

**EXTRACTION OF NOBLE
AND NON-FERROUS METALS FROM
TECHNOGENIC RAW MATERIALS OF
THE NORILSK INDUSTRIAL REGION:
PRACTICE AND RESEARCHES**

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The largest platinum technogenic deposits of the world are located in the Norilsk industrial region, formed over several decades in the processing of sulphide copper-nickel ores of MMC «Norilsk Nickel» (MMC «NN»). In NN MMC more than 300 million tons of dry industrial waste has been accumulated representing a perspective source of noble metals [1–4].

As additional sources of noble and non-ferrous metals today are considered: stored tails of sulphidic copper-nickel ores enrichment; stored pirrotine and magnetite concentrates; dumps of slags and dusts.

Now for recycling of technogenic waste of NN MMC is offered rather large number of concentrating and metallurgical technologies that are largely focused on receiving a concentrate of noble metals with its further processing in sludge technology.

Tails of Norilsk concentrating factories. The MPG expected resources of concentrating factories tails exceed 800–1000 t. Tails are characterized by the raised contents of platinum (to 2,1 g/t), palladium (to 5,8 g/t), rhodium (to 0,24 g/t), iridium (to 0,044 g/t), ruthenium and osmium (to 0,01–0,05 g/t), gold (to 1,4 g/t), copper (to 0,8 g/t), nickel (to 0,6 g/t) [1].

Actual problem of involvement in production of technogenic waste, including containing PGM, is the creation of the effective and economically reasonable concentrating technology, capable to ensure the qualitative concentrate of valuable components suitable for further processing within existing technologies. Especially as, in tails of enrichment the considerable part of PGM as free mineral allocation is possible to produce rich concentrates by using of gravity separation that will be suitable for processing at the Nadezhdinsky Metallurgical Plant (NMP) [5].

GK «Ruthenium» is practicing modern recycling technology of scatterings of PGMs and gold down the river Shchuchya, in the Norilsk region for a number of years in which upper courses there is a storage of dump tails of Norilsk concentrating factory. Maintenance of MPG in a scattering is 2–3 times more, than in tails, and reaches sometimes tens grams on ton (to 66,6 g/t of Pt, 77,8 g/t of Pd and 18,6 g/t of Au). The applied gravitational scheme of enrichment includes disintegration, classification and additional disintegration in a scrubber, receiving primary concentrate by means of vibrocentrifugal and centrifugal separators, operational development received product to demanded parameters. Extraction of MPG averages 59%, fluctuating from 25 to 67% [6].

The announced results of technological tests of centrifugal separators for processing technogenic dumps showed the possibility of a rich concentrate containing PGMs in an amount up to 20 kg/m.

In NN MMC the technology of additional recovery of MPG from tails of Norilsk concentrating factory is developed by a method of magnetic separation. The sum of Pt, Pd, Rh and Au in magnetic concentrates hesitates ranging from 20 to 40%. For further processing of received magnetic concentrates is offered melting on matte in the presence of charcoal. Also there is an opportunity to send them to a technological chain of Nickel plant as partial substitute of sandstone on ore and thermal melting [7].

According to the project of JSC Mekhanobr Engineering (St.Petersburg) a slurry of the tailings dam of NN MMC, with the maintenance of 20% of solids is subjected to classification (all marked size of material –1,2...0,25 mm), and then fed to the enrichment in the «Knelson» concentrators.

Platinum extraction from sand fraction of the current tailings of disseminated ore enrichment is at 40% at an 0,4% output of graviconcentrate. It is provided to overwork the graviconcentrate with the content of noble metals of 4 kg/t and more in metallurgical manufactory, and below 4 kg/t – as a part of furnace charge of a number of operations of pyrometallurgical repartition [8].

Stored pirrotine concentrates and iron cakes. At floatation enrichment of pirrotine ores of Talnakhsky and October deposits it is formed independent sulphidic product – nickel-pirrotine the concentrate, which stocks in storages make more than 10 million t. Pirrotine concentrate contains to 10 g/t and more MPG, 0,3 g/t of Au, more than 10 g/t of Ag, 1–3% of Ni and Cu, 0,1% With. Noble metals are disseminated in complex and thin composition of sulphidic minerals in the form of impregnations that does the mechanical methods of their separation from breed ineffective [9, 10, 11].

In NN MMC pirrotine concentrate is processed by flotation, preceded by the classification and grinding in ball mills for disclosure compacted grains. Finished concentrate combines with the general Norilsk nickel concentrate of Norilsk processing plant [11]. The disadvantage of this technological scheme is total depletion of the general nickel concentrate and increasing in specific expenses of energy at further pyrometallurgical processing of a material as the pirrotine is rich on iron and a poor product on nickel.

Since June 2009, began involvement in the processing of pirrotine concentrates which has been stored under a water sheet in Kayerkansky coal mine dump, by autoclave oxidizing leaching technology. Pirrotine concentrates in number of 25–30% (masses) are added to pirrotine concentrates of Talnakhsky concentrating factory for their co-processing in hydrometallurgical production of NMZ. The disadvantage of this method are substan-

tial losses of PGM during an autoclave oxidizing leaching [12].

The group of authors developed gravitational and floatation technology of pirrotine concentrates processing which represents allocation of a gravitational concentrate on the devices «Knelson», its enrichment on a concentration table of «Gemeni» (extraction of non-ferrous metals in tails of separation makes 99,0–99,5%) and flotation of tails of enrichment with receiving a rich concentrate on the noble metals, suitable for the subsequent processing in a metallurgical cycle of NN MMC [10].

Magnetite concentrates. Perspective technogenic fields of MPG are the storages of magnetite concentrates created at processing of rich chalkopirite ores of the Talnakhsky field. Those years ferroplatinum from these ores wasn't taken and the maintenance of PGM in dump tails of flotation reached 26 g/t. NN MMC conducts working off of a technogenic magnetite field on gravitational concentrating technology. Use of Knelson concentrators and concentration tables of «Gemeni» allows to receive the gravitational concentrates containing 5–7 kg/t of noble metals and suitable for further processing in a metallurgical cycle. Only for the first year from magnetitovy concentrates 1200 kg of MPG, about 1500 t of nickel and 1000 t of copper [13] are received.

The slag and dust dumps. Perspective sources of noble and non-ferrous metals are slag and dust dumps of dry and wet gas purifications systems of the metallurgical furnaces, accumulated in dumps of NN MMC. For example, in slag dumps of Nickel plant, along with nickel (the contents from 0,04 to 0,12%), copper (from 0,2 to 0,37%) and cobalt (from 0,05 to 0,07%), contains from 1 to 2,2 g/t of the sum of MPG and Au [14].

In work [14] the technological scheme of processing of slags based on application of X-ray radiometric separation is offered. The screening of slag in the class – 10 mm has to precede X-ray radiometric separation. The undersize product after gravitational enrichment can be processed according to the pyrometallurgical or floatation scheme. This technology of additional recovery of noble and non-ferrous metals has to fit successfully in existing on slag dumps production of rubble and a material for adding roads and a filler into concrete. The carried-out technological tests showed reality of such an approach. Processing the previously enriched slags according to the pyrometallurgical scheme is also possible.

In the St. Petersburg Mining University study on development of technology of concoction of noble metals were carried out on samples of a ground precipitation of the slag and dust ponds stores containing totally up to 20% for Cu, Ni, Co. Tests had very high contents (50–100 g/t) the sums of Au, Ag and MPG. It is experimentally shown that collecting of sulphide component of initial material by adhesive flotation in optimum conditions (diesel oil consumption – 20–50% of supply; material

size > 95% of fraction – 44 mkm; L/S = 2–4) at relative simplicity of realization of process provides high rates of concentration of valuable components with receiving the concentrate enriched by 3–5 times on noble metals.

Further processing of the flotoadgeze concentrate by the combining melting on metallized matte and its subsequent liquid-phase sulfatization at 200°C, L/S = 5, within 6 hours provides receiving a rich concentrate of Pt, Pd and Au (total with the contents not less than 1,5%) with extraction of silver, non-ferrous metals and rare platinoids in sulfuric acid solution.

On the basis of the executed researches it is offered process flow sheet of noble metals concentration from a slag dumps material of NN MMC including as the main stages adhesive flotation, collective melting of a concentrate, sulfate processing of matte with receiving a rich platinum concentrate and sorption of rare platinoids from sulfatization solution. This scheme provides the closed cycle of adhesive flotation with full regeneration of adhesive, receiving selective concentrates of noble metals and possibility of passing extraction of non-ferrous metals [15].

References

1. Dodin D.A., Izoitko V.M. // Ore. – 2006. – № 6. – P. 19–23.
2. Senyutina A.B. // Math. universities. Geology and exploration. – 2006. – № 6. – P. 70–73.
3. Dodin D.A., Neruchev S.S. etc // Mining Journal. – 1997. – № 2. – P. 8–11.
4. Stekhin A.I., Kunilov V.E., Oleshkevich O.I. // Core Taymyr. – 1995. – Issue 1. – P. 85–93.
5. Bought V.E., Ryabkin V.A. etc. // Non-ferrous metals. – 1996. – № 5. – P. 35–37.
6. Samoilov A.G., Shatkov V.A. // Mineral Resources of Russia. Economics and Management. – 2000. – № 1. – P. 45–48.
7. Fedoseev I.V. // Non-ferrous metals. – 2006. – № 3. – P. 39–40.
8. Senyutina A.B. The economic rationale involved in the development of man-made deposits of platinum group metals: the dissertation ... Candidate of Economic Sciences. – M, 2006. – 128 p.
9. Naftal M.N., Shestakov R.D. // Non-ferrous metals. – 2001. – № 6. – P. 43–48.
10. Kaitmazov N.G., Pykhtina B.S. etc. // Non-ferrous metals. – 2001. – № 6. – P. 41–42.
11. Brusnichkina L., Kirillov Y., Bolshakov L.A. // Non-ferrous metals. – 2009. – № 8. – P. 72–74.
12. Dmitriev I.V., Kudrin E.G., Petrov A.F. // Non-ferrous metals. 2010, № 6, p. 70–73
13. Fomichev V.B., Blagodatina Y., Sukharev S. // Non-ferrous metals. – 2000. – № 6. – P. 27–29.
14. Makarov V.A. Precious metals manmade mineral objects Siberian region: resources and the problems of geological and technological assessment. / II International Congress «Non-Ferrous Metals of Siberia – 2010» // Krasnoyarsk: Proceedings. – P. 37–45.
15. Petrov G., Kovalev V. Sulfatizatsionnoe autopsy from pyrometallurgical processing of man-made platinum-containing wastes Note Mining Institute. Innovative technologies in metallurgy and enrichment. – St. Petersburg, 2011. – t.192. – P. 32–35.

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