МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РЕСПУБЛИКИ КАЗАХСТАН
КАЗАХСКИЙ НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ ИМЕНИ К. И. САТПАЕВА

ИНСТИТУТ МЕТАЛЛУРГИИ И ОБОГАЩЕНИЯ

МАТЕРИАЛЫ

Международной научно-практической конференции

ЭФФЕКТИВНЫЕ ТЕХНОЛОГИИ ПРОИЗВОДСТВА ЦВЕТНЫХ, РЕДКИХ И БЛАГОРОДНЫХ МЕТАЛЛОВ

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Металлургия ғылымы мен өнеркәсібінің мәселелеріне және белгілі ғалым металлург, ҚР ҰҒА корреспондент мүшесі, Қазақстан Республикасы Мемлекеттік сыйлығының иегері Болат Балтақайұлы Бейсембаевті еске алуға арналған «Түсті, сирек және асыл металдарды өндірудің тиімді технологиялары» атты Халықаралық ғылыми-практикалық конференцияның

МАТЕРИАЛДАРЫ

МАТЕРИАЛЫ

Международной научно-практической конференции «Эффективные технологии производства цветных, редких и благородных металлов», посвященной проблемам металлургической науки и промышленности и памяти известного ученого-металлурга, члена-корреспондента Академии наук РК, лауреата Государственной премии Республики Казахстан Булата Балтакаевича Бейсембаева

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В Материалах конференции «Эффективные технологии производства цветных, редких и благородных металлов» представлены результаты фундаментальных и прикладных исследований в области металлургии цветных, редких и благородных металлов, обогащения минерального и техногенного сырья, получения высокочистых металлов и перспективных материалов, а также разработки новых и усовершенствования существующих технологических схем, процессов и аппаратов.

Материалы конференции предназначены для ученых и специалистов, работающих в области переработки минерального сырья и материаловедения.

«Түсті, сирек және асыл металдарды өндірудің тиімді технологиялары» атты конференцияның материалдарында түсті, сирек және асыл металдар металлургиясы, минералдық және техногенді шикізаттарды байыту, тазалығы жоғары металдар мен келешегі зор материалдарды алу, сонымен қатар жаңа технологиялық схемаларды, үрдістерді және аппараттарды жасап шығару және олардың бұрыннан келе жатқан түрлерін жетілдіру салаларындағы іргелі және қолданбалы зерттеулердің нәтижелері келтірілген.

Конференция материалдары материалтану және минералды шикізаттарды өңдеу саласында жұмыс жасайтын ғалымдар мен мамандарға арналған.

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THE RESEARCH OF GRAVITATIONAL AND MAGNETIC ENRICHMENT OF STALE TAILINGS OF MANGANESE WITH THE DETERMINATION OF THE POSSIBILITY OF THEIR PROCESSING

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Annotation. *The paper presents the results of the study of gravitational and magnetic enrichment of stale manganese tailings to determine the possibility of their processing using the process of jigging and magnetic separation. Based on the research results, worked out benefication schemes were using the following processes: jigging and enrichment on the concentration table; jigging and magnetic separation; magnetic separation. These schemes provide manganese concentrates with a manganese content of at least 38 %. The results showed that the highest technological parameters of enrichment of stale manganese tailings are obtained according to the scheme using only the process of magnetic separation of class 3 – 0.071 mm. An alternative technology scheme includes gravitational-magnetic enrichment processes.*

One of the main requirements to the used technologies of processing of manganese ores is the use of large-lump enrichment or so-called "sparing technologies", providing for the maximum production of large-lump concentrates [1-3].

As a rule, washing and jigging operations are used for the enrichment of manganese ores. Jigging is the main and the most cost-effective way to enrich manganese ores, due to the relatively high specific gravity of most manganese minerals (above 4 g/cm^3). Jigging of manganese ores gives good results in the enrichment of relatively large classes, from about 50 to 2.5 mm. For some thinly crafted ores, enrichment on concentration tables gives good results. Existing technologies of enrichment of manganese ore allow to extract manganese from the ore into a marketable concentrate, not more than 75 %, and about 25% of the manganese remains in the sludge and in the "tails" of enrichment that for decades stored in special storage facilities – sludge tanks.

The accumulation of sludge leads to a new alienation of land for sludge storage. In addition, large flows of slurry, the processes of drainage of waste water into the soil, drying of individual sections of sludge storage significantly worsens the environmental and sanitary situation in the areas of extraction and processing of manganese ore.

In the world metallurgical practice, manganese is one of the strategic metals, because it is a necessary additive for producing high-quality grades of steel. However, the large scale of extraction of manganese ores in Kazakhstan, in recent decades, led to a reduction in proven reserves of manganese ores.

In connection with these factors, studies to determine the gravitational enrichment of stale tailings (sludge) and determine the possibility of their processing using the deposition process and magnetic separation, to obtain manganese concentrates with a manganese content of at least 38% is relevant.

At the Department "Metallurgy and mineral processing" has been performed studies of the gravitational and magnetic enrichment of stale tailings of manganese, which was developed the technological scheme of processing and identifies possible technological indicators of enrichment.

Methods of the research: granulometric analysis, fractional analysis, gravity and magnetic enrichment [4,5,6]. At the same time, research on the study of material and chemical composition was carried out on the sample of manganese tailings.

The material composition was studied by x-ray diffractometric analysis on an automated diffractometer DRON-3 with CuKa- radiation, β-filter. The following are the interplanar distances and the phase composition of the samples (table.1) and the results of semi-quantitative x-ray phase analysis (table.2), the diffractogram of the sample (Fig.1).

Table 1-Interplanar distances and phase composition of the sample

d, Å	***I %***	***mineral***	***d, Å***	***I %***	***mineral***
7.26223	12.1	caolinite	2.51932	9.7	hematite
4.25836	9.8	quartz	2.48872	15.1	-
4.02916	10.4	-	2.45642	9.6	-
3.85033	13.9	-	2.28037	18.1	-
3.67167	10.0	-	2.08940	16.4	-
3.34270	24.2	-	1.90725	15.7	-
3.19207	18.3	feldspar	1.87155	16.2	-
3.02844	100.0	calcite	1.66020	12.3	-
2.71145	27.8	Braunite, hematite	1.60112	11.5	-
2.60652	8.6	almandine	1.52210	10.6	-

Table 2 - Results of semi-quantitative x-ray phase analysis

Mineral	***Formula***	***Concentration, %***
calcite	$Ca(CO_3)$	45.9
braunite	$(Mn_2O_3)_3MnSiO_3$	12.6
quartz	SiO_2	10.9
albite (feldspar)	$Na(AlSi_3O_8)$	8.2
caolinite	$Al_2(Si_2O_5)(OH)_4$	7.6
Dolomite	$CaMg(CO_3)_2$	5.0
almandine	$Ca_{1.5}Fe_{1.76}Al_{1.80}Si_{2.94}O_{12}$	4.9
hematite	Fe_2O_3	4.8

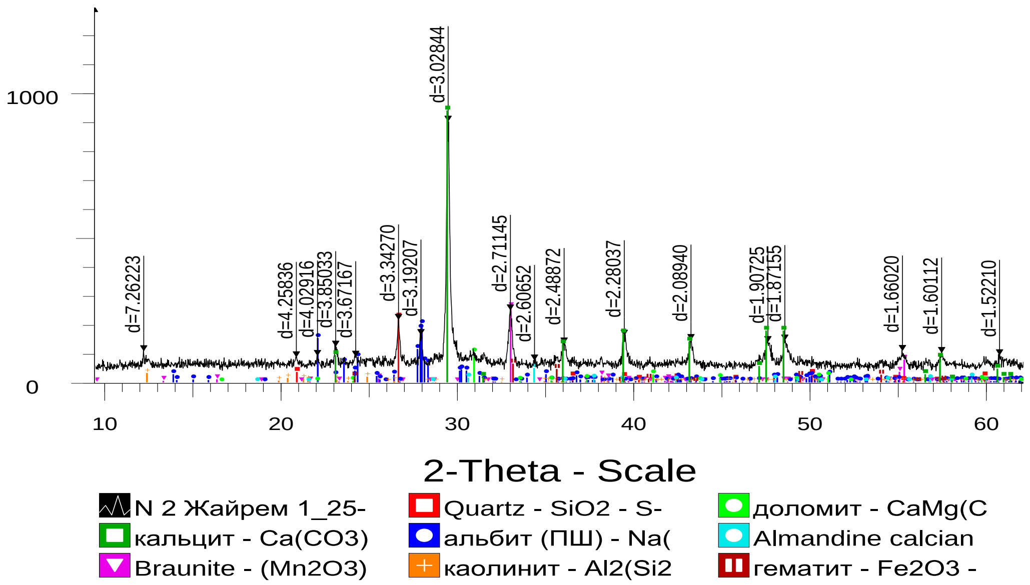

Figure 1 – The diffraction pattern of the sample

The chemical composition of the initial slurries is given in table 3.

Table 3 – Chemical composition of the original sludge

Mass proportion of elements, %													
Mn	Fe	S_{common}	Pb	Zn	Cu	As	SiO_2	Al_2O_3	CaO	MgO	P	Sb	Bi
17,42	5,48	0,24	0,19	0,077	0,003	0,018	13,87	2,67	23,02	1,14	0,067	0,002	0,001

The results of the study of the material composition of manganese tailings slurries showed that the mineral composition of slurries is represented by the following minerals: the main ore mineral is brownite ~12 %, which is observed both in the form of individual grains and in coalescence with quartz and calcite. Occurs hematite, rare grains of hausmannite. Non-metallic minerals make up about 60 % and are represented by calcite ~ 40 %, quartz ~ 10 %, albite ~ 6 %, rare grains of pomegranate, dolomite, kaolinite. Granulometric composition and distribution of manganese and iron content by size classes, in initial tails is given in table 4.

Table 4 – particle size distribution of the original tailings

Size classes, mm	Yield, %	Content, %		Extraction, %	
		Mn	Fe	Mn	Fe
– 3 + 1,25	26,40	17,41	4,06	25,18	20,25
– 1,25 + 0,63	29,72	18,03	5,10	29,35	28,64
– 0,63 + 0,315	17,84	18,66	6,36	18,24	21,44
– 0,315 + 0,16	12,68	20,0	6,71	13,90	16,07
– 0,16 + 0,071	5,49	20,72	6,69	6,23	6,94
– 0,071 + 0,0	7,87	16,46	4,48	7,10	6,66
Total	100,0	18,25	5,29	100,0	100,0

The weighted average content of manganese and iron according to the results of the study of granulometric composition was 18.25% and 5.29%, respectively. The principal amount of the manganese is extracted in classes 3 – 0,071 mm (machine class size 3 – 0.63 mm and 0.63 – mm 0,071).

The obtained size fractions performed mineralogical analysis, the results found a large part braunite found in the form of aggregate grains in intergrowths with quartz and carbonates in size fractions larger than 0.63 mm. In subsequent classes have a tendency to reduce the number of splices and braunite and hausmannite occur more often as a separate monomineral aggregates. Theoretically, the possible technological parameters obtained in the separation of machine classes with the density of 3450 kg / m^3 are shown in table 5.

Table 5 – Theoretically possible technological parameters obtained by separation of machine classes by density 3450 kg /m^3

Product name	Yield, %	Content,%		Extraction from ore, %	
		Mn	Fe	Mn	Fe
Fraction + 3450 kg/m^3 3–0,63 mm class	16,45	40,63	12,52	37,59	38,70
Fraction + 3450 kg/m^3 0,63 – 0,071 mm class	13,09	39,28	15,06	28,92	37,05
Total fraction + 3450 kg/m^3	**29,54**	**40,03**	**13,65**	**66,51**	**75,75**
Fraction - 3450 kg/m^3 3–0,63 mm class	39,67	7,38	1,46	16,46	10,89
Fraction - 3450 kg/m^3 0,63 – 0,071 mm class	22,92	7,57	1,58	9,76	6,81
Total fraction - 3450 kg/m^3	**62,59**	**7,45**	**1,51**	**26,22**	**17,70**
Ore	**-**	**17,78**	**5,32**	**-**	**-**

According to the results table. 5, it follows that to obtain a concentrate with a manganese content of at least 38%, the required separation density will be 3100 - 3200 kg/m^3.

Reseaches on the study of gravitational and magnetic enrichment are carried out. On the basis of the obtained results, technological schemes of processing of manganese sludges, with the production of concentrates with a manganese content of at least 38%, have been developed.

The developed schemes are shown in figures 2-4, and the obtained technological parameters are given in tables 6-8 [7].

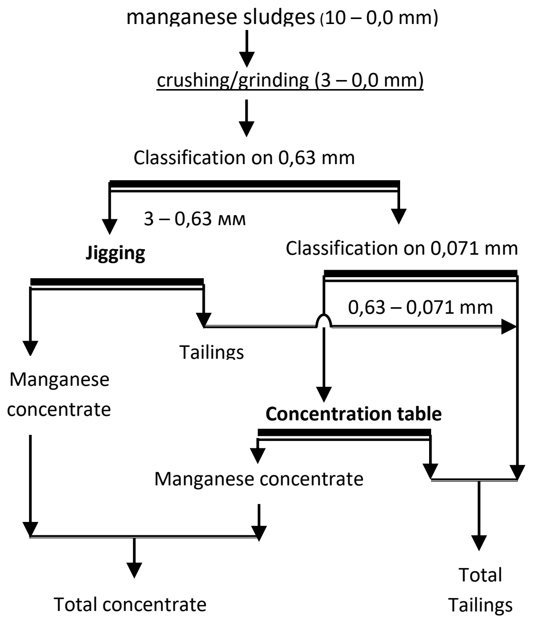

Fig.2 – Gravitational scheme of processing using the process of jigging and concentration table

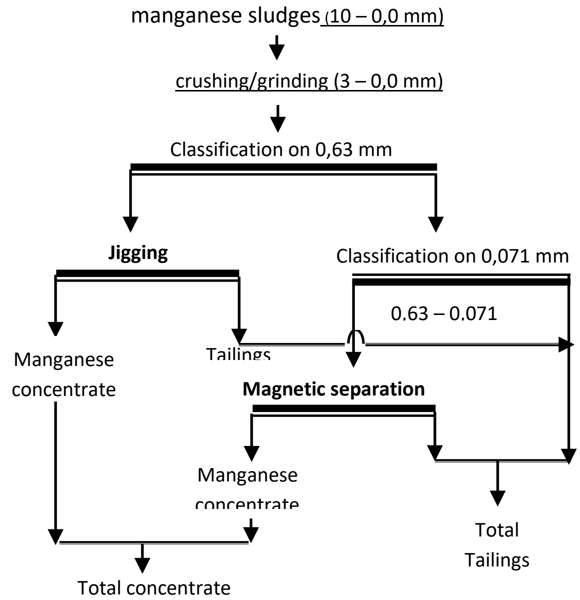

Fig.3 – Gravitational- magnetic processing scheme

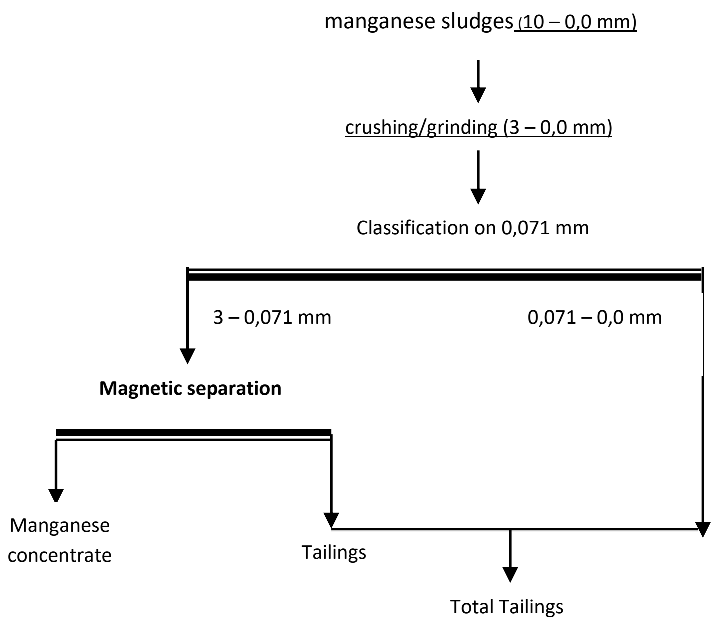

Fig.4 – Manganese sludges processing using the magnetic scheme

Table 6 – Technological parameters of the technology using the process of jigging and concentration table

Product name	Yield , %	Content, %		Extraction, %		Ratio Mn/Fe
		Mn	Fe	Mn	Fe	
3 – 0,63 mm jigging concentrate class	16,88	38,25	12,79	36,52	38,74	2,99
0,63 – 0,071 mm concentration table concentrate class	9,12	35,3	19,86	18,21	32,50	1,78
3 – 0,071 mm total concentrate class	**26,00**	**37,22**	**15,27**	**54,73**	**71,24**	**2,44**
Tailings+ sludges	74,00	10,82	2,17	45,27	28,76	
Ore	100,00	**17,68**	**5,57**	100,00	100,00	

Table 7 – Technological parameters of the gravitational-magnetic scheme

Product name	Yield , %	Content, %		Extraction, %		Ratio Mn/Fe
		Mn	Fe	Mn	Fe	
3 – 0,63 mm jigging concentrate class	16,88	38,25	12,79	37,28	39,5	**3,0**
0,63 – 0,071 mm magnetic separation concentrate class	14,22	38,24	8,45	31,38	22,01	**4,5**
3 – 0,071 mm total concentrate class	**31,10**	**38,25**	**10,81**	**68,66**	**61,51**	**3,5**
Tailings+ sludges	68,9	7,88	3,04	31,34	38,49	**-**
Ore	100,0	**17,33**	**5,46**	100,0	100,0	-

Table 8 – Technological parameters of the magnetic processing scheme

Product name	Yield , %	Content, %		Extraction, %		Ratio Mn/Fe
		Mn	Fe	Mn	Fe	
3 – 0,071 mm magnetic separation concentrate class	**32,64**	**38,41**	**7,52**	**69,47**	**45,22**	**5,11**
Tailings+ sludges	67,36	8,18	4,42	30,53	54,78	**-**
Ore	100,0	**18,05**	**5,43**	100,0	100,0	-

According to the developed enrichment schemes and the obtained technological parameters, the following conclusions can be drawn:

– using the jigging is possible to obtain a concentrate with a manganese content of at least 38 % only with a tight class with a fineness of 3-0.63 mm.

- using the jigging is impossible to obtain a concentrate with a manganese content of at least 38% with a wide – classified class with a size of 3-0.071 mm.

- obtaining a concentrate with a manganese content of at least 38 % from a thin class with a fineness of 0.63-0.071 mm is possible only by magnetic separation.

- the results showed that the preparation of concentrate from stale tailings (sludge), with a manganese content of 38% or more, is also possible using a magnetic separation process.

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