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MAGNETIC HYDROSEPARATION INSTEAD OF DESLIMING FOR THE CONDITIONS OF NORTHERN GOK

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Abstract. The magnetic technology of iron ore dressing, widely used in Krivbass, in contrast to factories abroad, in addition to magnetic separation, has another processing operation – desliming. The MD-5 and MD-9 deslimers used are installed before the magnetic separation of stages 2 and 3 and ensure the removal of dump tails from the discharge of hydrocyclones. According to the existing technology, about 60% of the waste mass is removed from the ore, of which the main share is on magnetic separators and 7-10% on deslimers. Technologically, the tailings of deslimers always cleaner in terms of iron content than magnetic separation. The task was to increase the output of tails on desliming. This will allow you to get dump tails with less iron loss. This task was solved by creating new devices based on the existing MD-5 and MD-9 deslimers - magnetic hydraulic separators MGS-5 and MGS-9. To do this, existing deslimers were equipped with special structural elements and permanent magnet magnetic systems, and then switched to magnetic hydroseparation mode. The technology using magnetic hydraulic separators MGS-5 and MGS-9 passed industrial tests in the period 1995-2007. Today it is used in all technological sections of the processing plants of FERREXPO POLTAVA MINING COMPANY and Joint Stock Company LEBEDINSKY MINING AND PROCESSING PLANT. The article informatively describes the industrial experience of using MGS-5 and MGS-9 at the Poltavsky and Lebedinsky GOKs. Based on the existing experience of industrial operation of the magnetic hydroseparation of the MGS, the predicted results for the technology using the MGS at the 1st and 2nd stages of desliming during the modernization of existing deslimers at the processing plant of Northern GOK are determined. As a result of the use of MGS at Northern GOK, it is expected to increase the yield of concentrate at the planned productivity of sections at the planned quality of concentrate by reducing the iron content in the tailings.

Keywords: deslimers, modernization, iron ore concentrate

Introduction. The five largest iron ore mining and processing plants of Krivbass were built in the period from 1955 (Southern GOK) to 1965 (Inguletsky GOK). The scheme of two-stage ore crushing with classification and magnetic separation after each stage adopted in the West was taken as a basis. Later, this scheme was transformed into a technology with three-stage grinding. This was accomplished by redistributing the pulp transport flows or, more simply, by combining adjacent half-sections. Also, unlike Western schemes, thanks to the works by the Institute of Mechanobrchermet (Krivoy Rog), the technology before the magnetic separation of the 2nd and 3rd stages began to use desliming.

At the first departments of ore-processing plants (ROF-1), MD-5 deslimers with a diameter of 5 meters were used, MD-9 was used during the construction of subsequent departments. Deslimers MD-12 has operational experience only at Stoilensky GOK (Stary Oskol, Russia)

The desliming operation ensures the removal of fine non-metallic particles and poor accretions from the hydrocyclone drain into the dump tails before its magnetic separation [1]. Desliming plays an important role in ensuring the high quality of the concentrate, since the not removed sludge flocculates and is attracted to the drum of magnetic separators, which dilutes the concentrate. Research work on improving the efficiency of desliming in the technology of iron ore enrichment has been carried out for many years at the Institute of Geotechnical Mechanics NAS of Ukraine [2, 3].

The purpose is to provide information materials on the industrial experience available in the IGTM NAS of Ukraine in improving the operation of desliming and

to outline the prospects for a similar modernization of desliming at Northern GOK (Private Joint Stock Company Northern Iron Ore Mining and Processing Plant).

It is known that in typical magnetic schemes of iron ore dressing, the total yield of dump tailings is about 60%. Some of them are discharged on magnetic separators, some on deslimers. The main share, about 40%, of the tails is removed at the 1st stage of magnetic separation, the share of desliming of both stages accounts for about 7-10%. It is also known from the practice of dressing that the tailings of the desliming operation are always cleaner in terms of iron content than the tails of magnetic separation.

The main idea of improving the dressing technology was to redistribute the tailings output between operations in such a way that the main share of the tailings were dumped on deslimers, and not on magnetic separators. As a result, the final dump tails will be cleaner in iron. It is immutable that the total amount of tails should be about 60%, however, it does not matter on which devices, or due to which operation they will be withdrawn.

Methods. Main idea**.** In order to ensure the implementation of this idea, it is necessary to ensure high efficiency of deslimers. For this purpose, the existing MD type deslimers have been upgraded, namely, equipped with additional structural elements, including magnetic ones, with a corresponding change in the operating mode. The upgraded deslimers were called MGS – magnetic hydraulic separators, or magnetic hydroseparators ("МГС" originally). When creating the MGS, the task was to significantly increase the yield of tails in the operation without increasing the iron content in them.

It is known that the desliming process is carried out in such a way that the iron content in the drain (tailings) of deslimers is as low as possible, and the iron gain in the sands is as high as possible [1].

Practice shows that these requirements are polar. For example, if we maintain a thin overflow on deslimers, we will get a relatively clean iron drain that enters the dump tails. However, with a low overflow, the speed of the upward flow in the deslimer will be small, the accretions and non-metallic particles have time to settle to the bottom, so the increase in the iron content in the sands will be insignificant, that is, desliming, as an dressing operation, loses its effectiveness.

In order to maintain a high rate of upward flow without increasing losses of iron with tails, it was proposed to place branched magnetic systems of permanent magnets in the working volume of the deslimer. At the same time, structural elements were placed in the volume of the deslimer to adjust the hydrodynamics (Fig.1).

The first work on the creation of the MGS was carried out by V.A. Chumakov at the Dnepropetrovsk Mining Institute. Later, these works were continued at Institute of Geotechnical Mechanics of National Academy of Sciences of Ukraine in the direction of simplifying the design of the MGS and increasing the dressing indicators.

Methods**.** The method of research is industrial testing of MGS equipment and forecasting. MGS devices are mounted on the basis of existing MD deslimers in which magnetic systems and hydrodynamic structural elements are installed, that is, MGS-5 is created on the basis of MD-5, MGS-9 on the basis of MD-9.

The effect of the MGS operation is that, firstly, due to the creation of a volumetric magnetic field in the separation zone, the content of magnetic iron in the tails decreases. Secondly, at the same time, the content of oxidized iron in the tails decreases. This is due to a change in hydrodynamics, which allows to keep weakly magnetic oxidized iron and rich accretions from being carried out into the drain, they fall into the sands and then into the concentrate. The result is a significant decrease in total and magnetic iron in the tails of the MGS under the same operating mode as on the MD. With a change in the regime, namely, with an increase in the overflow level at the MGC, the iron content in the tailings increases slightly, but at the same time the increase in iron in the sands of the MGC is invariably higher than it is achieved at the MD. That is, MGS allow you to work with a high level of overflow without a significant increase in the iron content in the tailings.

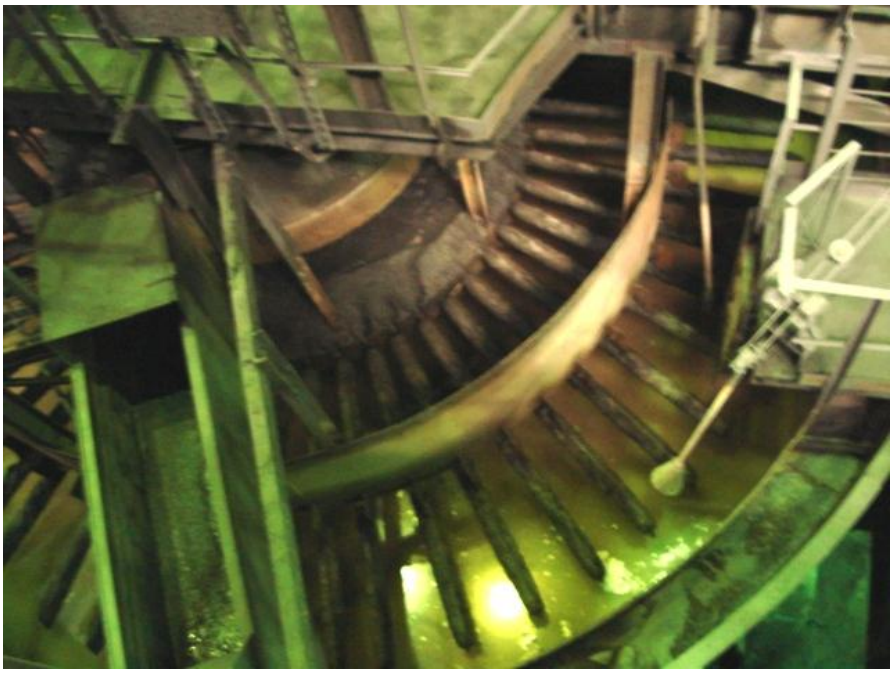

Figure 1 – Magnetic hydroseparator MGS-9

Results and discussion. The MGS devices have received recognition and have been widely replicated on two GOKs – Poltavsky and Lebedinsky. Industrial tests of MGS devices on various sections of the technological scheme were completed at the Poltava GOK in 1996, at Lebedinsky in 2007, then the MGS were included in the plans for the reconstruction of factories. As of today, at the Poltavsky GOK, MGS are working on all sections of ROF-1 and ROF-2, at the Lebedinsky GOK, they are equipped with three enrichment workshops and a fourth concentrate dressing workshop to a quality of 70%.

An important feature is that the MGS, compared with the MD, allows you to work with double the power load without increasing the iron content in the drain. Therefore, at both plants, work on one MGS is widely used in receiving the discharge of hydrocyclones of stage 1 and 2, whereas the traditional scheme involves working on two MD devices in each reception. A comparison of the performance of MD and

MGS in the operation is shown in Table 1 and 2, where the yield, total iron content and iron extraction are given as percentages.

Table 1 – Ferrexpo Poltava Mining Company.
Comparison of MD-5 and MGS-5 (for 2 stage, scheme of 3 crushing stage, ROF-1, sections № 7 *)

Products	**MD-5**			**MGS-5**			Change in $Fe_{gen.}$%
	Output	Content	Extr.	Output	Content	Extr.	
Feed	100	62.11	100	100	62.11	100	
Sands	98.57	62.83	99.71	97.67	63.34	99.60	+0.51
Discharge	1.43	12.5	0.29	2.33	10.66	0.40	-1.84

* Both apparatuses operated with similar productivity, on average 50 t /hour

Table 2 – Joint Stock Company Lebedinsky Mining and Processing Plant. Comparison of MD-9 and MGS-9 (for 1 stage, scheme of 3 crushing stage, dressing department № 3*)

Products	**MD-9**			**MGS-9**			Change in $Fe_{gen.}$%
	Output	Content	Extr.	Output	Content	Extr.	
Feed	100	58.58	100	100	58.58	100	
Sands	89.88	63.71	97.75	89.88	64.16	98.45	+0.45
Discharge	10.12	13.0	2.25	10.12	9.0	1.55	-4.0

* Productivity per one apparatus: MD-9 – 249 t/hour; MGS-9 – 272 t/hour

The technology with MGS deslimers instead of MD allows us to solve two tasks: to improve the quality of the final concentrate or to increase its yield at the planned quality. The solution of the first task was performed on Lebedinsky GOK, the second - on Poltavsky GOK.

At Lebedinsky GOK, the efficiency of the MGS compared to MD was especially evident on dressing department № 4 for additional preparation of concentrate. This department works with small product 92 - 96% of class minus 0.044 mm. Here, in the operation, the MGS devices provide a stable increase in iron in the sands with a decrease in the total iron content in the tails by 1.29 - 2.92%, while the magnetic iron content also decreases by 1.77 - 2.29%.

The use of MGS on the ROF-1 Poltavsky GOC made it possible to implement the scheme without the first stage of magnetic separation, that is, the main share of dump tailings was provided by MGS. At the same time, the quality of the final concentrate remained planned, and the total iron in the dump tailings decreased. By reducing the iron content in the tailings, the yield of concentrate increases without reducing its quality.

Taking into account the positive experience of industrial operation, technical proposals for the use of MGS in the conditions of NORTHERN GOK have been developed. The project provides that without reducing the productivity and quality of the concentrate, the use of MGS at stages 1 and 2 desliming will ensure a reduction in the iron content in the dump tailings (Tables 3 and 4).

Table 3 – Northern GOK. Desliming tailings (project)

Operation	Fe gen./ Fe magn., %		Change, %	
	MD	**MGS**	Fe gen., %	Fe magn., %
1 desl. st.	16.5 / 3.24	13.0 /1.5	-3.5	-1.74
2 desl. st.	14.4 / 3.0	13.4 / 2.0	-1.0	-1.0

Table 4 – Northern GOK**.** Indices of final tailings in terms of MD and MGS technology (project)

Technology	Fe gen., %	Fe magn., %
MD at st. 1 and 2	17.4	3.61
MGS at st. 1 and 2	17.03	3.4

According to NORTHERN GOK technology, we will accept the content of Fe total in the initial ore as 34.86%.

Then, with concentrate quality of 64.97% being similar for both schemes - with MD and with MGS, technology with MGSs, which are used at the desliming stages 1 and 2, provides increase of final concentrate output up to 0.48% due to the reduced iron content by 17.4-17.03 = 0.37% in the final tailings

When assessing the technical and economic indicators of a new technology, it should be taken into account that the modernization of existing deslimers is a one–time capital expenditure. The service life of the MGS is the same as the MD. The use of magnetic hydraulic separators MGS-5 and MGS-9 in the technology is not accompanied by an increase in the consumption of ore, water and electricity. The operating costs for repairs and maintenance, for example, MGS-9 remain the same as for existing MD-9 deslimers.

Conclusion. The technology using magnetic hydraulic separators MGS-5 and MGS-9 is used in all technological sections of the processing plants of FERREXPO POLTAVA MINING COMPANY and Joint Stock Company LEBEDINSKY MINING AND PROCESSING PLANT. The article informatively describes the industrial experience of using MGS-5 and MGS-9 at the Poltavsky and Lebedinsky GOKs. Based on the existing experience of industrial operation of the magnetic hydroseparation of the MGS, the predicted results for the technology using the MGS at the 1st and 2nd stages of desliming during the modernization of existing deslimers at the processing plant of Northern GOK are determined. As a result of the use of MGS at Northern GOK, it is expected to increase the yield of concentrate at the planned productivity of sections at the planned quality of concentrate by reducing the iron content in the tailings.

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ВИКОРИСТАННЯ МАГНІТНОЇ ГІДРОСЕПАРАЦІЇ ЗАМІСТЬ ДЕШЛАМАЦІЇ ДЛЯ УМОВ ПІВНІЧНОГО ГЗК

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Анотація. Широко застосовувана у Кривбасі магнітна технологія збагачення залізних руд, на відміну від фабрик далекого зарубіжжя, крім магнітної сепарації має ще одну збагачувальну операцію – дешламацію. Дешламатори МД-5 і МД-9, що використовуються, встановлюють перед магнітною сепарацією 2 і 3 стадій, вони забезпечують виведення відвальних хвостів зі зливу гідроциклонів. Відповідно до існуючої технології всього з руди виводиться близько 60% маси відходів, їх основна частина - на магнітних сепараторах і 7-10% на дешламаторах. Технологічно хвости дешламації завжди чистіші за вмістом заліза, ніж магнітної сепарації. Ставилося завдання збільшити вихід хвостів на дешламації. Це дозволить отримувати відвальні хвости з меншими втратами заліза. Це завдання вирішувалося шляхом створення на базі існуючих дешламаторів МД-5 та МД-9 нових апаратів - магнітних гідросепараторів МГС-5 та МГС-9. Для цього існуючі дешламатори оснащувалися спеціальними конструктивними елементами та магнітними системами на постійних магнітах, а потім переводилися в режим магнітної гідросепарації. Технологія з використанням магнітних гідросепараторів МГС-5 і МГС-9 пройшла промислові випробування у період 1995-2007 років. На сьогодні вона використовується на всіх технологічних секціях збагачувальних фабрик Полтавського та Лебединського ГЗК. У статті інформативно викладено промисловий досвід використання МГС-5 та МГС-9 на Полтавському і Лебединському ГЗК. На підставі наявного досвіду промислової експлуатації магнітної гідросепарації МГС визначено прогнозовані результати для технології з використанням МГС на 1 та 2 стадіях дешламації при модернізації існуючих дешламаторів на збагачувальній фабриці Північного ГЗК. В результаті використання МГС на ПівнГЗК очікується підвищення виходу концентрату при плановій продуктивності секцій та плановій якості концентрату за рахунок зниження вмісту заліза у відвальних хвостах.

Ключові слова: дешламатор, модернізація, концентрат

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