LABORATORY INVESTIGATIONS OF THE DEWATERING OF RESIDUES FORMED AFTER REFINING EFFLUENT AT THE VELIKO-ANADOLSK FIREBRICK FACTORY

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One of the most complicated problems involved in the extensive construction of sewerage purification plants is that of processing and utilizing the residues separated during the refining of the effluents. Drum and belt vacuum-filters [1] are mainly used for this job in the Soviet Union and abroad.

In the drum filters, produced on a regular basis according to GOST 5748-68, regeneration of the filtration fabric may be done continuously without switching them off, which is especially important for dewatering the residues from production effluent.

TABLE 1. Experimental and Calculated Data for Vacuum Filtration of Various Residues on Equipment with Immersed Funnels

Reagent	Filtration cycle time, min	Specific resistance of residue $r \cdot 10^{-10}$, cm/g	Productivity, kg/m²·h	Water content, %		Thickness of cake layer, mm	pH of runoff	Content of suspended substances, mg/liter	
				residue	cake			in runoff	in filtrate
Residue of clay									
$Al_2(SO_4)_3$	2	47,3	34,2	78,5	36,4	1,5	—	12	2740
	4		24,2		36,0	2,0			1240
	6		19,9		36,0	2,5			416
	8		16,9		35,8	3,0			382
$Al_2(SO_4)_3$ + PAA	2	16,6	39,3	86,8	37,8	2,0	6,5	42	1305
	4		27,8		37,2	2,5			1030
	6		22,7		36,8	3,0			458
	8		19,5		36,0	4,0			556
PAA	2	31,4	34,5	84,0	39,8	1,5	6,8	64	425
	4		23,7		37,0	2,0			418
	6		19,6		37,0	2,5			110
	8		17,0		37,0	3,0			134
Residue of kaolin									
$Al_2(SO_4)_3$	2	127,0	21,8	77,8	39,2	1,5	7,1	104	8685
	4		15,0		34,5	1,5			7850
	6		12,0		35,0	2,0			6200
	8		10,5		34,2	2,0			1080
$Al_2(SO_4)_3$ + PAA	2	9,4	85,7	78,7	42,3	2,0	7,1	52	1920
	4		58,0		38,4	3,0			688
	6		47,4		38,2	4,0			337
	8		41,6		38,6	5,0			334
PAA	2	20,6	56,9	78,6	40,5	1,5	7,2	58	1035
	4		40,5		39,8	2,0			980
	6		31,8		39,2	3,0			798
	8		28,3		36,6	4,0			328
Residue of chamotte									
$Al_2(SO_4)_3$	2	1,3	491,0	60,0	25,0	6,0	7,1	94	186
	4		347,2		25,0	7,0			282
	6		288,3		26,0	8,0			90
	8		250,1		26,1	9,0			128

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TABLE 1 (continued)

Reagent	Filtration cycle time, min	Specific resistance of residue r · 10^{-10}, cm/g	Productivity, kg/m²·h	Water content, %: residue	Water content, %: cake	Thickness of cake layer, mm	pH of runoff	Content of suspended substances, mg/liter: in runoff	in filtrate
Residue of chamotte–kaolin (1:1)									
$Al_2(SO_4)_3$	2 4 6 8	31,7	67,1 48,0 38,3 33,2	74,0	32,2 32,8 30,9 30,6	1,5 2,0 2,5 3,0	—	96	2680 1630 890 700
$Al_2(SO_4)_3$+ PAA	2 4 6 8	5,9	129,3 91,4 73,9 64,3	74,0	34,6 34,6 33,6 34,2	2,0 3,0 4,0 5,5	7,0	64	770 244 98 140
PAA	2 4 6 8	15,0	72,7 50,5 40,9 35,7	76,0	36,0 34,2 34,0 33,1	1,0 2,0 3,0 4,0	7,2	44	796 623 540 300

Dewatering the residues by vacuum filtration was studied in laboratory pouring and immersion funnels, imitating the operation of belt and drum vacuum-filters, respectively.

The tests were done with residues obtained after refining water containing components of kaolin, clay (for comparison with the basic residues), and chamotte in the pure form and in ratios chamotte—kaolin 1:1 and 1:4 (slips). The concentration of components in the suspensions was 10 g/liter. The flocculants consisted of $Al_2(SO_4)_3$ in amounts of 10 and 25 mg/liter, respectively, for the suspension of kaolin and clay, and polyacrylamide (PAA) in amounts of 5 mg/liter for all suspensions [2]. After introducing the optimum amounts of reagents the separation of the various phases occurred*; liquid medium was drained off and the residue was dewatered under vacuum.

The calculated specific resistance of the residue [1] and the productivity of the drum filters and also the factors characterizing the cake and filtrate are shown in Table 1. As a function of the type and ratio of components present in the water with the optimum batches of reagents, the calculated productivity of the vacuum-filter varies in wide limits.

The highest productivity of the drum vacuum filter is attained by processing the slip together with aluminum sulfate and PAA; the chamotte residue is quite well filtered off by adding only $Al_2(SO_4)_3$ to the water.

*The settling time of the coagulated stocks was 2 h, for flocculated — 15 min.

TABLE 2. Experimental and Calculation Data for Vacuum-Filtration of Various Residues on Equipment with Pouring Funnels

Residue	Reagent	Moisture, %: residue	Moisture, %: cake	Productivity: for original suspension, liter/m²·h	Productivity: for dry substance, kg/m²·h	Duration of filtration, h
Clay	Without reagent $Al_2(SO_4)_3$ $Al_2(SO_4)_3$+ PAA PAA	78,5 78,5 84,0 86,8	31,4 31,8 35,0 36,0	17,9 50,0 166,6 90,9	4,2 10,8 28,7 13,5	1,150 0,447 0,125 0,233
Kaolin	Without reagent $Al_2(SO_4)_3$ $Al_2(SO_4)_3$+ PAA PAA	77,8 77,8 78,7 78,6	31,7 31,8 34,2 33,8	16,1 17,2 142,8 100,0	3,8 4,1 33,4 21,8	1,283 1,200 0,145 0,220
Chamotte	Without reagent $Al_2(SO_4)_3$	59,7 60,0	24,3 26,2	2000,0 1428,5	887,9 753,6	0,012 0,014
Chamotte—kaolin (1:1)	Without reagent $Al_2(SO_4)_3$ $Al_2(SO_4)_3$+ PAA PAA	70,0 72,0 74,0 76,0	27,3 27,9 28,7 30,0	97,0 63,7 250,0 149,25	9,6 22,5 78,0 42,3	0,766 0,322 0,083 0,138
Chamotte—clay (1:4)	Without reagent $Al_2(SO_4)_3$ $Al_2(SO_4)_3$+ PAA PAA	85,4 85,8 86,0 86,3	35,2 38,5 38,2 39,4	7,3 43,5 227,3 108,7	1,2 6,8 34,2 16,3	2,816 0,470 0,092 0,189

TABLE 3. Basic Cost-Benefit Indices for Processing the Residues

Factor	Value when processing residues	
	without effluent floc.	with flocculation
Daily vol. of effluent, m^3	2392	2392
Ann. vol. of effluent, 10^3 m^3	865	865
Ann. amount of slurry formed by complete purification, tons	6,92	8,65
Ann. consump. of reagents, tons:		
aluminum sulfate	51,9	51,9
PAA	—	17,3
Ann. cost of reagents, 10^3 rubles	1,19	5,66
Capital investment,* 10^3 rubles	218,0	64,25
Annual operating costs, 10^3 rubles	60,6	33,03
Ann. overheads, 10^3 rubles	93,37	42,67
Ann. overheads per m^3 of water, rubles	0,107	0,049
Ann. savings, 10^3 rubles	—	50,70

*This takes into account the outlay on equipment and its installation.

The content of suspended substances in the filtrate with a short filtration time is higher than with a long time. With an increase in the duration of the filter cycle from 2 to 8 min, the moisture content of the cake is slightly reduced, but the highest productivity of the drum vacuum-filter is attained with a filter cycle of 2 min. The duration of the drying process of the rapid-filter residues for chamotte was 15-16% of the length of the filter cycle, compared with 40% for other residues.

These experiments showed that using the drum vacuum-filter produces high productivities but the filtrate retains large amounts of suspended material, which is due to the features of the design of the filters and their working conditions.

The belt vacuum-filters typically have different conditions and working cycles, contributing to the production of a purer filtrate. Tests with the pouring funnel were done with a vacuum of 0.067 MPa to the discontinuation of the separation of the filtrate, which yielded the maximum moisture content levels in the cake. The results of the experiments are shown in Table 2.

The water content of the cake when filtration is done on belt vacuum-filters is lower than for drums, which is due to the significant increase in the duration of the dewatering process.

Cake obtained after dewatering the residues on the drum or belt vacuum-filters may be delivered by dump cars to the raw material store for mixing with the main original raw materials.

The amount of cake containing kaolin, fireclay and chamotte is less than 0.5% of the total weight of material fired in the rotary kilns in terms of the original product, and does not affect the quality of the chamotte.

Table 3 gives the main cost-benefit factors for processing and utilizing the residues separated in the purification of effluents. As the main version we are using the dewatering method without preliminary flocculation of the effluent, and for comparison the method which incorporates PAA in the effluent with subsequent dewatering of the residue on drum vacuum-filters.

CONCLUSIONS

The process of filtering the residues formed in purifying the effluent depends on the composition of the residues and the method of treatment.

The highest productivity levels of the drum vacuum-filters are obtained by treating the suspensions together with aluminum sulfate and polyacrylamide; optimum values are also obtained for the outputs of belt-vacuum filters for these residues.

The residues after dewatering by vacuum filtration may be used repeatedly in the production process.

LITERATURE CITED

1. I. S. Turovskii, Treating Effluent Residues [in Russian], Moscow (1975).
2. I. S. Lavrov et al., Production of Refractories [in Russian], Regional thematic collection of papers, No. 9 (1980).
3. Methods (Basic Specifications) for Determining the Economic Effectiveness in the National Economy of New Techniques, Inventions, and Rationalizer's Proposals [in Russian], Moscow (1977).