in accordance with equation (2) and the definition of value T_0, we can obtain

$$\frac{t_{0,1}}{t_{0,2}} = \left(\frac{d_2}{d_1}\right)^{\varepsilon}. \qquad (3)$$

Thus, by conducting two tests on the ionization of water with different values of the ion exchanger grain diameters, we can calculate the value of the exponent ε, which can be used in calculating the output curves of ion-exchange filters using N. A. Shilov's equation

$$t = \beta x - t_0. \qquad (4)$$

The value of β in this equation can be found from the known formula

$$\beta = \frac{q_0}{u \cdot C_0}, \qquad (5)$$

where q_0 is the value of the total exchange capacity of the ion exchanger. Equation (5) can only be used when the value of q_0 does not depend on the surface area of the ion exchanger (the ion exchanger works by volume); when the value of q_0 depends on the ion exchanger surface area, the equation

$$\beta = \frac{q \cdot S \cdot q'_0}{u \cdot C_0} = k \cdot d^{-1},$$

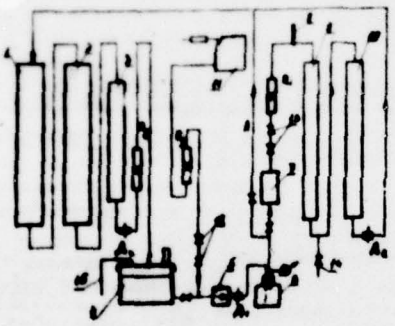
should be used to calculate β, where q is the bulk weight of the ion exchanger, S is its specific surface area, and q'_0 is the value of the total exchange capacity, expressed in mg-equ./cm².

The presence of the dependence of parameter β on the grain diameter of the ion exchanger can be established in the above two tests, from the results of which it is also easy to find the value of

K.

We conducted a series of tests on the ionization of a sodium chloride solution in order to determine the value of ξ. The tests were conducted on the device diagrammed in Fig. 1. Pure water brought from tank 4 by means of a gear-type pump was mixed in a specific ratio with an NaCl solution. The quantity of NaCl solution was dispensed by pinchcocks 12 depending on the readings of the salinometer with with sensor D_1. The flow rate of the sodium chloride solution was monitored by rotameter R_3. Part of the solution passed through thermostat 7, where it was heated to 30°C, and rotameter R_1 - for establishing the required filtration rate - and arrived at the experimental filter 9, which was charged with either a cationite or an anionite. When the experimental filter was charged with an anionite, the cationite was charged into filter 10, and vice versa. Thus, it was possible to follow the depletion of filter 9 by the salinometer with the sensor D_2 and to uniformly distribute samples taken from point 14. Then the water went to the purification assembly, consisting of three filters 1, 2 and 3 (cationite, anionite, and mixed, respectively); its purity was monitored by the salinometer with sensor D_3, and its quantity - by rotameter R_2 - and it was poured back into tank 4. Pure nitrogen was blown over the free space in the tank above the water in order to insulate it from the atmosphere. Equalizing container 6 with a manometer was located behind the pump.

Fig. 1. Diagram of device for determining the value of E: 1 - cationite filter; 2 - anionite filter; 3 - combination filter; 4 - tank; 5 - gear-type pump; 6 - equalizing container with manometer; 7 - thermostat; 8 - thermometer; 9 - experimental filter (cationite, anionite); 10 - filter (anionite, cationite); 11 - tank with NaCl solution; 12, 13 - pinchcocks; 14 - sampling pinchcocks; 15 - water supply line; R_1, R_2, R_3 - rotameters; D_1, D_2, D_3 - salinometer sensors.



All of the filters and tanks of the assembly were made of plexiglas or polyvinyl chloride. The diameter of the experimental filter was 14 mm.

The pinions of pump 5 were made of alloyed steel; therefore, iron in a quantity of 160 μk/l appeared in the water after the pump.

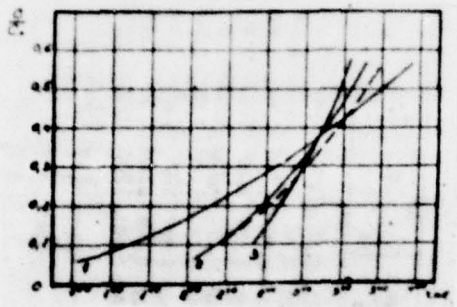
The output curves of the ionization of NaCl solutions on

high-acid cationite Wofatit KPS and high-base anionite Wofatit SBW at an initial NaCl solution concentration of $2 \cdot 10^{-3}$n, filtration rate of 50 m/h, and different grain diameters were registered on the assembly. The ion exchangers underwent preliminary regeneration according to [2].

The ion exchangers were fractionated as follows. The swollen ion exchangers were dispersed on screens by a large quantity of pure water. The resin remaining on the screen was carefully washed by a backward jet of water. The ion exchanger grains held in the holes in the screen were removed by a soft brush and were collected as a separate fraction. The sizes of 150-200 particles were measured with a measuring lens in order to determine the precise size of the fraction. The particle diameters did not differ by more than 5-6 hundredths of a millimeter from each other. The mean arithmetic value of all the measurements was used for the calculations. Thus, three fractions of 1.0, 0.6 and 0.4 mm were selected for the cationite, and for the anionite - 0.97, 0.58 and 0.39 mm.

The concentration of Na ions in the filtrate was determined on a flame photometer, and of chlorine - with diphenylcarbazone. Figure 2 shows the results of the tests with the cationite.

Fig. 2. Output curves of cationite. Filtration rate - 50 m/h: 1 - grain size - 1.0 mm; 2 - grain size - 0.6 mm; 3 - grain size 0.4 mm. The broken line shows the calculated curve.



The results of calculating coefficient $\mathcal{E}$ are given in Table 1. Coefficient $\mathcal{E}$ was calculated for nine values of the relative concentration for each pair of curves. After this, the points were plotted on millimeter paper and the "mean weighted" value of all the points was determined.

The height of the layer and the speed of the front, calculated for point $C/C_0 = 0.37$ according to the results of the three tests with the cationite, are given in Table 2.

Table 1. KEY: (1) h.

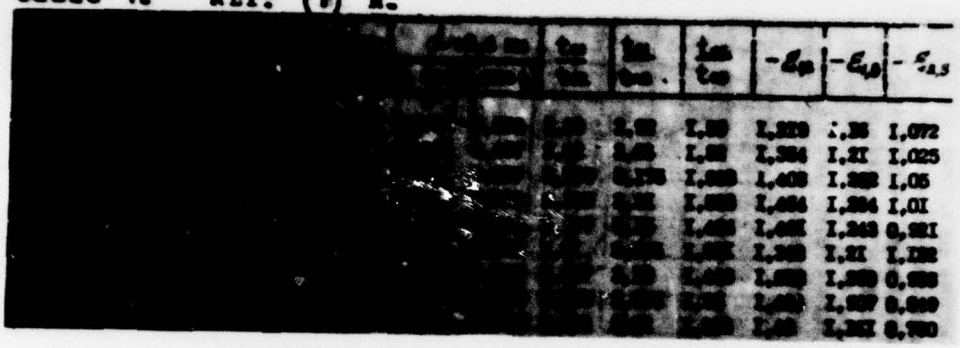
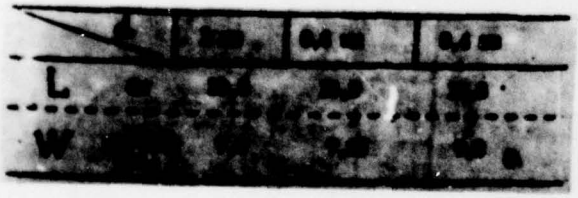


Table 2. KEY: (1) cm/h.



The value of ε calculated from Table 1 is $\varepsilon = -1.2$.

The output curves for the anicnite are shcwn in Fig. 3. The experimental data and results of the calculatien of ε for the anionite are given in Tables 3 and 4.

Fig. 3. Output curves of anionite. Filtration rate - 50 m/h. 1 - grain size - 0.97 mm; 2 - grain size - 0.58 mm; 3 - grain size - 0.39 mm. The broken line shows the calculated curve.

Table 3. KEY: (1) h.

$\frac{d}{C_0}$	d = 0,97 мм		d = 0,58 мм		d = 0,39 мм		$\frac{t_{01}}{t_{02}}$	$\frac{t_{01}}{t_{03}}$	$\frac{t_{02}}{t_{03}}$	$-\varepsilon_{1,2}$	$-\varepsilon_{1,3}$	$-\varepsilon_{2,3}$
	[illegible]	[illegible] (1)	[illegible] (1)	[illegible] (1)	[illegible] (1)	[illegible] (1)						
0,I	[illegible]	[illegible]	I,42	0,234	I,I38	0,0986	I,676	3,04	I,75	I,I03	I,5	I,39
[illegible]	[illegible]	[illegible]	I,495	0,I59	I,I83	0,0737	I,82	3,9	I,8	I,I8	I,49	I,45
[illegible]	[illegible]	[illegible]	I,946	0,I09	I,I76	0,052I	I,9I2	4,0	I,72	I,I76	I,52	I,34
[illegible]	2,II	[illegible]	[illegible]	0,07I	I,I94	0,0337	I,95	4,II	2,I06	I,3I7	I,55	I,9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	I,207	0,0205	I,97	3,74	I,90	I,336	I,5	I,59
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	I,22I	0,0086	2,254	3,62	I,64	I,6	I,4I	I,22
[illegible]	[illegible]	[illegible]	I,67	[illegible]	I,233	-0,0062	I,9I	4,98	2,58	I,275	I,75	2,346
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	I,234	-0,0I8I	I,9I	4,75	2,48	I,275	I,7	2,246
[illegible]	[illegible]	[illegible]	I,7[illegible]	[illegible]	I,257	-0,0295	I,89	2,I2	2,II3	I,258	0,83	I,85

Table 4. KEY: (1) cm/h.

d мм	0,97	0,58	0,4
L см	38	28,3	2I,4
$W_{(1)}$ $\frac{см}{час}$	I6,9	I7,I	I7,4

The value of ε for the anionite calculated as the weighted mean value from Table 3 is $\varepsilon = -1$.

It follows from Tables 2 and 4 that the rate of the parallel transfer of the front does not depend on the value of the diameter of the ion exchangers; therefore, the value of parameter β can be determined from equation (5) in this case.

The output curves for the ionization of sodium chloride solutions on ion exchangers with a grain diameter of 0.6 (cationite) and 0.58 mm (anionite) were calculated on the basis of the results obtained.

The calculated curves are shown by the broken lines in Figures 2 and 3. The mean errors in the section of the output curve in question are 3.5o/o and 1.42o/o, respectively.

Bibliography

1. [illegible]
2. [illegible]

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