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WASTE MATERIAL FROM THE FLOTATION „FELDSPAR" BUJANOVAC AS ROW MATERIAL IN THE CERAMIC INDUSTRY AFTER REMOVING THE SURPLUS OF IRON

D. S. RADULOVIC*, Z. SEKULIC, S. MIHAJLOVIC, V. JOVANOVIC

Institute for Technology of Nuclear and other Mineral Raw Materials, Franshet d' Esperey 86, 11000 Belgrade, Serbia and Montenegro

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Abstract

In this work is given a scheme of the results of determining the conditions under which the waste material from plant for flotation "Feldspar" Bujanovac can become the start as row material for the ceramic industry. In the frame of this researches are issued the examines of possibilities of thickening and filtering the sample of the waste on class -0.063 mm, after the magnetic separation in laboratory conditions.

Key words: *feldspar, valorisation, waste, magnetic separation, dewatering.*

[#] ***Corresponding author:*** *d.radulovic@itnms.ac.yu*

1. Introduction

Waste material from the flotation plant "Feldspar" Bujanovac by its chemical and mineral composition (1, 2) is very valuable raw material that in present conditions is practically underutilized. In this paper we have treated waste material appearing in the plant in the existing work conditions.

Additionally, this plant has large quantities of this raw material (rough estimate is over 100 000 t) that is very valuable from the point of view of ceramic industry. In accordance with the request of the Italian ceramic industry, which is a business partner of "Feldspar" Bujanovac, the task was to obtain a product with the following characteristics from waste material in the flotation plant "Feldspar" Bujanovac:

- product size to be 100% - 0,063 mm
- Fe_2O_3 content to be lower than 0,2%
- moisture content in the finished product to be around 20% (moisture content should be such to enable the product to be loaded and transported in extra-large bags)

In accordance with the research strategy of the Institute for Technology of Nuclear and other Mineral Raw Materials in the field of research and application of flotation and dewatering process (3, 4, 7, 8, 9) and based on previous results the following tests have been carried out:

- Possibility of sorting and grinding the waste material starting sample,
- Possibility of magnetic separation of ground and sorted product,
- Determination of conditions of thickening and filtration of waste material sample after magnetic separation in laboratory conditions (4).

The work plan within laboratory testing has envisaged the following:

- Physical/chemical and mineralogical characterization
- Determination of composition according to grain sizes
- Determination the conditions for successfully magnetic separation

In the frame of this work is showed only the part from researches predicted upon because they are connected for the possibility of the magnetic separation and they was very large how in application different devices such in application different matrixes to the high gradient magnetic separator.

2. Determination of physical/chemical and mineralogical properties of waste material samples from the flotation plant "Feldspar" Bujanovac

2.1. Chemical composition of the waste material starting sample

Chemical analyses have been made on the starting sample in the Laboratory for chemical analysis of the Institute for Technology of Nuclear and other Mineral Raw Materials. Results of chemical analyses are given in Table 1.

Table 1. Chemical composition of the waste material starting sample

Composition	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	Cr_2O_3	CaO	Na_2O	K_2O	Red heat waste
Contents %	68.55	20.74	0.56	0.025	0.08	0.46	3.25	4.13	1.71

2.2.1. Mineralogy analysis of the start sample of waste

Generally, the start sample of chats is feldspar-mica mineral row material with bigger content of quartz. The content of mica declines to lower classes. Feldspars are presented by microcline (main mineral according the presence) orthoclase and Na-plagioclase. The content of Na plagioclase increases to lower classes. All the feldspars are weakly sericitized and caolinised. From the minerals of iron is determined limonite-getite. Except mica, all other grains are with sharp angles. In the whole sample (all the classes) is not noticed the present of intergrowth. All the samples are similar according the composition, and only in the class -0,063+0,050 mm are important appearing of the hard minerals.

2.2.2 Microscopy analysis of the sample of the magnetic fraction of chats from class -0.063mm

Mineral composition: Quartz, feldspars, Fe hydroxides, micas, zircon, granates, apatite

Microdescription: Examined sample consists from dominant feldspar and quartz. From the mineral feldspar are presented potassium feldspars and plagioclases. From accessory minerals is fortified the presence of granate, zircon, and apatite. From the minerals carriers of iron is fortified presence of Fe hydroxides , and granatas which can content the iron. This minerals usually appears like free, or like inclusions in feldspars and quartz. The method of x-ray diffraction proved the presence of main minerals and the presence of Fe-hydroxides (lepidocrokite), too.

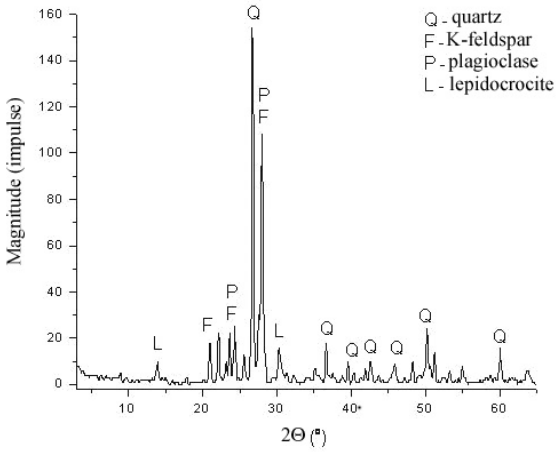


Fig. 1. Difractogram of parha magnetic fraction of the examined sample

2.3. Determination of composition according to grain sizes

As the starting sample of waste material from "Feldspar" - Bujanovac has been sieved wet through a sieve with holes of 0,063 mm, composition according to grain sizes has been determined so that the class -0,05 + 0,00 mm was sorted on cyclosizer and the class + 0,05 mm has been sieved wet through a series of sieves (3, 4, 5, 7, 8, 9, 10). Sorting and sieving results are shown tabular.

Table 2. Composition of waste material sample according to grain sizes

Size class (mm)	**M, %**	**? ? M, %**	***?? M, %***
+ 0,150	6,18	6,18	*100,00*
-0,150 + 0,100	17,69	23,87	*93,82*
-0,100 + 0,075	6,34	30,21	*77,13*
-0,075 + 0,063	6,40	36,61	*69,79*
-0,063 + 0,050	11,58	48,19	*63,39*
-0,050 + 0,044	0,56	48,75	*51,81*
-0,044 + 0,033	6,35	55,10	*51,25*
-0,033 + 0,023	8,87	63,97	*44,90*
-0,023 + 0,015	9,36	73,33	*36,03*
-0,015 + 0,011	5,15	78,48	*26,67*
-0,011 + 0,000	21,52	100,00	*21,52*
Input	100,00	/	/

Based on granulometric composition (table2 and figure 2) we can conclude that the upper size limit of the start sample is under the 0.2 mm, apropos classing into the plant "Feldspat"- Bujanovac doesn't work properly, because according the technology scheme waste need to be under the 0.063 mm. Class -0.063 mm is the start sample for further researches of magnetic separation.

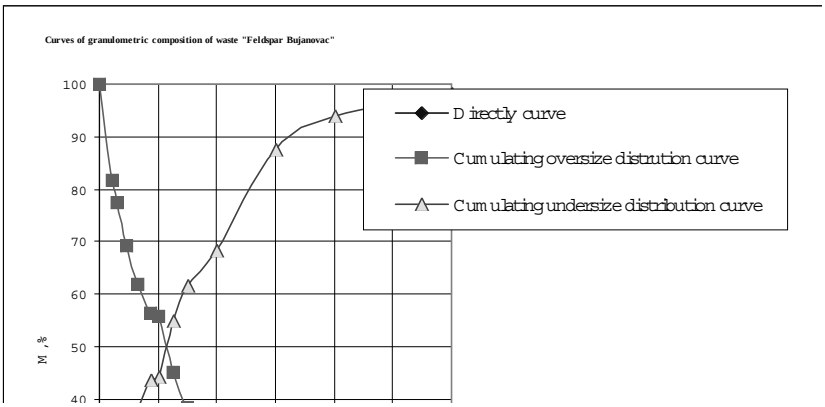


Fig. 2. Curves of granulometric composition of waste sample from "Feldspar Bujanovac"

3. Experimental

Experimental part of this work consists in classing the row material by procedure of wet sieving on the sieve with the whole 0.063 mm, then class -0.063+0.00 mm treated on more magnetic devices in the aim of removing the surplus of iron. The product prepared on this way satisfy the requests of the ceramic industry and according its chemistry and granulometric composition, and except that we need to dewater it by the procedure of thickening and filtering. In the further flow of examination are determined the specific surfaces of thickening and specific capacity of filtering for the different samples of chats. The waste material starting sample in the form of pulp had a mass of m=16470 g after drying, from it five samples have been taken for the tests of magnetic separation of m=500 g, and one sample for sedimentation and thickening experiments had mass of m=2500g. After that, start sample is sieved on the sieve by the whole 0.063 mm, class +0.05 mm, then it is sieved on series, and the class -0.05+0.00 mm is classed on cyclosyzer and on that way is determined granulometric composition of the treated sample (3, 4). Sedimentation tests were carried out by using the Kynch method (11) on the sample of waste by class -0.063+0.00 mm. During that to the samples is changed the percent of the solid phase in the entering row material. For the examines of filtering is used method with filter list. The written scheme of preparing the sample is showed on the figure 3.

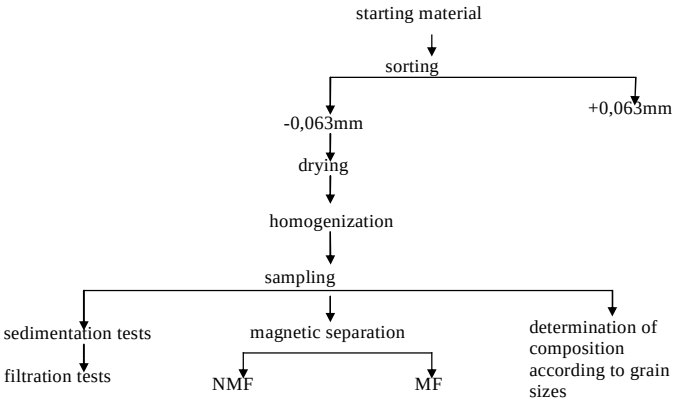


Fig. 3. Written scheme of laboratory treatment of waste material samples from the flotation plant "Feldspar" Bujanovac (4)

4. Description of the results of experiment of magnetic separation on the samples of waste Feldspar -Bujanovac

Experiments of the magnetic separation are done on high gradient magnetic separator "SALA-HGMS" model 10-15-20, with different magnetic induction and on different matrix in the aim of getting the product by defined quality from the aspect of content the iron (6, 7, 10).

On the sample by class -0.063mm are token three samples for the experiments on (high gradient magnetic separator) SALA-HGMS, the experiments are done with matrix 0.3 during the magnetic induction 0.4; 1.4; and 2T. After the all three experiments is done chemistry analysis and it is made the balances showed in tables 3, 4 and 5.

4.1.Magnetic separation with matrix 0.3

Table 3. Magnetic induction 0,7T

	M;%	**Fe_2O_3,%**	***I Fe_2O_3***
NMF	79,35	0,36	*33,22*
MF	20,65	2,78	*66,78*
INPUT	*100,00*	*0,86*	*100,00*

Table 4. Magnetic induction 1,4T

	M;%	**Fe_2O_3,%**	***I Fe_2O_3***
NMF	75,75	0,306	*26,96*
MF	24,25	2,59	*73,04*
INPUT	*100,00*	*0,86*	*100,00*

Table 5. Magnetic induction 2,0T

	M;%	**Fe_2O_3,%**	***I Fe_2O_3***
NMF	68,06	0,255	*20,18*
MF	31,94	2,15	*79,82*
INPUT	*100,00*	*0,86*	*100,00*

Because this series of the experiments haven't give the result even with maximum magnetic induction from 2T (apropos content of Fe_2O_3 was under the defined 0.2%) it is done the series of the experiments with the same value of the induction but with matrix 0.07.

4.2. Magnetic separation with matrix 0,07

Table 6. Magnetic induction 2,0T

	M;%	**Fe_2O_3,%**	***I Fe_2O_3***
NMF	60,20	0,163	*11,42*
MF	39,80	1,914	*88,58*
INPUT	*100,00*	*0,86*	*100,00*

5. Review of results of sedimentation tests opn waste material samples "Feldspar" Bujanovac

Sedimentation tests have been carried out by using the Kynch method on waste material samples of the class -0,063 mm. During such tests on the starting raw material the percentage of solidity was 5, 10 and 15%. During the first three tests pH value was around 5,5 (pH value of waste material coming out of the plant is around 2,5 whereas pH value of waste material from tailing dump is around 5,5). Test results have been shown as three curved lines within three diagrams (figures 4, 5 and 6).

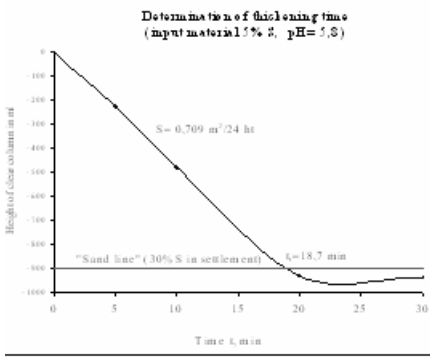


Fig. 4. Determination of time thickening for the start sample of waste material "Feldspar"Bujanovac with 5% solidity when pH value is 5,8

Based on calculated time specific thickening area S is calculated:

$S= 695 \times tr/C_o$ $H_o= 695 \times 18,7/ 51,6 \times 355= 0,709\ m^2/24^{th}$,

where is t_r - thickening time, min; C_0 - contents of solid phase, g/l;

H_0- column height of input pulp, mm.

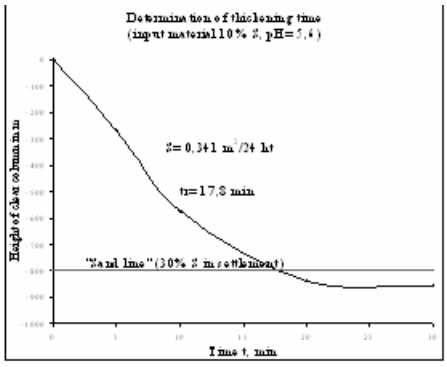


Fig. 5. Determination the calculated time of thickenining for the start sample of chats "Feldspar" Bujanovac with 10% solidity while pH=5,6

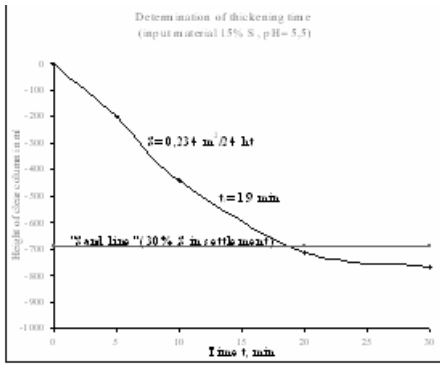
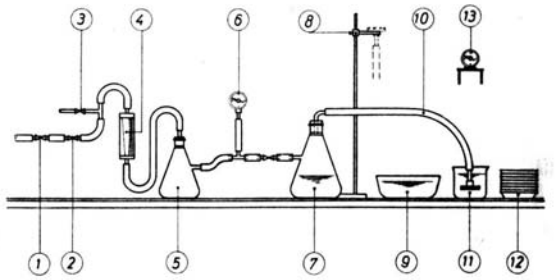


Fig. 6. Determination the calculated time of thickenining for the start sample of chats "Feldspar" Bujanovac with 15% solidity while pH=5,5

6. Review of results of filtration tests on waste material samples "Feldspar" - Bujanovac

For filtration tests the method with paper filter has been used. The look of laboratory equipment on which the experiment was done is showed on the figure 7.



1. Valve
2. Butterfly-ventil
3. faucet for reducing vacuum on the sheet
4. Fluometer for measuring the air during the drying
5. Dish from 11
6. Vacuum meter
7. Filter bottle
8. Shank of filter paper during the drying
9. Dish for liquid for washing
10. Gummy vacuum hose
11. Dish for pulp
12. Set from numbered glasses or plates with diameter 15cm
13. Timer

Fig. 7. Laboratory equipment for carried out the experiment of filtering by filter paper (11)

Included this examination is done more experiments and here are showed the results of one of them, during which the experiment is done on the same row material on which is done coagulation. It is adopted that the % of the solid phase in sediment, apropos in input for filtering is 30%,. Based the laboratory data's is made the calculation of the specific capacity of filtering according the model:

a) Waste material sample for filtration has the following characteristics

- percentage of solidity at input (30% solidity)
- size class - 0,063 mm
- sample mass m=2 kg
- specific sample mass γ=2,65 g/cm3

$q=q_w(100-w)/100=0,3095x(100-30,92)/100=0,2138 g/cm^2/min$

apropos

$q=0,1283\ t/m^2/h$

q_w - specific filtration capacity of wet cake with moisture w;

q - specific filtration capacity of dry cake;

t - filtration time in minutes

w - moisture in %

As the plant operates with a capacity of Q = 4t/h for this capacity the area of filter cloth should be F = 31.18 m^2.

7. Conclusions

Based on performed laboratory tests and analyses the following can be concluded:

- It is possible that existed waste material from the chats ,use after the procedures of the preparing like a star row material in the ceramic industry , because the content of Fe_2O_3 is decreased by magnetic separation on 0.16%.
- After the filtering kek contents about 30% moisture but in that conditions it has same special mechanic characteristics (it is possible with finished product to do the manipulation , apropos shipping, unshipping.
- Classing in the plant feldspar-Bujanovac doesn't work for the long time with the needed sharp of separation , what we can see based the granulometric content and GGK of chats.
- Flotation in the plant Feldspar Bujanovac don work properly what we can see based on mineralogy and chemistry composition of chats (big presence of the useful minerals in waste material).

Problems with classing can be solved, by regulating the work of classificatory, with which we would solve the existed problems, apropos appearing the useful minerals in the waste. However, as the mineralogical analysis shows that there is no middling in any classes of sizes in samples of waste materials, special flotation of large and small classes should be introduced.

If operation continues with existing conditions in the plant (with waste material whose upper size limit is 0.2 mm) it is possible dewatering, apropos thickening and filtering of chats based the results showed in the paper (point 5 and 6). Based on known mass flow of waste material and the other technology parameters, we can make the choice for the equipment for thickening and filtering.

8. Aknowledgements

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