



Proceedings of
XVI BALKAN MINERAL PROCESSING CONGRESS
Belgrade, Serbia, June 17-19, 2015



Mining Institute
Belgrade



Academy of Engineering
Sciences of Serbia



University
of Belgrade



Proceedings of
**XVI BALKAN MINERAL
PROCESSING CONGRESS**

Belgrade, Serbia, June 17-19, 2015

55
years of
Mining
Institute
Belgrade

70
years of
Faculty
of Mining
and Geology
University
of Belgrade

VOLUME
I

VOLUME I

Edited by

Nadežda Čalić, Ljubiša Andrić,
Igor Miljanović, Ivana Simović



MINING INSTITUTE BELGRADE

ACADEMY OF ENGINEERING SCIENCES OF SERBIA

UNIVERSITY OF BELGRADE

Proceedings of
XVI BALKAN MINERAL PROCESSING CONGRESS
Belgrade, Serbia, June 17-19, 2015



VOLUME I

Edited by

Nadežda Čalić, Ljubiša Andrić,
Igor Miljanović, Ivana Simović

2015

XVI BALKAN MINERAL PROCESSING CONGRESS
BOOK OF PROCEEDINGS

Editors: Prof. Dr. Nadežda Čalić, Academy of Engineering Sciences of Serbia
Prof. Dr. Ljubiša Andrić, ITNMS and Academy of Engineering Sciences of Serbia
Prof. Dr. Igor Miljanović, University of Belgrade, Faculty of Mining and Geology
Dipl. Eng. Ivana Simović, Mining Institute Belgrade, Serbia

Congres Organizers and Publishers:



MINING INSTITUTE BELGRADE
11080 Belgrade, Batajnički put 2
Tel: + 381 11 21 99 277, fax: + 381 11 26 14 632,
e. mail: direktor@ribeograd.ac.rs, <http://www.ribeograd.ac.rs>



ACADEMY OF ENGINEERING SCIENCE OF SERBIA
Department for Mining, Geology and Systems Sciences
11000 Belgrade, Kraljice Marije 16
Tel: + 381 11 3370652, +381 64 11 27 533,
e. mail: ains@ains.rs, <http://www.ains.rs>



UNIVERSITY OF BELGRADE
11000 Belgrade, Studentski trg 1
Tel: + 381 11 3207400, fax: + 381 11 3207481
e. mail: kabinet@rect.bg.ac.rs, <http://www.bg.ac.rs>

For the publishers: MSc Milinko Radosavljević, director, Mining Institute Belgrade

Printed by: Colorgrafx, Belgrade

Issued in: 2015.

Circulation: 300

ISBN: ISBN 978-86-82673-10-1 (MI)

CIP - Каталогизacija u publikaciji -
Narodna biblioteka Srbije, Beograd

622.7(082)

BALKAN Mineral Processing Congress (16th ; 2015 ; Belgrade)
Proceedings of XVI Balkan Mineral Processing Congress, Belgrade, Serbia,
June 17-19, 2015. Vol. 1 / [congress organizers] Mining Institute Belgrade
[and] Academy of Engineering Science of Serbia [and] University of Belgrade
; edited by Nadežda Čalić ... [et al.]. - Belgrade : Mining Institute :
Academy of Engineering Science of Serbia : University of Belgrade, 2015
(Belgrade : Colorgrafx). - VII, 589 str. : ilustr. ; 30 cm

Tiraž 300. - Str. VII: Foreword / Nadežda Čalić. - Bibliografija uz svaki
rad. - Registar.

ISBN 978-86-82673-10-1 (MI)

1. Čalić, Nadežda [urednik] [autor dodatnog teksta]
2. Mining Institute (Belgrade)
a) Rude - Priprema - Zbornici

COBISS.SR-ID 215731468

Copyright ©: Mining Institute Belgrade, Academy of Engineering Science of Serbia, University of Belgrade.

XVI BALKAN MINERAL PROCESSING CONGRESS



HELD UNDER THE AUSPICES OF THE MINISTRY OF MINING AND ENERGY, AND FINANCIALLY SUPPORTED BY THE MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGICAL DEVELOPMENT OF REPUBLIC OF SERBIA

SPONSORS:

GENERAL SPONSOR



GOLDEN SPONSORS



SILVER SPONSOR



BRONZE SPONSOR



BMPC International Scientific Committee

President:

Prof. Dr. Güven Önal, Turkey

Vice President:

Prof. Dr. Ljubiša Andrić, Serbia

Members:

Prof. Dr. Gülhan Özbayoğlu, Turkey

Prof. Dr. Neşet Acarkan, Turkey

Prof. Dr. Georgios Anastassakis, Greece

Prof. Dr. Ivan Nishkov, Bulgaria

Prof. Dr. Dessislava Kostova, Bulgaria

Prof. Dr. Sanda Krausz, Romania

Dr. Eng. Viorica Ciocan, Romania

Prof. Dr. Nadežda Čalić, Serbia

Prof. Dr. Genç Demi, Albania

Assoc. Prof. Dr. Kimet Fetahu, Albania

Assoc. Prof. Dr. Nedžad Alić, Bosnia and Herzegovina

Dipl. Eng. Miroslav Glušac, Bosnia and Herzegovina

Prof. Dr. Boris Krstev, FYR Macedonia

Dipl. Eng. Boris Fidancev, FYR Macedonia

Prof. Dr. Shyqri Kelmendi, coreponding member

Honorary members:

Prof. Dr. Nadejda Davcheva-Ilcheva, Bulgaria

Prof. Dr. Paraschiv Ilie, Romania

Prof. Dr. Zeki Douğan, Turkey

Prof. Dr. Suna Atak, Turkey

Prof. Dr. Dušan Salatic, Serbia

XVI BMPC Organizing Committee

President:

Prof. Dr. Nadežda Čalić, Academy of Engineering Sciences of Serbia

Vice Presidents:

Prof. Dr. Ljubiša Andrić, Institute for Technology of Nuclear and other Mineral Raw Materials-ITNMS, and Academy of Engineering Sciences of Serbia

Dipl. Eng. Ivana Simović, Mining institute Belgrade

Prof. Dr. Igor Miljanović, University of Belgrade, Faculty of Mining and Geology

Members:

Dipl. Eng. Kostović Nebojša, Mining institute Belgrade

Dipl. Eng. Pavle Stjepanović, Mining institute Belgrade

Dr. Dragan Radulović, ITNMS Belgrade

Dipl. Eng. Nenad Milojković, Mining institute Belgrade

Dr. Vladan Milošević, ITNMS Belgrade

Dipl. Eng. Klara Konc Janković, Mining institute Belgrade

Mr. Dejan Todorović ITNMS Belgrade

Dipl. Eng. Dejan Lazić, Mining institute Belgrade

Dr. Milan Petrov, ITNMS Belgrade

Dipl. Eng. Jelena Čarapić, ITNMS Belgrade

Dr. Slavica Mihajlović, ITNMS Belgrade

Dipl. Eng. Ljubiša Spasić, Coal Basin Kolubara

Mr. Vladimir Jovanović, ITNMS Belgrade

Dipl. Eng. Slavko Slipčević, Power Plants and Mines Kostolac

Dr. Jovica Sokolović, University of Belgrade, Technical faculty at Bor

Mr. Zoran Bartulović, ITNMS Belgrade

Dr. Dragan Milanović, Mining and Metallurgy Institute Bor

Dipl. Eng. Branislav Ivošević, ITNMS Belgrade

Mr. Dejan Antić, University of Belgrade, Technical faculty at Bor

Dr. Zoran Stevanović, Mining and Metallurgy Institute Bor

Dipl. Eng. Maja Trumić, University of Belgrade, Technical faculty at Bor

Dr. Miroslav Ignjatović, Chamber of Commerce and Industry of Serbia

XVI BMPC Scientific Committee

Prof. Dr. Predrag Lazić

Prof. Dr. Milena Kostović

Prof. Dr. Zoran Marković

Prof. Dr. Milan Trumić

Prof. Dr. Grozdanka Bogdanović

Prof. Dr. Rodoljub Stanojlović

Honorary members:

Prof. Dr. Dragiša Draškić

Prof. Dr. Dušan Salatić

Prof. Dr. Stevan Puštrić

Prof. Dr. Jovo Pavlica

Prof. Dr. Slaven Deušić

Prof. Dr. Siniša Milošević

Prof. Dr. Nedeljko Magdalinović

Prof. Dr. Milorad Grujić

Foreword

Practically, all human societies depend on the availability and use of mined products. Mining and mineral processing has played a vital part in the history and economy of the Balkans.

In the world, mineral processing was an art till the 1920s, when it started to become a science. The achievements of fundamental science enabled the explanation of phenomena in the processes of mineral processing, or they started from fundamental science to come to an appropriate solution in mineral processing. In many respects mineral processing becomes fundamental science.

Balkan countries have more or less rapidly accepted innovations in the field of mining and mineral processing.

Generations of professionals from Balkan trained on the tradition of mining schools, afterward universities, (Schemnitz established 1702, Jachimov 1716, Banska Štiavnica 1725, Jekatarinburg 1730, L' Ecole Polytechnique 1794 in Paris, Politehnika in Prague, and certainly the most famous Bergakademie Freiberg founded in 1765, and much later, universities in the United States and Soviet Union) contributed to today's level of development of mineral processing, and contributed to the quality of studies of mineral processing, both in the world, and so in the Balkans.

After the Second World War in the Balkans a large number of universities, faculty, institutes and laboratories of mining industry with special departments for mineral processing were opened. In many Balkan countries remarkable impact on development of mineral processing had Russian and American schools.

A great number of researchers and specialists in Balkan area were occupied for more decades by the research in mineral processing. The goal of this research was establishment of concentration process in industry, capacity enlargement, optimization of processes, increase the energy efficiency of processes and devices, introduction or construction of new machines. Based on those activities, Balkan mining has been evolving and continuously operates up to nowadays. As a result, in the Balkan countries appeared a significant number of successful researchers in the field of mineral processing. They founded the first Balkan mineral processing Committee (1973), and then the Balkan Academy of Mineral Technology.

Balkan Congress on Mineral Processing is beening held for 40 years. Participation in the work of the Committee of the Balkan mineral processing is a strong link between the development of the science and profession with global trends, and it provides the possibility of establishing direct contacts between researchers, designers, equipment manufacturers and investors from the region and around the world. It has already become tradition to hold every second year an international event, "Balkan Mineral Processing Congress," in which participate, not only Balkan experts, than experts from the whole world.

Maintenance XVI Balkan Congress on Mineral Processing in Belgrade from 16 to 21 June 2015 is held under the auspices of the Ministry of Mines and Energy of Serbia, with the financial assistance of the Ministry of Republic of Serbia. Incomparably greater financial support Congress had from sponsors who strongly support the mineral processing industry all over the world.



Prof. dr Nadežda Čalić

The XVI BMPC Chair

VOLUME I

PLENARY

Nadežda Čalić, A BRIEF LOOK ON THE LONG HISTORY OF METALIC ORES PROCESSING IN THE BALKANS	21
S. Komar Kawatra, SUSTAINABILITY IN MINERAL PROCESSING PLANTS	29
Valentine A. Chanturiya, Igor Zh. Bunin, Maria Ryazantseva and Irina Khabarova USE OF HIGH – POWER ELECTROMAGNETIC PULSES (HPEMP) FOR THE MODIFICATION OF THE SULPHIDES SURFACE.	37
James L. Hendrix, OVERVIEW OF TREATING GOLD ORES CONTAINING LOW-GRADE COPPER VALUES	45
Miloljub Grbović, Svetislav Radivojević, Ljutica Košutić, Dušan Salatić, COPPER MINE MAJDANPEK 60 YEARS LATER – IS IT HOW WE IMAGINED IT?	53

MATERIAL ANALYSIS AND MINERAL CHARACTERIZATION

Dean David, THE EFFECT OF METALLURGICAL SAMPLE COMPOSITING ON THE MEASUREMENT OF OREBODY VARIABILITY	59
Tomasz Niedoba, Agnieszka Surowiak, Dariusz Jamróz, METHODS OF DETERMINING CRUCIAL PROPERTIES TO IDENTIFY THE TYPE OF COAL.	69
G. Demirci, M. Taksuk, GENERAL CHARACTERIZATION OF TUNÇBILEK COALS, TURKEY	75
Merve Yüksel, H. Semih Demircan, Emre Erkan, Sercan Sevgül, ANALYSING THE REFRACTORINESS OF KAYMAZ GOLD ORE BY DIAGNOSTIC LEACHING	79
Mashukov A. V., Mashukova A. E., Bistryakova S. A., VARIATIONS OF THE COPPER CONTENT IN THE ORES OF NORILSK TYPE.	83
Andreas Iordanidis, Javier Garcia-Guinea, Konstantinos Gudulas, CHARACTERIZATION OF THE LINING MORTAR OF A CISTERN FROM THE ANCIENT MINING AND METALLURGICAL SITE OF LAVRION, GREECE	87
Milorad Grujic, Blagoje Spaskovski, Masan Grujic, Zoran Markovic, CHARACTERIZATION OF PORPHIRY COPPER ORE FROM NORTH REVIR ZONE TS2 MAJDANPEK.	93
Deniz Talan, Ümit Atalay, N. Emre Altun, CHARACTERIZATION OF KAYSERI-DEVELI PB-ZN OXIDE ORE	99
Mira Milić, RESULTS OF RIVER AGGREGATE BANJA LUKA REGION FOR PRODUCTION OF CONCRETE.	103
Özen Kılıç, EFFECTS OF PHYSICAL PROPERTIES TO THERMAL DECOMPOSITION OF DOLOMITES	109
Martin Griesdorn, NEW POSSIBILITIES TO INFLUENCE PELLET PROPERTIES BY PHOTO-OPTICAL PARTICLE ANALYSES	115

COMMINUTION AND CLASSIFICATION

Alex Jankovic, Walter Valery, ADVANCES IN ORE COMMINUTION PRACTICE OVER THE LAST 25 YEARS.	123
Biröl Sönmez, Renato Oliveira, Alex Jankovic, Walter Valery, Murat Us, METSO HRC™-ENERGY-EFFICIENT COMMINUTION TECHNOLOGY.	131
M. Ranchev, V. Kovacheva, I. Grigorova, I. Nishkov, D. Mochev, D. Nikolov, A. Angelov, T. Pukov, TECHNOLOGICAL PARAMETER ANALYSIS IN THE SECONDARY-TERTIARY CRUSHING STAGE IN ASSAREL CONCENTRATOR	139
M. Ranchev, I. Grigorova, V. Kovacheva, D. Mochev, I. Nishkov, D. Nikolov, A. Angelov, T. Pukov, GRINDING IN ASSAREL CONCENTRATOR – IMPROVEMENT WAYS.	147
M. Ranchev, I. Grigorova, V. Kovacheva, D. Mochev, I. Nishkov, D. Nikolov, A. Angelov, T. Pukov IMPROVEMENT POSSIBILITIES OF DISINTEGRATION PROCESS IN ASSAREL CONCENTRATOR.	153
Yakup Umucu, Vedat Deniz, Osman Mart, Abdi Kemal Yüce, COMPARISON OF GRINDING EFFICIENCY BETWEEN BALL MILLS AND VERTICAL ROLLER MILLS AND COARSE GRINDING	161

D.Katircioğlu Bayel, Ö.Y.Toraman, INFLUENCE OF GRINDING AID ON THE BREAKAGE PROCESS OF CALCIUM CARBONATE IN A VERTICAL STIRRED BALL MILL	165
Ahmad Hassanzadeh, INCREASING PRIMARY GRINDING CIRCUIT EFFICIENCY CONSIDERING GRINDING CAPACITY ENHANCEMENT	171
Zhivko Iliev, Ivailo Bogdanov, Nikolay Ivanov, ANALYSIS OF THE VIBRATION STATE OF THE ECCENTRIC SHAFT WITH THE BEARINGS OF A COMPLEX PENDULUM JAW CRUSHER.	179
G.I. Gazaleeva, N.V. Shikhov, A.A. Mushketov, APPLICATION OF SPECIAL METHODS OF DISINTEGRATION FOR DRESSING OF ORES AND NONMETALLIC RAW MATERIALS .	185
Lubomir Kuzev, COMPARATIVE STUDY OF GRINDABILITY IN STANDART BOND BALL MILL WITH TWO GRINDING MEDIA – BALLS AND TETRABALLPEBS.	191
Çetin Hoşten, Hande Mertyürek, A GRAPHICAL ASSESSMENT OF THE EFFECT OF FEED SIZE DISTRIBUTION ON PARTICLE-BED COMMUNUTION IN PISTON-DIE PRESS	197
Malyshev V.P., Zubrina Y.S., Makasheva A.M., Fedorovich J.A., ENTROPY OF MATERIAL GRINDING IN BALL MILLS	203
Nedeljko Magdalinović, Milan Trumić, Srđana Magdalinović, Maja Trumić, THE KINETICS OF GRINDING IN THE INDUSTRIAL ROD MILL	207
Rasskazova A.V., D.E. Alexandrova T.N., INFLUENCE OF MECHANOACTIVATION OF FILLING COMPOUND ON THE STRENGTH OF COAL BRIQUETTE	211

PHYSICAL CONCENTRATION METHODS

Vladislav Ivanchenko, Yuri, Chugunov, Alla Ivanchenko, MINERALOGY AND DRY CONCENTRATION OF THE ORES OF HEMATITE AND GOETHITE	219
Ali Güney*, Firat Burat, Murat Olgaç Kangal, IMPROVEMENT OF CHROMITE CONCENTRATE HAVING HIGH OLIVINE CONTENT	223
Sándor Nagy, József Faitli, Imre Gombkötő, Barnabás Csőke, Tamás Magyar, Jakab Csaba MECHANICAL PREPARATION METHODS FOR LCD PANELS ORIGINATED FROM USED TVS AND MONITORS.	229
Feridun Boylu, Ufuk Aykaç , Caner Yiğitoğlu, Firat Karakaş and Mehmet S. Çeli, INVESTIGATION OF D_p CONTROLLED DISCHARGING SYSTEM ON BENEFICIATION OF COALS THROUGH PNEUMATIC JIGS.	237
Yakup Umucu, Vedat Deniz, Ahmet hatipoğlu, Başer Tamgüç, Tarik Tunay AN INVESTIGATION ON THE WASHABILITY TREATMENT FOR THE REMOVAL OF SERPENTINE AND MAGNESITE FROM OLIVINE IN THREE DIFFERENT SIZE FRACTIONS.	245
D. Gucbilmez, S.L. Ergü, L. Weitkämper, A STUDY ON GRAVITY SEPARATION OF COARSE AND FINE SIZES SEPARATELY	249
Mladenko Knežević, Draško Simić, Nenad Marjanović, EXTRACTING RICH ULTRA-FINES FRACTION OF LIMONITE IRON ORE FROM TAILINGS, USING FILTER-PRESS	253
A.V.Kurkov, E.S.Bronitskaya, A.A.Rogozhin, APPLICATION OF HIGH INTENSITY MAGNETIC SEPARATION FOR BENEFICIATION OF RARE METAL ORES BEARING RARE EARTH ELEMENTS	261
Mukhtar A.A., Muhymbekova M.K., Nurumgaliev A.H., Momynbekov A.D., Nuskabekov J.S. INVESTIGATION OF MAGNETIC ROASTING PROCESS OF AYATSK LIMONITE ORE WITH WATER-OLI EMULSION	269
Kremena Mincheva, Tashka Ignatova, Stefan Ignatov, Aylin Dzhelyaydinova, Tsvetelin Petkov, Ali Kyazimov, ALTERNATIVE PROCESSES FOR PRODUCTION OF LOW IRON SILICA SAND FROM KAOLINOVO REGION, BULGARIA	273
H. Knapp, L. Horckmans, F. Bouillot, C. Fricke-Begemann, J. Makowe, A. Ducastel, A. Stark, Hermann Wotruba, SENSOR-BASED IDENTIFICATION OF SPENT REFRACTORY BRICKS	279
Amel Zahirović, THE INFLUENCE OF MODIFICATION LIMONITE ORE BASICITY ON THE QUALITY OF SINTER.	285

Elias Stamboliadis, Fuat Kivrakoglu, Meryem Nur Tumbaz, George Patsalis, NEW DEVELOPMENTS IN MAGNETIC SEPARATION	291
S. Mohammadnejad, M. Noaparast, S. Z. Shafaei Tonkaboni, Y. Olyaei, H. Haghi, S. M. Hosseini, THE APPLICATION OF SHAKING TABLE FOR SCHEELITE ENRICHMENT FROM NEZAM-ABAD MINE USING BOX-BEHNKEN DESIGN	299
Khalil Al Rawashdah, Sudgi Al Hamad, CONCENTRATION OF ZIRCON, MONOZIT FROM JORDANIAN BLACK SAND USING GRAVITY, MAGNATIC PROCESS	305
İbrahim Utku Ermiş, CONCENTRATION OF AYDIN-ÇINE REGION FELDSPAR WITH HIGH GRADE RUTILE VIA MULTI GRAVITY SEPARATOR.	309

FLOTATION AND SURFACE CHEMISTRY PROCESSES

Elena Chanturiya, ABOUT INTERRELATION OF COMPOSITIONAL, TEXTURAL, ELECTRICAL, ELECTROCHEMICAL AND THE FLOTATION PROPERTIES OF NATURAL PYRITE OF COPPER-ZINC SULFIDES ORES	315
V.I.Ryaboy, E. D. Shepeta, V.P. Kretov, S.E. Levkovets, I.V.Ryaboy, INFLUENCE OF THE SURFACE-ACTIVE PROPERTIES OF THE RE-AGENTS CONTAINING SODIUM DIALKYLDITHIOPHOSPHATES ON THE FLOTATION OF SULFIDES	321
P. M. Solozhenkin, Sanda Krausz, MODIFIED FATTY ACIDS AS FLOTATION REAGENTS FOR NON-SULFIDE ORES: MOLECULAR MODELING FOR PROGNOSIS OF COLLECTOR ACTIVITY EVALUATION	327
Vladislava Ignatkina , Vladimir Bocharov, Lily Khachatryan, SELECTIVE REAGENT REGIMES AND FLOWSHEET OF FLOTATION TECNOLOGY OF FINELY DISSEMINATED ORES OF NON-FERROUS METALS	333
Sabri Kouachi, Ahmad Hassanzadeh, Moustapha Bouhenguel, Behzad V. Hassas, Mehmet S. Çelik, CONTRIBUTION OF INTERCEPTIONAL EFFECT TO THE CALCULATION OF COLLISION EFFICIENCY OF PARTICLE BUBBLE ENCOUNTER IN FLOTATION	339
Valentina Ivanova, Galina Mitrofanova, FLOTATION OF EUDIALITE: CORRELATION OF EXPERIMENTAL DATA WITH THE RESULTS OF QUANTUM-CHEMICAL CALCULATIONS	347
Vladislava Ignatkina, Phillip Milovich, Alexander Pankin, USE OF SULFHYDRYL COLLECTORS TO INCREASE THE CONTRAST OF FLOTATION PROPERTIES OF SULFIDE MINERALS	353
Ali Uçar, Osman Ö. Taş, Oktay Şahbaz, Bahri Öteyaka, EFFECTS OF BIAS FACTOR AND GAS VELOCITY ON COLUMN FLOTATION OF COLEMANITE	359
A.E.Yüce, G. Bulut, B.Even, O.Güven, FLOTATION RESULTS ACCURACY: THE RIGHT MINERALOGY, LIBERATION SIZE AND PROCESS PARAMETERS	365
Fırat Burat, Mustafa Özer, Beste Aydın, Güven Önal, BENEFICIATION OF OXIDIZED- SULFIDIZED COMPLEX COPPER ORE BY FLOTATION AND LEACHING	371
Dragan Milanovic, Zoran S Markovic, Daniela Urošević, Srdjana Magdalinovic, Zoran Stirbanovic INFLUENCE OF BASIC AND ACIDIC pH REGULATORS ON THE SHEELITE ZETA POTENTIAL	377
Hidayet Çalışkan, Behzad V. Hassas, Mustafa Çınar, Mehmet S. Çelik, EFFECT OF ROUGHNESS AND SHAPE FACTOR ON FLOTATION RECOVERIES OF GLASS BEADS	385
Daniela Urošević, Zoran S. Marković, Dragan Milanović, Srđana Magdalinović, Mile Dimitrijević, Zoran Štirbanović, Ljubiša Andrić, MEASURING OF ELECTROKINETIC-ZETA POTENTIAL IN THE SUSPENSION FORMED FROM SMELTING SLAG.	391
Blagica Cekova, Viktorija Bezovska, Filip Jovanovski, A STUDY ON THE ADSORPTION PROPERTIES OF THE NATURAL ZEOFIT MATERIAL	399
Medyanik N.L, Girevaya K.Y., Shevelin I.Yu, Girevoi T.A., REFINING OF MINERALIZED PROCESS WATERS BY IONIC FLOTATION METHOD	403
Carlos Castañeda Olivera, Antonio Gutiérrez Merma, Leonardo Maurício Torem, FUNDAMENTAL ASPECTS OF THE BIOFLOTATION OF HEMATITE USING THE <i>RHODOCOCCUS</i> <i>ERYTHROPOLIS</i> BACTERIA	407
Elayne Rohem Peçanha, Marisa Bezerra de Melo Monte, Maurício Leonardo Torem, ON THE FUNDAMENTAL ASPECTS OF HEMATITE BIOFLOTATION USING A GRAM-POSITIVE BACILLUS SUBTILIS STRAIN AS A BIOREAGENT	415

Alexander A. Nikolaev, Professor Boris E. Goryachev, INTRODUCING POWDER COMPRESSION TECHNIQUE AS A SUPPLEMENTARY METHOD OF INVESTIGATION THE SURFACE HETEROGENEITY OF SOLIDS AND PARTICLES FOR FLOTATION . . .	423
Tussupbayev N., Bekturganov N., Semushkina L., Turisbekov D., Mukhanova A., INTENSIFICATION OF FLOTATION OF HEAVY-CONCENTRATING COMPLEX ORE WITH APPLICATION OF PROCESS OF RE-GRINDING AND MODIFIED COLLECTING AGENT	429
Z. Bartulović, D. Todorović, V. Milošević, B. Ivošević, J. Čarapić, V. Jovanović, COPPER MINERALS FLOTATION COLLECTOR SELECTION FOR PROCESSING OF THE ORE FROM PYRITE-RICH PARTS FROM „VELIKI KRIVELJ“ DEPOSIT	437
Dejan Todorović, Vladan Milošević, Bartulović Zoran, Branislav Ivošević, Jelena Čarapić, Vladimir Jovanović, Sonja Milićević, PILOT-PLANT FLOTATION TESTING OF COPPER, LEAD AND ZINC MINERALS FROM RICH POLYMETALLIC ORE	441
Jelena Čarapić, Branislav Ivošević, Vladan Milošević, Zoran Bartulović, Dejan Todorović, Vladimir Jovanović, Sonja Milićević, THE POSSIBILITY OF APPLYING CONTEMPORARY FLOTATION COLLECTORS TO IMPROVE THE TECHNOLOGICAL EFFECTS OF PROCESSING COMPLEX ORE WITH PYRITE HIGH CONTENT FROM THE UPPER LAYERS DEPOSIT “VELIKI KRIVELJ”	449
Sanja Petrović, Vukosava Grujić, Srđana Magdalinović, Ljubiša Andrić, Ivana Jovanović, Daniela Urošević, INFLUENCE OF FLOTATION PULP DENSITY ON COPPER CONCENTRATE GRADE AND RECOVERY FROM ORE DEPOSIT „CEROVO“	455
Ivana Jovanović, Srđana Magdalinović, Vukosava Grujić, Daniela Urošević, Miomir Mikić, Sanja Petrović, DETERMINATION OF OPTIMAL REAGENT REGIME IN FLOTATION PROCESS OF COPPER MINERALS FROM „CEROVO“ DEPOSIT	459
Ivana Jovanović, Ljubiša Andrić, Vladan Milošević, Dejan Todorović, Zoran Bartulović, Miomir Mikić, RECOVERY OF COPPER, GOLD AND SILVER FROM ORE DEPOSIT TENKA-3 IN DEPENDENCE ON GRINDING FINENESS	465
Milorad Grujić, Blagoje Spaskovski, Masan Grujić, Zoran Marković, INVESTIGATION IN FLOTABILITY OF PORPHYRY COPPER ORE FROM NORTH REVER ZONE TS2 MAJDANPEK	469
Gracijan Strainović, Zoran Marković, Ivana Profirović, Sandra Radulović, Ana Stanojević, Slavica Milosavljević, FLOTATION CHARACTERISTIC OF COPPER ORE IN FUNCTION OF PARTICLE SIZE DISTRIBUTION IN PRESENCE OF COLLECTOR TYPE XANTHATE AND THIONOCARBAMATE	473
Juliana S. Siqueira, Antonio E. C. Peres, RECOVERY OF SULFIDES FROM A SILICATE ZINC ORE	477
Can Güngören, Tarık M. Erbek, Orhan Ozdemir, Safak G. Ozkan, EFFECT OF SIMULTANEOUS ULTRASONIC TREATMENT ON QUARTZ-AMINE FLOTATION SYSTEM.	483
Sergey A. Kondratiev, FLOTATION STRENGTH OF DESORBABLE FORMS OF REAGENTS AND ITS ESTIMATION	491
Jacques Bezuidenhout, Nathalie Sterbik, Gunter Lipowsky, A LABORATORY INVESTIGATION INTO THE EFFECT OF GANGUE COMPOSITION ON THE FLOTATION RECOVERY AND GRADE OF TWO CU ORES	497
Oktay Bayat, Mahmut Altiner, Zehra Altincelep, UPGRADING BITLIS (TURKEY) KYANITES WITH FLOTATION AND MULTI GRAVITATIONAL METHODS	503
Milan Petrov, Ljubiša Andrić, Vladimir Jovanović, Mašan Grujić, Meline Vukadinović, FLEET-EXTRACTION OF BLUE WATER.	509
Boris Krstev, Aleksandar Krstev, THE PRINCIPLES AND EXAMPLES OF KINETIC PERFORMANCE FOR DOMESTIC LEAD AND ZINC ORES	517
Victor Samiguin, Chingis Lekhatinov, Moshchanetskiy Pavel, MULTI-ZONE FLOTATION CELL'S AUTOMATED STAND	521
Victor Samiguin, Chingis Lekhatinov, Moshchanetskiy Pavel, THE EFFECTIVE AERATION-HYDRODYNAMIC OPERATING MODE OF MULTIZONE FLOTATION CELL.	527
N. Emre Altun, Chuanfu Xiao, Jiann-Yang Hwang, REMOVAL OF UNBURNED CARBON FROM FLY ASH USING A CONCURRENT FLOTATION COLUMN	533
Firat Karakas, Feridun Boylu, İsmail Bentli, Mehmet S. Çelik, BENEFICIATION OF SAPHANE ALUNITE BY FLOTATION	539
Taki Güler, Selçuk Aktürk, BENEFICIATION OF OLIVINE ORE BY NA-OLEATE FLOTATION	543

Milena R. Kostović, Dragan K. Stanković, SHORT CIRCUIT CURRENT MEASUREMENT TECHNIQUE IN ELECTROCHEMICAL STUDIES OF SULPHIDE MINERAL – GRINDING MEDIA INTERACTION	549
--	-----

PROCESSING OF INDUSTRIAL MINERALS

Konstantinos Gudulas, Efthimios Papastergiadis, Andreas Iordanidis, Petros Samaras, STUDY OF THE ADSORPTION CAPACITY OF A NATURAL MINERAL AND A SOLID BIOWASTE	557
Georgios Anastassakis, FELDSPAR-CONTAINING ROCKS OF GREECE: MINERALOGICAL CHARACTERISTICS AND PROCESSING FLOW-SHEETS	565
Stanislav Titkov, Tamara Gurkova, Nina Panteleeva, TECHNOLOGY FOR FLOTATION PROCESSING OF POTASH ORES	573
A. Mitrović, M. Zdujić, EVALUATION OF SELECTED SERBIAN KAOLIN CLAYS AS A RAW MATERIAL FOR THE CEMENT AND CONCRETE INDUSTRY	579
Dragan S. Radulović, Slavica R. Mihajlović, Živko Sekulić, Vladimir D. Jovanović, OBTAINING FILLERS BASED ON LIMESTONE FROM DEPOSIT DARZA – ULCINJ, FOR APPLICATIONS IN VARIOUS INDUSTRIES	585

INDEX OF AUTHORS

VOLUME II

COAL PROCESSING

B. Sarıkaya, M. Taksuk, M. Cokuslu, H. Aykul, A CASE STUDY ABOUT PRIMARY AND SECONDARY CIRCUIT DENSITY VARIATIONS IN OMERLER COAL WASHING PLANT WITH STATISTICAL PROCESS CONTROL(SPC) METHOD	593
Zlatko Ječmenica, SUPPLY OF CARBONATE USED AS AN ABSORBENT FOR FLUE GAS DESULPHURIZATION PROJECT IN UGLJEVIK THERMAL POWER PLANT	601
M. Taksuk, H. Yagar, M. Gulsoy, H. Aykul, STATISTICALLY PROCESS CONTROL ANALYZE OF THERMAL COAL AT TUNÇBILEK POWER PLANT	607
Yildirim Tosun, BLACK CARBON PRODUCTION FROM PYROLYSIS AND COMBUSTION OF PYROLYSIS OIL OF ASPHALTITE, WASTE TIRE AND WOOD	615
Miloljub Grbović, Miroslav Spasojević, NEW COAL CLEANING PROCESS FOR LIGNITES FROM SERBIAN MULTILAYER DEPOSITS	623
Yildirim Tosun, MICROWAVE ACTIVATED CRUSHING AND GRINDING OF TURKISH COALS AND SHALE FOR CLEANING AND DESULFURIZATION	629
Ayşe Erdem, Akan Gülmez, Oğuz Altun, Zeki Olgun, TECHNOLOGICAL EVALUATION OF COAL WASHING PLANT SLIME TAILINGS OF MANISA SOMA DEREKÖY (TURKEY).	637
G.Özbayoğlu Sulfur, SULFUR DISTRIBUTION OF TURKISH LIGNITES AND THEIR AMENABILITY TO DESULFURIZATION BY PHYSICAL METHODS	643
Selçuk Özgen, Zeki Olgun, STUDIES OF A HYDROCYCLONE TO PRODUCE CLEAN COAL FROM TUNÇBILEK/TURKEY FINE LIGNITE TAILINGS	647
Jovica Sokolović, Rodoljub Stanojlović, Zoran Marković, Zoran Stirbanović, Suzana Stanković, Vojka Gardić, VALORIZATION OF COAL FROM THE OLD TAILING PONDS FROM ANTHRACITE MINE “VRSKA CUKA” AVRAMICA, SERBIA	651

PLANT AND PROCESS DESIGN AND OPERATING PRACTICE

Irina Pestriak, Valery Morozov, Erdenetuya Otchir, MODELING OF PROCESSES AND THE DEVELOPMENT OF CLOSED CYCLE OF CONDITIONING RECYCLED WATER DURING THE PROCESSING COPPER-MOLYBDENUM ORES	659
Zivko Gocev, Aleksandar Krstev, Boris Krstev, Mirjana Golomeova, Afrodita Zendelska, THE MODELS OF OPTIMIZATION FOR INCREASING OF COPPER AND GOLD RECOVERIES IN BUCIM MINE	665

Mariana Gabriela Flucus, Mihai Florian Flucus, Ioan Flucus, CONSIDERATIONS REGARDING THE USE OF MATHEMATICAL MODELING IN INDUSTRIAL IMPACT STUDIES INVOLVING POLLUTANT DISPERSION	671
Todor Angelov, Georgy Savov, Aleksander Tsekov, Dejan Karanfilov, BUCIM COPPER PROJECT NEW DEVELOPMENTS	677
Nihad Omerović, Igor Miljanović, Ruzmir Avdić, RESOLVING OPTIMIZATION PROBLEMS OF PREPARATION ERUPTIVE AGGREGATES USING PROGRAMING DRIVEN BY EVENTS	683
Nihad Omerović, Igor Miljanović, Ruzmir Avdić, OPTIMIZATION OF GRINDING ERUPTIVE AGGREGATES USING METHODS OF MULTI-CRITERIA ANALYSIS	687

PYRO-HYDROMETALLURGY AND BIO-PROCESSING

Branislav Marković, Vladislav Matković, Miroslav Sokić, VANADIUM RECOVERY AS FERROVANADIUM FROM SPENT CATALYSTS	697
Ahmet Göveli, M. Ümit Atalay, NICKEL EXTRACTION FROM TURKISH LATERITIC ORE BY HYDROCHLORIC ACID LEACHING	701
SH.R. Samikhov, Z.A. Zinchenko, N. Shermatov, THE STUDY AND DEVELOPMENT OF THE MATHEMATICAL MODELS OF POOR GOLD-CONTAINING ORES THE PROCESS HEAP (THE DUMP) LEACHING	709
K.K. Mamyrbayeva, V.A. Lukanov, A. Eshmoldayeva, PROCESSING OF AKTOGAI (KAZAKHSTAN) MIXED COPPER ORE	713
Ş. Beste Aydin, Hüseyin Baştürkcü, Alim Gül, EVALUATION OF LEACHING PARAMETERS FOR GOLD ORE CONTAINING ELECTRUM.	719
Milena Danovska, Dejan Karanfilov, Mirjana Golomeova, Boris Krstev, Afrodita Zendelska DESIGN OF A HIGH CURRENT EXTRACTION/STRIPPING SYSTEM USING EXTRACTION AND STRIPPING ISOTHERMS.	723
Tomuş Nicolae, Zlăgnea Marius, Botez Adriana, Dobre Oana, Radu Aura Daniela, RESEARCHES CONCERNING THE POSSIBILITY TO OBTAIN THE URANIUM CONCENTRATES BY ELECTROLYSIS	729
Nikolay V. Vorobiev-Desyatovsky, Sergey A. Kubyshkin, Rimma I. Ibragimova, PROSPECTS OF USING ACTIVATED CARBON FOR DETOXICATION OF CYANIDE SOLUTIONS IN GOLD HYDROMETALLURGY	737
M. Deniz Turan, Z. Abidin Sari, Mehmed Erdem, SELECTIVE LEACHING OF BLENDED COPPER SLAG	745
Galina Sedelnikova, Dmitriy Kim, Natalya Ibragimova, HEAP BIOOXIDATION OF COMPLEX GOLD SULFIDE ORE.	749
Jana Ficeriova, Erika Dutkova, NON-CYANIDE LEACHING AND ELECTROLYSIS OF GOLD	757
Vapur H., Demirci S., Top S., Altiner M, REMOVAL OF IRON CONTENT IN FELDSPAR ORES BY LEACHING WITH ORGANIC ACIDS	761
Emre Erkan, H.Semih Demircan, Merve Cankurtaran, Sercan Sevgul, EFFECTS OF DIFFERENT CRUSH SIZE ON HEAP LEACH RECOVERY OF HIMMETDEDE OXIDE ORE	767
Aleksandar Krstev, Boris Krstev et al., THE PRINCIPLES AND EXAMPLES OF LEACHING AND BIO-LEACHING OF COPPER ORES	773
S. Beikzadeh-Noei, S. Sheibani, F. Rashchi, S. M. J. Mirazimi, BIOLEACHING KINETICS OF COPPER RECOVERY FROM LOW GRADE COPPER ORE	777
Jelena V. Milojković, Marija L. Mihajlović, Zorica R. Lopičić, Marija S. Petrović, Tatjana D. Šoštarić, Jelena T. Petrović, Marija R.. Stanojević, DEVELOPMENT OF HYBRID ORGANIC-INORGANIC (BIO)SORBENTS FOR PB(II) REMOVAL	783
Irena I. Spasova, Marina V. Nicolova, Plamen S. Georgiev and Stoyan N. Groudev, COMPARATIVE VARIANTS OF MICROBIAL PRETREATMENT OF A GOLD-BEARING SULPHIDE CONCENTRATE UNDER DIFFERENT GROWTH AND TECHNOLOGICAL CONDITIONS	787

T.N. Alexandrova, A.V.Alexandrov, N.M. Litvinova, ADVANCED METHODS OF PROCESSING REFRACTORY GOLD BEARING ORES	791
Svetlana Bratkova, Rosen Ivanov, Anatoliy Angelov, Katerina Nikolova, THE INFLUENCE OF HYDRAULIC RETENTION TIME ON THE PERFORMANCE OF MICROBIAL FUEL CELL INTEGRATED IN SUCCESSIVE ALKALINITY-PRODUCING SYSTEM	795
Meryem Göktaş, Murat Erdemoğlu, BENEFICIATION OF LATERITIC NI-CO ORE FROM MANISA – ÇALDAĞ, TURKEY	801
P.V. Aleksandrov, A.S. Medvedev, MECHANISM OF INTERACTION BETWEEN MOLYBDENITE CONCENTRATE AND SODIUM CHLORIDE WHEN HEATED IN THE PRESENCE OF OXYGEN	807
Y. Olyaei, M. Noaparast, S. Z. Shafaei Tonkaboni, A. Amini, H. Haghi, THE EXTRACTION OF GOLD FROM THE HAMZE-QARNEIN ORE BY HEAP LEACHING IN LABORATORY SCALE	813
Birgül Benli, Yücel Özsoy, Fatma Arslan, EFFECTS OF ACID TREATMENTS ON REFRACTORY GOLD ORE PRIOR TO CONVENTIONAL GOLD RECOVERY	817
A. Rezaei, Y. Olyaei, S. Z. Shafaei Tonkaboni, M. Noaparast, H. Haghi, A. Allahverdi, COPPER RECOVERY FROM MESKANI OXIDE ORE USING HEAP LEACHING	823
Vesna Conić, Ljiljana Avramović, Radojka Jonović, Radmila Marković, Mile Bugarin, SX-EW TREATMENT OF THE SOLUTION OBTAINED AFTER ACID LEACHING RTB BOR FLOTATION TAILING	827
S. Abdi Bastami, B. Rezaie, A. Amini, H. Abdollahi and Amir Pazooki, PRELIMINARY CYANIDATION OF ZAVVARIAN GOLD ORE	831
Yücel Özsoy, Birgül Benli, Fatma Arslan, APPLICATION OF BIOOXIDATION PRIOR TO CYANIDATION CASE STUDY: TURKISH SULFIDIC GOLD-BEARING ORES.	835

SOLID WASTE AND WASTE WATER TREATMENT and SOIL REMEDIATION

Mihai Alexandru, MINERAL WASTE MANAGEMENT IN THE PORT OF CONSTANTA	845
Tussupbayev N., Bekturganov N., Semushkina L., Turisbekov Mukhanova A., Musina M. FLOTATION PROCESSING OF TECHNOGENIC MINERAL RAW MATERIALS BASED ON COMPOSITION AGENT.	853
Yuri Chugunov, Vladislav Ivanchenko ,TECHNOLOGY FOR ENRICHMENT AND REPROCESSING OF SLAG WASTE INCINERATION PLANTS	859
Ilker Acar, M.U. Atalay, VARIATION OF CENOSPHERES IN BITUMINOUS COAL FLY ASHES	861
D.V. Makarov, O.V. Suvorova, V.A. Kumarova, N.K. Manakova, R.G. Melkonyan, BUILDING MATERIALS FROM MINING AND CONCENTRATION WASTES OF THE MURMANSK REGION, RUSSIA.	869
M.V. Belitska, LITHOLOGY AND TECHNOLOGICAL FEATURES OF SEDIMENTS RIVER INHULETS POLLUTED WITH THE WASTES OF INDUSTRI IN KRIVEY RIG BASIN (UKRAINE)	875
S.A. Kvyatkovskiy, G.Zh. Abdykirova, Ye.A. Sitko, M.T. Shazhaliyev, S.B. Dyussenova, INFLUENCE OF TEMPERATURE CONDITIONS OF CONVERTER SLAG PROCESSING ON THE COPPER SULPHIDE AND FERRUM CRYSTALS FORMATION	879
Shavakyleva Olga Petrovna, Sedinkina Nataliya Anatolievna, WAYS TO IMPROVE THE EFFICIENCY OF PROCESSING MAN-MADE RESOURCES	883
G.Zh. Abdykirova, N.S. Bekturganov, M.Sh. Tanekeeva, A.Ye. Sydykov, Sh.A. Telkov, G.A. Toylanbay, RESEARCH ON OBTAINING ELECTROLYTIC MANGANESE DIOXIDE FROM MANGANESE-CONTAINING SLUDGE LEACHING SOLUTIONS	887
Julia Bajurova, Anton Svetlov, Olga Suvorova, Victoria Kumarova, Dmitriy Makarov, Vladimir Masloboev, THE POSSIBILITY OF COMPLEX PROCESSING OF COPPER-NICKEL CONCENTRATION TAILINGS	891
Grozdanka D. Bogdanović, Velizar Stanković, Milan M.Antonijević, Dejan V.Antić, Dragan Milojević, Darko Milicević, ACID LEACHING OF COPPER FROM MINING - WASTE DUMP	895

H. Nourizadeh, F. Rashchi, SYNTHESIS OF VANADIUM PENTOXIDE FROM POWER PLANTS FLY ASH LEACHING SOLUTION	901
Ivana Jovanović, Igor Miljanović, Miomir Mikić, REVIEW OF CONTEMPORARY WORLD STUDIES ON CHARACTERISTICS OF FLY ASH AS A SECONDARY MINERAL RESOURCE; PART 2	905
Pedro P. M. Ribeiro, Iranildes D. Santos, Achilles J. B. Dutra, COPPER CONCENTRATION FROM CRUSHED AND GRINDED PRINTED CIRCUIT BOARDS USING A ZIG-ZAG CLASSIFIER	913
Gulsen Tozsina, Ali Ihsan Arolb, EFFECT OF MARBLE WASTE ON THE ACID GENERATION INHIBITION AND HEAVY METAL MOBILITY IN COPPER SULPHIDE TAILINGS	919
Madali Naimanbayev, Nina Lokhova, Zhazira Baltabekova, Arailym Dukembayeva, Zhan-tore Dzhurkanov, RECEIVING A CONCENTRATE OF RARE-EARTH ELEMENTS FROM WITHDRAWAL FROM PROCESSING OF PHOSPHORITES	927
Gábor Mucsi, Imre Gombkötő, Zoltán Molnár, Viktor Török, MECHANICAL ACTIVATION AND CLASSIFICATION OF FLY ASH TO ENHANCE ITS REACTIVITY	931
Shyqri Kelmendi, Bajram Mustafa, Faton Kelmendi, USE OF FLY ASH IN UNDERGROUND MINES LIKE HYDRAULIC FILL MATERIAL.	939
Irina V. Shadrinova, Natalia N. Orekhova, EXPERIMENTAL COMPARISON OF PROCESSES FOR RECOVERY OF COPPER AND ZINC FROM MINE WATER	945
Ultrakova A., Naymanbaev M. A., Onayev M., Dzhurkanov J., Alzhanbayeva N., PROCESSING OF TITANIUM PRODUCTION CHLORIDE WASTES OBTAINING NIOBIUM ENRICHED MIDDINGS.	953
Mirjana Golomeova, Afrodita Zendelska, Boris Krstev, Blagoj Golomeov, Aleksandar Krstev, REMOVAL OF HEAVY METAL IONS FROM AQUEOUS SOLUTIONS USING CLINOPTILOLITE	959
Bajram Mustafa, Shyqri Kelmendi, Sali Kurshumliu, TREATMENT OF THE ACIDIC WATERS IN TREPJA JAROSIT TAILINGS	965
Ataç Başçetin, Orhan Özdemir, Deniz Adıgüzel, Yasin Baktarhan, Mink Ter Harmsel, USE OF GEOEXTILE FILTRATION SYSTEM (GEOTUBE® TECHNOLOGY) FOR DEWATERING OF MINERAL PROCESSING PLANT TAILINGS.	969
Viorica Ciocan, Sanda Krauzs, THE DOMESTIC RESIDUAL WATERS ADVANCED CLEANING WITH MAGNESIUM MINERALS	973
Ünzile Yenial, Gülay Bulut, UTILIZATION OF MINING WASTES FOR WASTEWATER TREATMENT	979
Marius Zlagnean, Sorin O. Mihai, Nicolae Tomus, Alexandru Nicolici, Sorin Halga, NEW TRENDS IN TAILINGS DISPOSAL – STUDY CASE: ROVINA MINING PROJECT, ROMANIA	987
Predrag Dimovski, Zdravko Hojka, Branimir Monevski, PROPOSAL OF OPTIMAL SOLUTION FOR DUMPING FLY ASH AND SLAG FROM THERMO POWER PLANTS, HEATING PLANTS AND METALLURGIC FACILITIES.	995
Stoyan N. Groudev, Plamen S. Georgiev, Irena I. Spasova and Marina V. Nicolova, BIOREMEDIATION OF AN ALKALINE SOIL HEAVILY POLLUTED WITH RADIONUCLIDES AND HEAVY METALS.	1003
Jelena D. Nikolić, Vladimir D. Živanović, Srđan D. Matijašević, Snežana N. Zildžović, Snežana R. Grujić, Sonja V. Smiljanić, Ana M. Vujošević, ECO-MATERIALS FOR SOIL REMEDIATION BASED ON POLYPHOSPHATE GLASSES.	1007
Milica M. Vlahović, Sanja P. Martinović, Tatjana D. Volkov Husović, LEACHING BEHAVIOR OF SULFUR CONCRETE WITH FLY ASH USED FOR REMOVAL OF HEAVY METALS FROM WASTEWATER	1013
Tatjana Šoštarić, Marija Petrović, Jelena Milojković, Jelena Petrović, Marija Stanojević, Ljubiša Andrić, Mirjana Stojanović, BIOSORPTION OF Cu(II) IONS FROM AQUEOUS SOLUTION BY WASTE APRICOT STONES PRE-TREATED BY MECHANICAL ACTIVATION	1017
A. Ekrem Yüce; Güven Önal; Gündüz Ateşok, BENEFICIATION AND PRE FEASIBILITY STUDIES FOR IRON STEEL CONVERTER SLAG	1021

Florent Dobroshi, Fatos Rexhepi, Blerim Baruti, Dilaver Salihi, Mensur Kelmendi, Ilirian Malollari HIGH ACIDITY INDICATORS OF THE PHYSICO - CHEMICAL PROPERTIES OF DRINKING WATER IN SOME VILLAGES IN THE DISTRICT OF THE "TREPÇA" MINE.	1025
E. Dutková and J. Ficeriová, LEACHING OF GOLD FROM ACTIVATED GOLDSMITH' S WASTE	1029
Violeta Čolaković, Vladan Čanović, Branka Jovanović, Dragan Milošević, DRAINAGE OF SURFACE AND UNDERGROUND WATERS FROM THE SURFACE OF THE FUTURE FLYING AND BOTTOM ASH DEPOT "CIRIKOVAC"	1035
Pavle Stjepanović, Nenad Milojković, Klara Konc Janković, Dejan Lazić, ANALYSIS OF THE DEPOSITED MATERIALS OF FLYING AND BOTTOM ASH AT THE DEPOT OF TPPT B	1041
Jasmina Nešković, Klara Konc Janković, Dejan Lazić, Pavle Stjepanović, TECHNICAL TESTS OF THE PREPARATION OF MINERAL ORES AT THE CORES OF SURVEY DRILL SITES OF THE KRAKU BUGARESKU BASIN	1049
Nenad Milojković, Grozdana Tomasović, Jasmina Nešković, THE TECHNOLOGY OF TRANSFORMATION OF DANGEROUS WASTE FROM THE LAND POLLUTED BY CRUDE OIL INTO INERT WASTE	1055

SUSTAINABILITY IN MINERAL PROCESSING

Lyubomir Ilchev, Nadezhda Davcheva-Ilcheva, INDICATORS DESCRIBING PRESSURES ON ENVIRONMENT FROM MINING, CONCENTRATION AND METALLURGY	1061
Desislava Kostova, Valentin Velev, REINDUSTRIALIZATION AND BULGARIAN MINING INDUSTRY	1065
Teodora Tinkova, Irena Grigorova, Ivan Nishkov, NEW APPROACHES ON GYPSUM BODY COMPOSITE MATERIALS ADDITION	1069
Irena Grigorova, INDUSTRIAL MINERALS PROCESSING WASTE – NEW SECONDARY PRODUCTS.	1077
Vladimir Jovanović, Živko Sekulić, Branislav Ivošević, Slavica Mihajlović, Milan Petrov, Dragan Radulović, MECHANICAL PROPERTIES OF LIMESTONE BRIQUETTES AND PELLETS WITH BENTONITE FOR CALCIFICATION OF ACID SOIL	1083

APPLICATIONS OF MINERAL PROCESSING IN RELATED INDUSTRIES

Murat Erdemoğlu, MECHANOSYNTHESIS OF SRTIO ₃ AND BATIO ₃ THROUGH INTENSIVE BALL MILLING	1087
H. Serdar Mutlu, Turan Uysal Muhammed Şener, Murat Erdemoğlu, INVESTIGATIONS FOR INNOVATIVE CERAMIC WALL TILES: SYNERGISTIC EFFECTS OF PYROPHYLLITE AND COLEMANITE.	1095
Eugenia Panturu, Razvan – Ioan Panturu, Antoneta Filcenco – Olteanu, Aura Daniela Radu KINETICS OF URANIUM ADSORPTION ON CARBON IMPREGNATED WITH ZERO- VALENT IRON NANOPARTICLES	1103
Ljiljana Tankosić, Nadežda Čalić, Milena Kostović, SELECTIVE FLOCCULATION OF LIMONITE AND CLAY BY POLYACRYLAMIDES	1109
Bulent Toka, A. İ. Arol, THE RHEOLOGICAL AND FILTRATE PROPERTIES OF BENTONITES ACTIVATED WITH BORATE AND TREATED WITH POLYMERS	1115
Yury V. Semenov, OPTIMIZATION OF ORGANO-MINERAL SORBENTS AND DEVICES FOR REMOVAL OF OIL POLLUTION FROM WATER SURFACE	1125
Anja Terzić, Lato Pezo, Ljubiša Andrić, Milan Trumić, Grozdanka Bogadanović, EFFECTS OF MECHANICAL ACTIVATION ON THE PARAMETERS OF MICA QUALITY FOR APPLICATION IN INSULATION MATERIALS - CHEMOMETRIC APPROACH.	1131
Marko Pavlović, Tatjana Volkov-Husović, Ljubiša Andrić, FILLERS FOR FOUNDRY COATING	1139
Sanja P. Martinović, Milica M. Vlahović, Tatjana D. Volkov Husović, POSSIBILITY OF USING DIATOMACEOUS EARTH FROM KOLUBARA AND VESJE DEPOSITS FOR PRODUCTION OF BEER FILTER AIDS.	1143

INDEX OF AUTHORS

THE POSSIBILITY OF APPLYING CONTEMPORARY FLOTATION COLLECTORS TO IMPROVE THE TECHNOLOGICAL EFFECTS OF PROCESSING COMPLEX ORE WITH PYRITE HIGH CONTENT FROM THE UPPER LAYERS DEPOSIT " VELIKI KRIVELJ"

***Jelena Čarapić, *Vladan Milošević, *Zoran Bartulović, *Dejan Todorović, *Sonja Milićević**

*Institute for Technology of Nuclear and Other Mineral Raw Materials, 86 Franchet d'Esperey Blvd, 11000 Belgrade, Serbia

Abstract:

This paper presents part of a complex technological flotation investigations of copper ore from the upper layers deposit "Veliki Krivelj". Ore copper content is in the average range and sulfur content is significantly higher than usual. High content of sulfur derives from the increased content of mineral pyrite, which is very difficult to depress in flotation. Because of this, it is very difficult to control and to stabilize flotation process and technological results are below the planned one. In order to increase the flotation process efficiency and the copper concentrate quality, technological laboratory tests were conducted in the ITNMS Mineral Processing laboratory. Investigations were undertaken with an aim to examine the possibility of applying new collector structures (manuf. Flomin) which are implemented effectively for the ores with similar features in the World. The results in paper presents technological effects achieved by applying the tested collector and compared to the reagent that is used in the Flotation Plant "Veliki Krivelj".

Because of the good results, which showed that the tested collector has a high selectivity for copper, it was decided to be tested on an industrial scale.

Key words : flotation, copper, Veliki Krivelj, collectors, Flomin

INTRODUCTION

To maximize the exploitation and increased processing capacity of open pit „Veliki Krivelj“ there is a need for mining ore from this deposit upper layers. Ore characteristics from the open pit "Veliki Krivelj" upper layers are different from the deposit other part ore characteristics, especially from a technological point of view. The chemical composition from this parts causes major problems in processing, and resulting the final product lower quality and recovery than the planned ones. Although the copper content is in the whole deposit average range, a significant difference occurs in the much higher sulfur content in the open pit "Veliki Krivelj" upper layers ore from whole deposit average content (over 4%).

The high content of sulphur points to the increased content of mineral pyrite. This mineral is very difficult to depress during copper minerals flotation process and all the above directly affects the the flotation process efficiency to produce the required quality Cu concentrate.

This paper presents part of a complex technological flotation investigations on copper ore from the deposit "Veliki Krivelj" upper layers. Investigations were undertaken with an aim to examine the possibility of applying new collector structures with high selectivity for copper. During the tests the following reagents are applied : PEX collector (currently in use), collector manufacturers Flomin C 2440 and D-250 as frother.

The results achieved during the tests and suggestions for improving the copper ore concentration technological process from the deposit upper layers in Flotation Plant " Veliki Krivelj " are presented in this paper.

CHARACTERISTICS OF ORE SAMPLE

All technological tests were performed in the Mineral processing laboratory ITNMS on the sample which represents geological exploration drilling core from deposit "Veliki Krivelj" part intended for exploitation in the following period.

Physical properties of ore sample

- density $\gamma = 2750 \text{ kg/m}^3$;
- pH, 68% of solids, pH=4.1
- moisture $W=5 \%$;
- Bond work index $W_i = 13.14 \text{ kWh/t}$;
- particle size distribution after crushing (Figure 1).

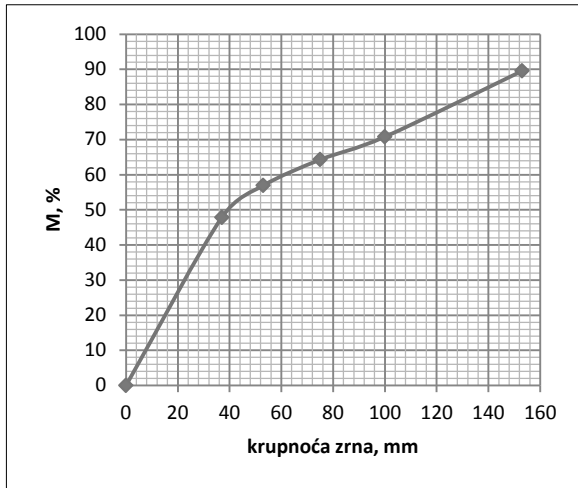


Figure 1 Granulometrijski sastav izlaza iz mlina – kumulativna kriva proseva

Chemical composition

Table 1, Chemical composition of ore sample

Ore sample from pyrite-rich parts of deposit			
Component	Cu	S	Fe
Content, %	0.21	5.81	6.12

Mineral composition

Mineralogical analysis was performed with immersion method, microscopic ore method and the method of electron microscopy scanning at the following size class: $-0.037+0 \text{ mm}$; $-0.053+0.037 \text{ mm}$; $-0.075+0.053 \text{ mm}$; $-0.1+0.075 \text{ mm}$; $-0.3+0.1 \text{ mm}$; $-0.83+0.3 \text{ mm}$; $-1.6+0.83 \text{ mm}$; $+1.6 \text{ mm}$).

Mineralogical composition of this ore sample is: pyrite, chalcopyrite, chalcocite, bornite, covellite, cuprite, magnetite, pyrrhotite, hematite, rutile, molybdenite, limonite, sphalerite, galena, cassiterite, malachite. Gangue minerals are feldspar (K-feldspar and plagioclase), quartz.

The most abundant sulphide mineral is pyrite 13,7, chalcopyrite is presented with amount of 0,7% and other ore minerals are presented in the sample to 0.2%.

EXPERIMENTAL

During the implementation of technological laboratory tests on ore samples it was performed several series of flotation test using the following flotation reagents:

- Collector PEX which is currently in use, and this test is labeled as "zero", test which is a standard for comparison
- collector manufacturer Flomin 2440

Experimental procedure

A. Grinding

- sample mass $Q = 680.0 \text{ g}$
- 68.0 % solids
- $t_m = 5.75 \text{ min}$
- grinding fineness 58.0 % - 0.074 mm
- pH= 9.2

B. Conditioning

- $t_k = 6.0 \text{ min}$
- 28.0% solids
- pH = 10.5

reagents consumption

- collector PEX 50 % of total dose
- collector C - 2440 50 % of total dose 15.0 g / t

C. Rough flotation

- $t_f = 20.0 \text{ min}$
- pH= 10.5

reagents consumption

- frother DOW 250
- collector PEX 25+25% % (5,10 min) of total dose 15.0 g/t
- collector C - 2440 25+25% % (5,10 min) of total dose 7 g/t

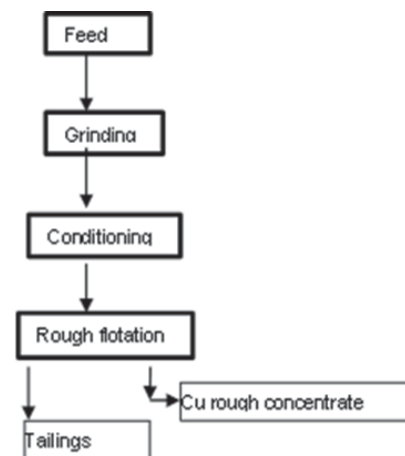


Figure 2, Experimental procedure

Technological results

Mass content of the product concentration, copper recovery, sulfur distribution, copper content, sulfur content, iron content obtained in "zero" flotation test are presented in Table 2.

Table 2. Material balance – collector PEX

Prod.	M, %	Cu, %	S, %	Cu rec., %	S rec., %	Fe, %
Feed	100.00	0.21	5.81	100.00	100.00	6.21
Cu RC	12.40	1.29	37.79	76.18	80.67	43.65
Tail.	87.60	0.06	1.28	23.82	19.33	0.81

From the series of experiment, made in order to improve the technological results, experiment which gave the best results was isolated, and that results are presented in Table 3.

Table 3. Material balance – collector Flomin 2440

Prod.	M, %	Cu, %	S, %	Cu rec., %	S rec., %	Fe, %
Feed	100.00	0.21	5.81	100.00	100.00	6.21
Cu RC	5.76	2.78	15.29	76.24	15.15	29.88
Tail.	94.24	0.05	5.23	23.76	84.85	4.67

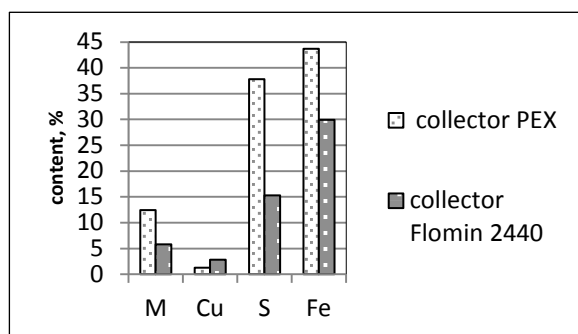


Figure 3, Mas, Cu, S, and Fe content

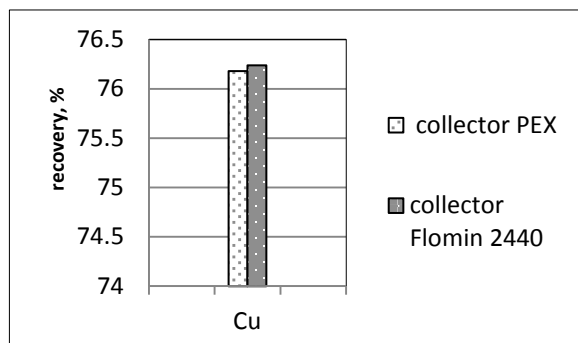


Figure 4, Cu, recovery

Rational mineralogical analysis of both concentrates (based on the chemical analysis of copper, sulfur, iron and mineralogical

composition of ore sample) is present in Table 4 and Figure 5.

Table 4. minerals, content

Product	collector PEX	collector Flomin 2440
<i>Cu RC</i>		
CuFeS ₂ , %	3.73	8.03
FeS ₂ , %	91.09	58.78

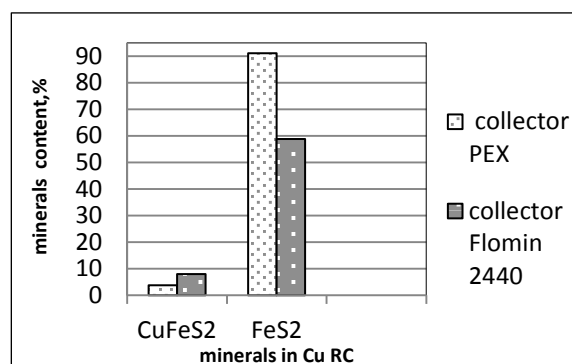


Figure 5, minerals, content

DISCUSSION

After completed laboratory tests and technological results analysis, it can be concluded as follows:

The sample physico-chemical characterization indicates that: the sample is typical for ore deposit „Veliki Krivelj“; physical properties within the projected values range; considering chemical aspect, very poor copper with a very high sulfur and iron content. Due to these characteristics, this ore type is very problematic for copper sulphide minerals flotation concentration.

Increased sulfur and iron contents originating from pyrites, which was confirmed by mineralogical analysis. Processing practical experience of ores with such characteristics, indicates a continuing problem and considerably poorer copper mineral concentrations technological indicators, using the projected technological schemes and reagent regime. The main reason for this is significantly higher pyrite content of the projected value and physico-chemical processes at phase boundaries in flotation pulp which are a consequence of the collector affinity towards the sulfur hydrophobization in pyrite.

Ore flotation laboratory testing, according to the technological scheme and conditions in flotation plant "Veliki Krivelj", confirm the quite poor

results and technological indicators for ore processing with high sulfur content. Zero experiment was performed using the collector KEX, following plant current scheme technological parameters. Achieved technological parameters are as follows:

- ✓ rough concentrate weight is 12,40%
- ✓ the rough concentrate copper content is 1,29%
- ✓ the rough concentrate sulfur content is 37,79%
- ✓ the rough concentrate copper recovery is 76,19%
- ✓ the rough concentrate sulfur distribution is 80,67%
- ✓ final concentrate copper content is 10,33%
- ✓ final concentrate copper recovery is 45,09%

It is obvious that the rough concentrate weight is extremely high i.e. almost double the projected value. Having regard low copper and high sulfur content and sulfur distribution, it is clear that this rough flotation concentrate mass is a consequence of flotation sulfur carrier minerals i.e. pyrite. Satisfactory copper recovery is a concentrate mass participation product. Copper minerals concentration effects are extremely bad, as evidenced by the copper content and copper recovery in final concentrate. It can be stated that the use of xanthate based collectors for copper minerals concentration from ore with a high pyrite content can not be achieved better technological parameters from the displayed. The reason for this is the fact that xanthate based collectors thanks to its strong affinity towards sulphide minerals and may not be sufficiently selective. Therefore the optimal copper minerals concentration from this raw material can not be achieved.

Applying collector Flomin C2440 were achieved more favorable technological results from aspects of concentration process technical and technological conditions. Correlation between the concentration products mass proportion, copper and sulfur content in them and their distribution at process end are the primary advantage of this collector application. Achieved technological parameters are as follows:

- ✓ rough concentrate weight is 5,76%
- ✓ the rough concentrate copper content is 2,78%
- ✓ the rough concentrate sulfur content is 15,29%
- ✓ the rough concentrate copper recovery is 76,22%
- ✓ the rough concentrate sulfur distribution is 15,15%

- ✓ final concentrate copper content is 13,24%
- ✓ final concentrate copper recovery is 46,53%

CONCLUSIONS

- Technological results presented in this paper, definitely confirm that the application of current "Veliki Krivelj" technological plant schemes, in no case can not achieve better technological effects. It is concluded that, to improve the techno-economic parameters of this raw material processing, technological scheme that is designed and implemented at the facility "Veliki Krivelj" must be changed from the aspect reagent regime.
- Remarkable copper minerals flotation results were achieved by applying collectors from manufacturer Flomin, with a commercial label C 2440.
- Achieved results by applying of these collectors are much better than the results obtained in the plant by the designed scheme, and to some extent better than achieved results by use of all other tested collectors. The main reason for the achieved results difference by applying these collectors in relation to the other, lies in their high selectivity for copper minerals holders in relation to the pyrite. The essence is that their action mechanism is based on the affinity towards copper and not to the sulphide minerals, where belongs pyrite.
- Despite the fact that achieved results were significantly better by these collectors use than all the others, they do not reach the technological indicators optimal values level. The reason for this is, among other things, low copper content and high sulfur content in the feed ore. It is very interesting that all technological indicators values that are lower than projected and optimal, are consequences of primary concentrate low mass portion. This suggests that by these collectors application and the mass concentrates correction with quite high copper content and the concentration degree, can expect better techno-economic effects in the plant, where it is easier to perform certain products mass participation correction.

Acknowledgements

These investigations were conducted under the Project 33007, "Implementation of new technical, technological and environmental solutions in the mining and metallurgical operations RBB and RBM", funded by the Ministry of Science and Technological Development of the Republic of Serbia.

References

- Farinato R.S., Nagaraj D.R., Larkin P, Lucas J., Brinen J.S., 1993. *Spectroscopic, flotation and wettability studies of alkyl and allyl thionocarbamates*. Society for Mining.
- Milošević V. i dr., *Studija flotacijske prerade kompleksne rude sa viših etaža rudnika "Veliki Krivelj", ITNMS 2014.*
- Nagaraj D.R., C.Basilio and R.H.Yoon, *The Chemistry and Structure-Activity Relationships for New Sulfide Collectors, Proceedings of the International Symposium on Processing of Complex Ores, Halifax, 1989, p.157-166.*
- Radosavljević S., N.Canić, Z. Bartulović, M. Stojanović: *Mineralogical Balance and Reproducibility of Gold Recovery from Copper Deposit "Veliki Krivelj"-Bor. VII International Mineral Processing Symposium, Istanbul-Turkey, 1998.*