XVI International Mineral Processing
and Recycling Conference
28-30 May 2025, Belgrade, Serbia

DOI: 10.5937/IMPRC25556D
Original research article

RECYCLING OF CHROMIUM TAILINGS IN BULQIZA PLANT

Genc Demi[1#], 0009-0008-9816-3137,
Bukurosh Koci[1], 0009-0001-8793-4097,
Islam Nika[2], 0009-0006-0847-8334,
[1]Faculty of Geology and Mining, Tirana, Albania
[2]Fabrika Pasurimit Kromit, Bulqize, Albania

ABSTRACT – Chromium mineral processing plant of Bulqiza has begun operation 50 years ago, treating low grade chromium ores grade 12 % to 26 % Cr_2O_3 and producing chromium concentrates for export. About 1.8 million tons of tailings are stocked in a dam close to the plant. Recycle and enrichment of existing tailings is profitable, because this kind of raw material doesn't need expenses for crushing, grinding and exploitation. The existing plant is in operation for more than 25 years treating existing tailings. Grade of concentrate produced from enrichment of tailings is in the value 38-40 % Cr_2O_3 and Cr_2O_3 recovery is in the value 25-33%. The content of particles under 100 µ, the slimes, in raw material is high. In the paper are described the continuous efforts to improve the Cr_2O_3 recovery. The testing carried out to improve Cr_2O_3 recovery of tailings enrichment is presented in this paper, as well as analyses of existing process, raw material and products. It is concluded that majority of losses are present in the slimes which are not separated in existing spiral separators and shaking tables. Basing in the study some measures and arrangements in the flowsheet are taken and it is achieved the recovery improvement. In the paper are presented the tests and results of concentration of fine particle fraction, using different methods.

Keywords: Tailings, Tables, Spirals, Grinding, Desliming.

INTRODUCTION

Chromium dressing plant of Bulqiza is continuously in operation since 1970 year. About 4 million ton low grade lumpy chromium ore are treated during 1970-2025 period of time. Production quantity has been about 1.8 million ton chromium concentrate with 48-50 % Cr_2O_3 content for this period of time.

Tailings are deposited in a dam close to the plant. The quantity of tailings is about 2 million ton and Cr_2O_3 content varies from 10 to 13% with an average 11.5 %. The losses of Cr_2O_3 component during operation of the plant with lumpy ore have been in the value of 25-35%. The analysis of technological process and tailings performed during this operation has shown that the main reason of the losses has been that about 50% of Cr_2O_3 component in the tailings were present in fraction under 0.1mm. It means that it was generated a big slime production in the grinding cycle, and it was performed a low efficient classification and low recovery of chromium fine particles [3,4].

After crushing and grinding of lumpy raw material under 1.5 mm, the quantity of -74

[#] corresponding author: gencdemi@yahoo.com

micron fraction was over 42%. These fine particles were concentrated with low recovery in existing shaking tables, which had not been designed and produced for the treatment of fine particles under 74 micron.

About 25% of losses were in tailings regarding low separation sharpness of existing equipment designed for course particles and about 50% of losses were present in slimes (fine particles under 74 microns).

The enrichment of these old tailings is with advantage from economical point of view. The reason is that the raw material in this case is not exploited in the mine and that it is not crushed and ground and it doesn’t need expenses processes like crushing and grinding. As a consequence the expenses for this type of raw material are only for excavation and transport from the dam to the plant. [2]

It is the reason that Bulqiza chromium enrichment plant begun the treatment of existing old tailings recirculating them in existing adopted plant since 2001. In the beginning it was adopted the flowsheet of lumpy enrichment with the flowsheet for recycling and enrichment of old tailings. This flowsheet is shown in Figure 1.

From 2001 till now the analyses and testing to improve the technological figures have been carried out continuously.

Some improvements were carried out based in the analyses of process and the enrichment schema for tailings was changed in some chains, as it is shown in Figure 2.

The new tailings produced from the enrichment of old tailings has been deposited in the same tailings dam trying to deposit them separately from old tailings. However it is happening more or less a mixture of old tailings with the new ones.

It is the reason that the enrichment of tailings has been more difficult last times and it is predicted that the enrichment of tailings could be prolonged and about 10 years more in the case that will be used gravimetric methods.

There were carried out some efforts to test the possibility of enrichment with flotation or magnetic methods of fine particles that are going in losses with gravimetric methods.

EXPERIMENTAL

As it was mentioned above, in the beginning the flow sheet for tailings enrichment is shown in Figure 1 [5].

The existing tailings with 6-8% moisture were excavating, loading and transported from the dam to the plant by trucks. The vibrating screen (202) with aperture 1.2 mm was separating in wet way the over screen +1.2 mm which was ground in rod mill (206). The discharge of the mill was pumped closing the grinding cycle in the same screen. Underflow of the screen was pumped in a hydrocyclone (302) where was separated the fraction under 74 microns in overflow. The underflow of hydrocyclone was treated in two scales of spiral separators (304, 307 and 308) separating final concentrate, final tailings and middlings. The middlings were pumped in the hydrocyclone (401), underflow of which went to the hydraulic classifiers (402) The underflows of the rooms of hydraulic classifier were treated in the first scale of shaking tables (403) where were separated final concentrate, final tailings and middlings. The overflows of hydraulic classifiers fed thickener cones (404, 406) overflows of which went to final tailings, while underflow was treated in shaking tables (405, 407) separating final concentrate, final tailings and middlings. All the middlings of first shaking table scale were pumped to hydrocyclone (409) to thick the pulp before hydraulic classifiers (410) the underflows of which were treated in second scale of shaking tables (411), while overflow went to cone thickeners (412, 414) and after that to shaking tables (413, 415). All shaking tables of second scale were separating final concentrate, final tailings and middlings, which were recirculated again in hydraulic classifiers closing the cycle.

All overflows of hydrocyclones (302, 401 and 409) were collected and pumped in the battery of hydrocylones 75 mm (420), overflow of which was minus 15 microns and went in final tailings, while underflow was treated in Duplex concentrators (421), where were separated final concentrate and final tailings.

All final products were dewatered in screw classifiers (501, 310, 417). The overflow of tailings screw classifiers (310 and 417) contained slime and were pumped in enrichment process again.

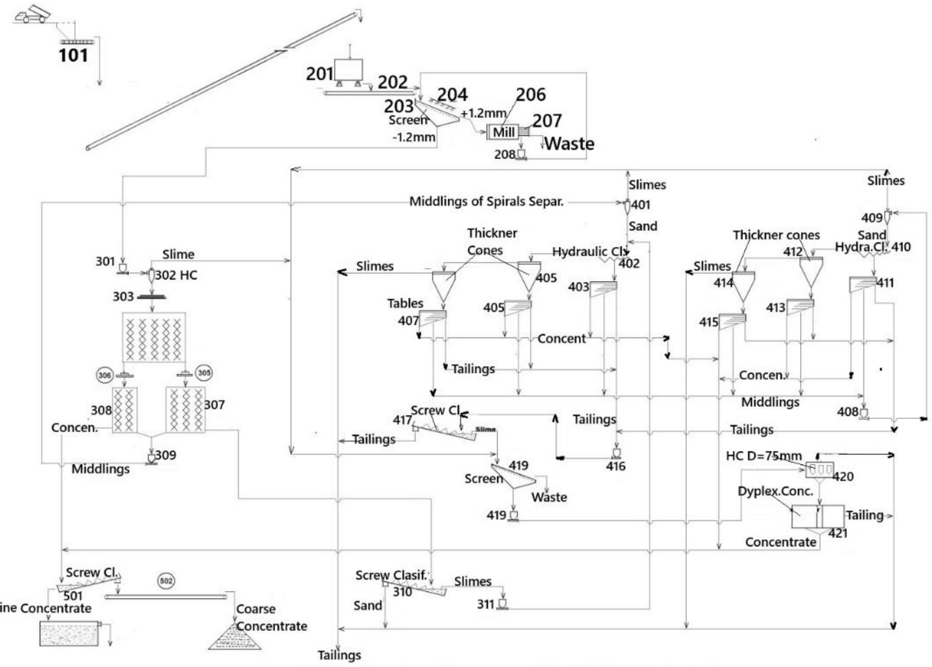

Figure 1 The former flowsheet of tailings enrichment [5]

The analyse of technological process was carried out to find the reasons and necessary data to improve the technological figures.

The main improvements were as follows:

In the former flowsheet the tailings like raw material were forced to pass the crushing workshop, putting in operation the crushers and all the equipment of crushing workshop and spending high value of not useful energy. Except it the nature of tailings with high content of humidity was causing big problems blocking the crushers. In the improved actual schema it was avoid passing the raw material between crushing workshop and it was substituted with a bin, belt feeder and a trommel for tailings disintegration.

It was changed the aperture of the screen before grinding from 1.2 mm to 0.63 mm that resulted with a better grade of liberation of course fraction.

It was changed the separation of final concentrate in spiral separators, separating only middlings and tailings, treating spiral middlings in hydraulic classifiers and shaking tables. It was added one step of treatment in spiral separators.

It was separated the fine fraction under 74 µ from tailings and it was treated separately in shaking tables with high frequency 420 per minute and short step 5 mm.

The improved technological schema is shown in Figure 2.

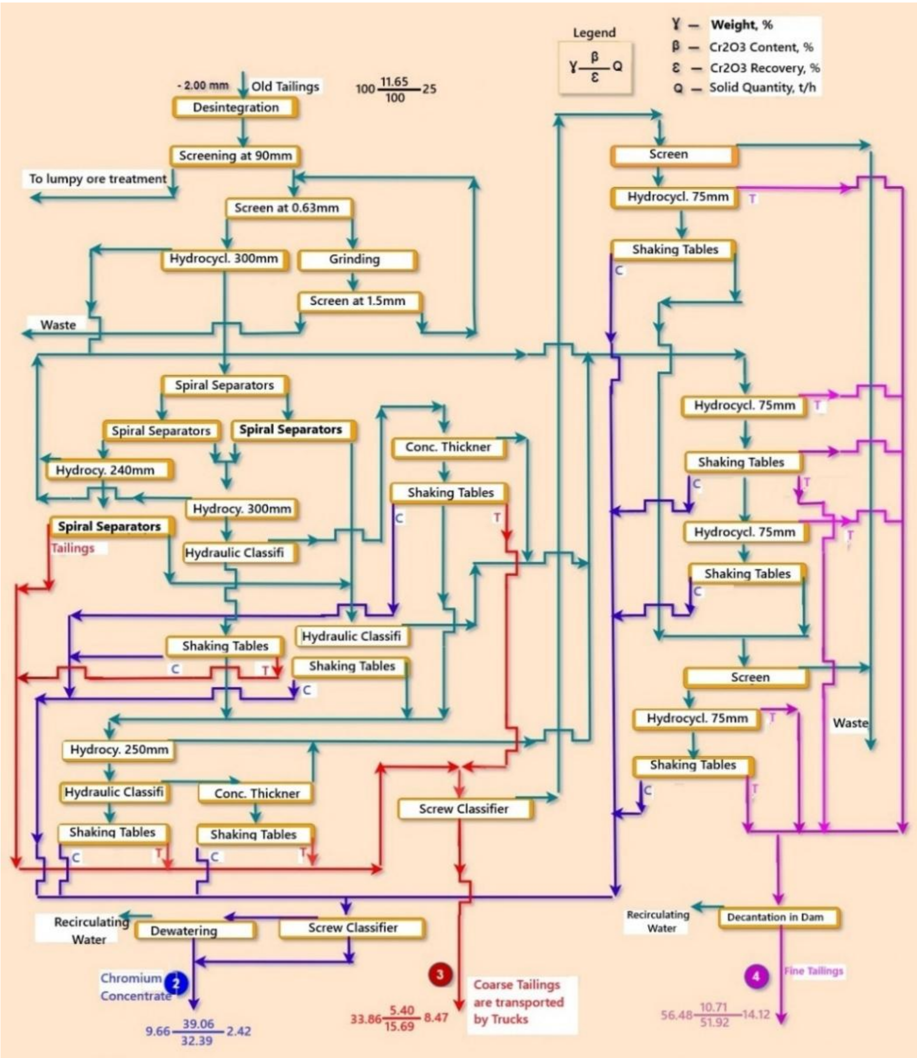

Figure 2 The actual improved technological scheme [6]

There were analysed the improved schema for a period of time since 2020 to 2024 year.

The figures achieved can be considered good, taking in consideration that the treated material is very fine and difficult to be concentrated by gravimetric way.

Several tests were carried out in High Gradient Magnetic Separation HGMS with slime product of Bulqiza dressing plant [5]. From the results obtained the expected performance of a HGMS carousel machine on this material would be a concentrate grade of 36 % Cr2O3 at minimum 60 % Cr_2O_3 recovery. The HGMS parameters would be a magnetic field of 5.1 kGauss, flow velocity 200 mm/s matrix load 0.3 g/cm^3 and matrix XR (or XM). This process was not applied in industrial scale because the figures cannot be warranted and the equipment is very expenses [4].

Another method studied is flotation [1]. The experimental results show that chromite can be readily floated from a slime-free acidic pulp with an Na or K-oleate collector at pH = 2.5 and 5.5 utilizing EDTA also without the use of such modifiers as HF and $AlCl_3$ normally employed and the separation of serpentine can be done at natural pH without depressant if the dosage of collector is not high in relation to the serpentine assay. Comparison of the flotation kinetics of the various minerals reveals that the values for chromite are similar at pH = 2.5 and 5.5, while that for serpentine is lower at 5.5 than at 2.5, unlike olivine which appears to float better at 5.5 than 2.5.

The technical feasibility of rougher flotation at natural pH for stripping serpentine has been confirmed on ores from Bulqiza tailing deposit and Bulqiza tailing of existing processing plant. In this case, cleaner flotation to eliminate olivine can be performed at pH = 2.5-3. The Cr_2O_3 grade and recovery are about 51% and 67% respectively. [1]

RESULTS AND DISCUSSION

The results of recycling and enrichment treatment with gravimetric way in the plant for a long time are presented in the Figure 2 of technological scheme. The particle size distribution and Cr_2O_3 content of the fractions plus and minus 20 µ in the concentrate and tailings are given in the Table 1. [6].

Table 1 Minus and plus 20 µ fraction distribution in raw material and products and Cr_2O_3 content

Fractins µ	Raw Material			Concentrate			Tailings		
	Weig. %	Cr_2O_3, %	Recov. %	Weig. %	Cr_2O_3, %	Recov. %	Weig. %	Cr_2O_3, %	Recov. %
+20	48.63	7.27	30.36	7.49	38.40	24.69	41.14	1.61	5.67
-20	51.37	15.79	69.64	2.17	41.34	7.70	49.20	14.67	61.94
Total	100.00	11.65	100.00	9.66	39.06	32.39	90.34	8.73	67.61

From the results of the table it is clear that the reason of main losses and low grade of concentrate is the high content of fine particles smaller than 20 µ in raw material which cannot be separated with gravimetric methods.

It is necessary testing of wet magnetic separation and flotation of – 20 µ particles. Also last time is mounted a battery of hydrocyclones D=38 mm that will separate the from the overflow of hydrocyclones D=75mm the particles 5 to 20 microns to treat them in shaking tables.

CONCLUSION

Based on the tests carried out in industrial scale results that Cr_2O_3 recovery in concentrate is about 32.4 % and grade of concentrate is about 39% Cr_2O_3 using gravimetric methods.

About 70 % of Cr2O3 quantity that is contained in the raw material (old tailings) is concentrated in the fraction – 20 μ**,** from which only 7.7 % is recovered in chromium concentrate, while about 62 % has passed in the tailings.

The technological figures needs to be improved using flotation or magnetic methods for the treatment of particles under 20 μ.

REFERENCES

1. Belardi, G, Demi G, and Cico, Sh, 2005. Production of high content of Cr and low SiO_2 concentrates from Albanian chromite, in Proceedings of XI Balkan Mineral Processing Congress, Durres 2005, pp 158-165 (Faculty of Geology and Mine, Tirana, Albania). ISBN 99943-694-6-6.
2. Hido, M, Fetahu, K, Peza, V, 2005. Technology of chromium ore processing in Albania, in Proceedings of XI Balkan Mineral Processing Congress, Durres 2005, pp 267-273 (Faculty of Geology and Mine, Tirana, Albania). ISBN 99943-694-6-6.
3. Demi G, Koci, B, and Boci, S, 2006. Gravity concentration of poor chromium ores in Albania, in Proceedings of XXIV International Mineral Processing Congress, Istanbul 2006, pp 310-313 (Istanbul Technical University, Mining Faculty, Turkey). ISBN 975-7946-27-3.
4. Demi G, Fetahu, K, 2008. Treatment of chromium ores in Albania, in Proceedings of XXIII International Mineral Processing Congress, Beijing 2008, pp 4356-4362 (Wang Dian Zuo Sun Chuan Yao Wang Fu Liang Zhang Li Cheng Han Long). ISBN 978-7-03-022711-9(Beijing).
5. Demi G. (2012) Enrichment of chromium tailings in Albania. XXVI International Mineral Processing Congress IMPC 2012 New Delhi, India, Book of abstracts, Vol. 2, pp 661, Paper No. 1053, Session No. 8D-05.
6. Demi G., Koci B., Nika I., 2024. Report of technological figures and analyses of raw material and products of enrichment tailings in Bulqiza plant during period of time 2020 – 2024.