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PROCEEDINGS

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Editors:
Ljubiša Balanović
Dejan Tanikić

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović

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INVESTIGATION ON BENEFICIATION OF IRON FROM COPPER ORE OF MAURITANIA COPPER MINE (MCM) BY MAGNETIC SEPARATION

Jovica Sokolović[1], Grozdanka Bogdanović[1], Velizar Stanković[1], Gracijan Strainović[2], Ivana Ilić[1], Milan Gorgievski[1], Miljan Marković[1]

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Abstract
In this study, magnetic separation were used to beneficiation iron from copper ore of Mauritania Copper Mine (MCM). The work aimed to maximize the recovery of iron values by upgrading to a high-grade product suitable for steelmaking industry. The received ore contains 1.30% Cu, and 49.50% Fe. Research was conducted on two size fractions: A (-3.35+0 mm) and B (-0.425+0 mm), as a product of grinding the crushed ore until to reach a size fraction of containing 60% of particles < 75 μm. Comparing the mass yields as the distribution of copper and iron by magnetic and non-magnetic fractions, the better results is achieved on the finer size fraction at the magnetic field of ***7.15 x 10^{-4} T.*** *Under that condition, the magnetic fraction, has a mass yield of* ***23.43 %,*** *containing* ***74.86% Fe and 0.2% Cu.*** *The magnetic fraction, with 74.86% Fe, can be used as a raw material in iron metallurgy.*

Keywords*: copper, MCM ore, iron, magnetic, separation*

1. INTRODUCTION

Magnetic separation is one of the most widely used processes for the upgradation of iron ore [1, 2]. The concentration of various ferrous and non-ferrous minerals has become an important application from industrial minerals [3]. This method of concentration can be used very effectively to extract and valorize iron from other ores, such as copper ore from MCM [4]. In this study, the results of the laboratory magnetic concentration analysis tests were shown.

2. EXPERIMENTAL

2.1. Materials

Research was conducted on copper ore of Mauritania Copper Mine (MCM). The results of the chemical analysis show that the received ore contains 1.30% Cu, and 49.50% Fe. The dominant iron minerals include goethite, hematite, and siderite [4].

2.2. Laboratory magnetic concentration

The teste of magnetic concentration were carried out on the laboratory Davis Tube magnetic analyzer at different strengths of magnetic field in the range from 1.79 to 11.02 x 10-4 T. The conditions under which the laboratory experiment took place in magnetic analyzer were as follows: temperature: 22 ^{0}C, solid-liquid ratio: S:L = 1:4, current: 1, 3, 5, 7 and 9 A and time: 10-15 min.

Research was conducted on two samples with different size fractions: Sample A (-3,35+0 mm) and Sample B (-0,425+0 mm), which is the product of grinding the copper ore with a content of -0.075 mm size fraction of 60%. The content of iron (Fe) and copper (Cu) were analyzed in the obtained magnetic (MF) and nonmagnetic (NMF) fractions in all carried out experiments.

3. RESULTS AND DISCUSSION

Results of the laboratory magnetic concentration tests of sample A (-3,35+0 mm) are shown in Table 1 – 2, and Figures 1 – 2.

Table 1 - Results of the laboratory magnetic concentration tests of sample A (-3,35+0 mm)

Current (A)	**1**	**3**	**5**	**7**	**9**
Magnetic induction (T) x 10^{-4}	**1.79**	**4.63**	**7.15**	**9.55**	**11.02**
Mass of Magnetic (MF) fraction (%)	5.11	27.57	33.57	34.71	34.07
Mass of Non-magnetic (NMF) fraction (%)	94.89	72.43	66.43	65.29	65.93
Σ	100.00	100.00	100.00	100.00	100.00

Table 2 - Results of Cu and Fe grade of the magnetic (MF) and nonmagnetic (NMF) fractions

	Magnetic (MF) fraction				**Non-magnetic (NMF) fraction**			
Current (A)	**Cu (%)**	**RCu (%)**	**Fe (%)**	**RFe (%)**	**Cu (%)**	**RCu (%)**	**Fe (%)**	**RFe (%)**
1	0.20	0.77	77.35	7.99	1.36	99.23	48.00	92.01
3	0.47	10.00	66.57	37.07	1.62	90.00	43.01	62.93
5	0.56	14.58	71.38	48.42	1.67	85.42	38.43	51.58
7	0.52	13.99	69.85	48.98	1.71	86.01	38.69	51.02
9	0.53	13.76	70.57	48.55	1.71	86.24	38.65	51.45

RCu – Distribution of copper in the magnetic (MF) and nonmagnetic (NMF) fractions
RFe – Distribution of iron in the magnetic (MF) and nonmagnetic (NMF) fractions

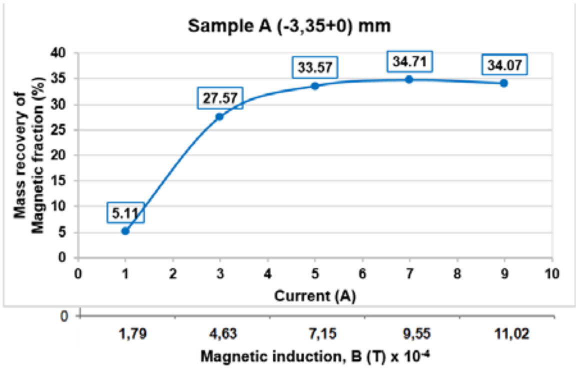

Figure 1 - Effect of intensity on mass recovery of the magnetic fraction

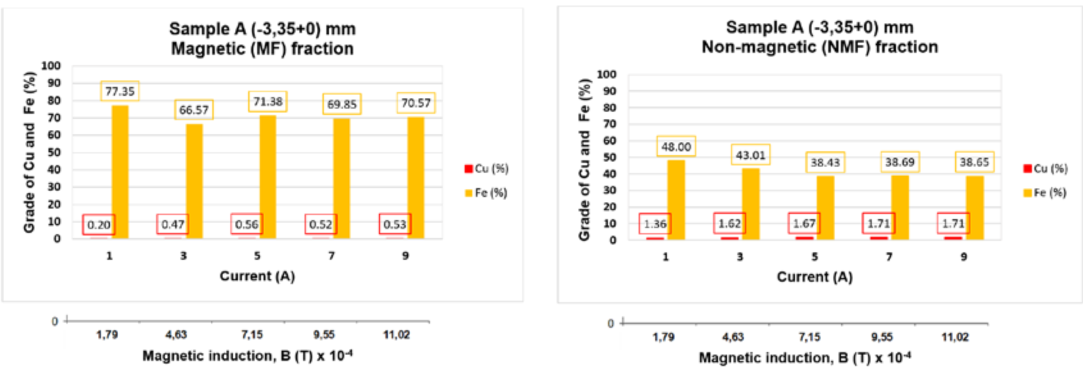

Figure 2 - Effect of intensity on Cu and Fe grade of the
a) magnetic fraction and b) non-magnetic fraction

Based on the results of the experiments shown in Tables 1 and 2, it can be concluded that the magnetic field strength significantly influences the mass recovery and quality of the magnetic product. The best magnetic separation of the tested sample into the magnetic and non-magnetic fractions is obtained at a current intensity of **7 A** or at the induction of a magnetic field of **9.55 x 10-4 T.**

The non-magnetic fraction, obtained from this magnetic field induction in the mass of **65.29%** and with copper and iron content of **1.71% Cu** and **38.65% Fe**, is useful for further leaching treatment, in order to recovery copper.
Results of the laboratory magnetic concentration tests of sample B (-0,425+0 mm) are shown in Table 3 – 4 and Figures 3 – 4.

Table 3 - Results of the laboratory magnetic concentration tests of sample B (-0,425+0 mm)

Current (A)	**1**	**3**	**5**	**7**	**9**
Magnetic induction (T) x 10^{-4}	**1.79**	**4.63**	**7.15**	**9.55**	**11.02**
Mass of Magnetic (MF) fraction (%)	12.83	21.73	23.43	23.19	23.84
Mass of Non-magnetic (NMF) fraction (%)	87.17	78.27	76.57	76.81	76.16
Σ	100.00	100.00	100.00	100.00	100.00

Table 4 - Results of Cu and Fe grade of the magnetic (MF) and nonmagnetic (NMF) fractions

	Magnetic (MF) fraction				**Non-magnetic (NMF) fraction**			
Current (A)	**Cu (%)**	**RCu (%)**	**Fe (%)**	**RFe (%)**	**Cu (%)**	**RCu (%)**	**Fe (%)**	**RFe (%)**
1	0.18	1.82	75.20	19.48	1.46	98.18	45.72	80.52
3	0.20	3.31	75.48	33.14	1.61	96.69	42.29	66.86
5	0.20	3.57	74.86	35.44	1.64	96.43	41.74	64.56
7	0.21	3.75	75.75	35.48	1.63	96.25	41.58	64.52
9	0.20	3.69	74.83	36.04	1.64	96.31	41.57	63.96

RCu – Distribution of copper in the magnetic (MF) and nonmagnetic (NMF) fractions
RFe – Distribution of iron in the magnetic (MF) and nonmagnetic (NMF) fractions

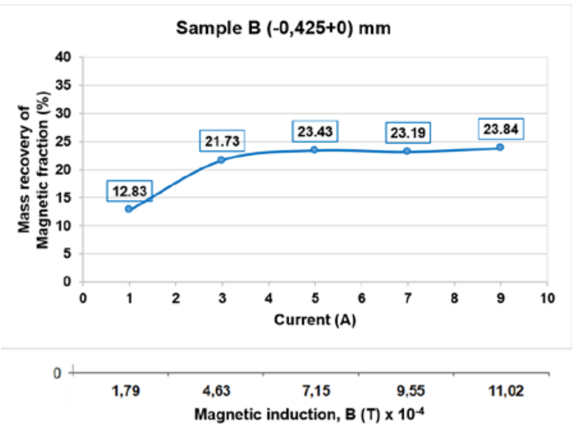

Figure 3 - Effect of intensity on mass recovery of the magnetic fraction

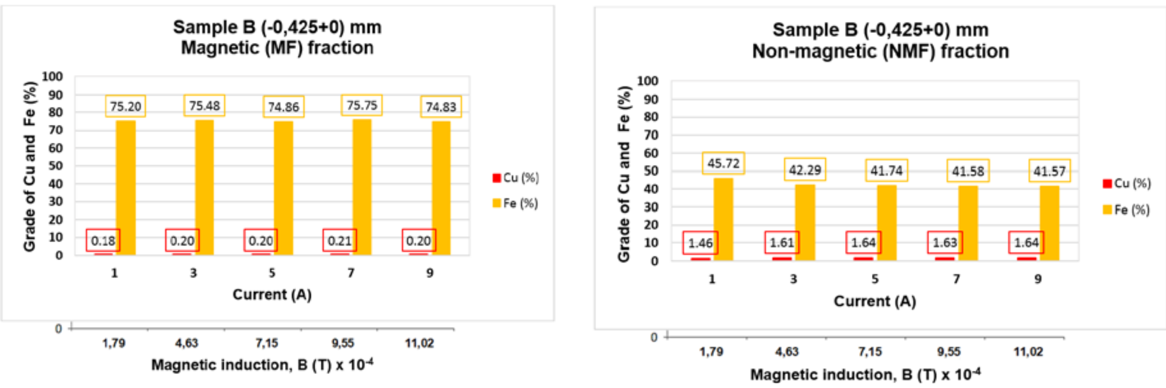

Figure 4 - Effect of intensity on Cu and Fe grade of the
a) magnetic fraction and b) non-magnetic fraction

According to the results of the experiments shown in Tables 3 and 4, it can be concluded that at a current intensity of **5 A** or the induction of a magnetic field of **7.15 10^{-4} T**, the best magnetic separation results of the tested sample into magnetic and non-magnetic fractions is obtained. The optimum grade that could be obtained from single-stage magnetic separation was **74.86% Fe**, in the case of sample B.
The magnetic fraction, which has a mass yield of **23.43%** with iron content of **74.86% Fe**, can be used as a raw material in iron metallurgy to obtain steel. The minimum iron content in the ore for steel production varies depending on the specific process and requirements of the steelmaking industry. However, in general, iron ore with a minimum iron content of around 50% to 55% is typically used for steel production.
The non-magnetic fraction, which has a mass yield of **76.57%** with copper and iron content of **1.64% Cu** and **41.74% Fe**, is thus appropriate for additional leaching treatment in order to recover copper. Further leaching studies of non-magnetic fraction are needed to maximize the efficiency of copper upgrading.

4. CONCLUSION

Magnetic concentration analysis of the oxide ore was conducted on two size fractions: A (-3.35+0 mm) corresponding to the crushed ore and B (-0.425+0 mm), as a product of grinding the crushed ore until to reach a size fraction of containing 60% of particles < 75 μm. Magnetic concentration tests were carried out on the laboratory Davis Tube magnetic analyser, at magnetic field strengths in a range from 1.79 x 10^{-4} to 11.02 x 10^{-4} T. Experimental results shown a better magnetic separation is achieved on the finer size fraction at the current intensity of **5 A** what corresponds to **7.15 10^{-4} T**. Under that condition, the magnetic fraction, has a mass yield of **23.43 %,** containing **74.86% Fe and 0.2% Cu.** The non-magnetic fraction has a mass yield of **76.57 %,** with an increased copper content of **1.64 % Cu, while** an iron concentration was **41.74 % Fe**. The magnetic fraction, with 74.86% Fe, can be used as a raw material in iron metallurgy. Also, further leaching studies of non-magnetic fraction are needed to maximize the efficiency of copper upgrading.

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