

# 8<sup>th</sup> BALKAN MINING CONGRESS

## PROCEEDINGS

---

September 28 – 30, 2022  
Belgrade



MINING INSTITUTE BELGRADE

**CIP**

# 8<sup>th</sup> BALKAN MINING CONGRESS

PROCEEDINGS

Belgrade, September 28 – 30, 2022

## **Editors:**

Academician prof. Dr. Slobodan Vujić

Dr. Milinko Radosavljević

Dr. Svetlana Polavder

## **Organizer of the Congress and Publisher:**



MINING INSTITUTE Ltd. BELGRADE

Serbia, 11080 Belgrade, Batajnički put 2

Phone: +381 11 21 95 112; +381 11 21 98 112

Fax: +381 11 26 14 632

<http://ribeograd.ac.rs>; [office@ribeograd.ac.rs](mailto:office@ribeograd.ac.rs);

## **Co-organizers:**

Balkan Academy of Mining Sciences

Department of Mining, Geological and Systems Sciences

of the Academy of Engineering Sciences of Serbia

## **For the publisher:**

Dr. Milinko Radosavljević.

director of the Mining Institute Belgrade

## **Technical editors:**

MSc Jasmina Nešković

Rade Šarac, mining engineer

Pavle Stjepanović, mining engineer

## **Prepress:**

Leposava Knežević

## **The press:**

Colorgrafx, Belgrade

**Circulation:** 300

**Publication year:** 2022

ISBN 978-86-82673-21-7

The papers are printed in their original form. The authors are responsible for the data presented.

## **Copyright ©**

Mining institute Ltd. Belgrade

## INTERNATIONAL COORDINATION COMMITTEE

Academician prof. Dr. Slobodan Vujić, Serbia, president  
Prof. Dr. Tzolo Voutov, Bulgaria  
Prof. Dr. Vladimir Malbašić, Republic of Srpska B&H  
Dr. Marjan Hudej, Slovenia  
MSc. Sasho Jovchevski, Northern Macedonia  
Prof. Dr. Bahtiyar Unver, Turkey  
Prof. Dr. Nicolae Iliaş, Romania  
Dr. Miodrag Gomilanović, Montenegro  
Prof. Dr. Jani Bakallbashi, Albania  
Emeritus prof. Konstantinos Panagopoulos, Greece

## NATIONAL SCIENTIFIC COUNCIL

Academician prof. Dr. Slobodan Vujić, president  
Academician prof. Dr. Aleksandar Grubić  
Dr. Milinko Radosavljević  
Emeritus prof. Nadežda Čalić  
Prof. Dr. Rade Jelenković  
Prof. Dr. Milan Trumić  
Prof. Dr. Slobodan Trajković  
Prof. Dr. Jasminka Cvejić  
Prof. Dr. Milenko Pušić  
Prof. Dr. Aleksandar Milutinović  
Prof. Dr. Predrag Lazić  
Prof. Dr. Lazar Kričak  
Prof. Dr. Vladimir Čebašek  
Prof. Dr. Tomislav Šubaranović  
Prof. Dr. Miloš Tanasijević  
Prof. Dr. Bojan Dimitrijević

## NATIONAL ORGANIZING COMMITTEE

Dr. Milinko Radosavljević, president  
Dr. Svetlana Polavder, vice president  
MSc. Jasmina Nešković, vice president  
Pavle Stjepanović, secretary  
Rade Šarac, secretary  
Prof. Dr. Srđan Kostić  
Dr. Sandra Petković  
Dr. Dragica Jagodić Krunić  
Dejan Milijanović, mining engineer  
Željko Praštalo, mining engineer  
Dragan Milošević, mining engineer  
Marko Pavlović, mechanical engineer  
Vladan Čanović, engineer of geology  
Stevan Čorluka, engineer of geology

**Gratitude for the support of the 8<sup>th</sup> Congress:**

*Mining Institute Ltd. Belgrade*

*Ministry of Education, Science and Technological Development  
of the Republic of Serbia*

*Tevel d.o.o. Slovenia*



## THE CONTENT

Chanturiya V.A. INNOVATIVE PROCESSES FOR THE RECOVERY OF RARE AND RARE EARTH ELEMENTS FROM COMPLEX ORES. ....	21
Vujić S., Radosavljević M., Polavder S. USE OF ECOLOGY FOR THE DESTRUCTION OF MINING. ....	27
Milošević D., Makar N., Praštalo Ž., Čolaković V., Stjepanović P. MULTIPLE UTILIZATION OF THE INTERNAL LANDFILLS OF THE KOSTOLAC COAL BASIN IN THE FUNCTION OF REPURPOSING OF LANDFILL SPACE .....	35
Praštalo Ž., Maksimović N., Boševski T. SPECIFICITY OF TECHNICAL – TECHNOLOGICAL SYSTEM OF TAILINGS MINING ON COAL MINE SUVODOL. ....	46
Jovanović B., Makar N., Filipov I., Radić B. ANALYSIS OF THE POSSIBILITY OF EXPANDING THE EXPLOITATION FIELD OF THE KOVIN MINE. ....	54
Milošević D., Radosavljević M., Praštalo Ž., Čanović V. EXPLOITATION UNDERLYING PRODUCTIVE SERIES IN THE WET WORKING ENVIRONMENT OF THE CLAY DEPOSITS .....	59
Anastasov D., Eftimov Z. INNOVATIVE MINING TECHNOLOGIES WITH COMPLEX GEOMECHANICAL CHARACTERISTICS .....	66
Negovanović M., Kričak L., Ignjatović S., Milanović S., Marković J., Simić N., Šarac R. FLYROCK INDUCED BY BLASTING IN SURFACE MINING .....	73
Laszlo R., Gheorghiosu E., Ilici S., Radeanu C., Miron C. UNDERWATER ROCK REMOVAL ACTIVITIES BY BLASTING TECHNIQUES ..	84
Krastev Shishkov P., Krasimirova Stoycheva N. ADVANCED SOLUTIONS WITH FAST-COMBUSTING ENERGETIC COMPOSITIONS FOR BLASTING OF DIMENSION STONES, OR IN TENDER CONDITIONS OF CIVIL ENGINEERING .....	99

Krasimirova Stoycheva N., Krastev Shishkov P. ADVANCED BLASTING TECHNIQUES WITH EXTRAORDINARY APPROACHES FOR EXTRACTION OF DIMENSION STONES IN ROCK-CLADDING INDUSTRY . . . . .	105
Chevalier E., Agbaba G. THE CONTINUOUS IMPROVEMENT OF THE BLASTING PRACTICES WITHIN CARMEUSE . . . . .	111
Đenadić S., Tanasijević M., Miletić F., Jovančić P. APPLICATION OF THE FUZZY THEORY IN THE EVALUATION OF OPERATING PARAMETERS OF AUXILIARY MECHANIZATION ON OPEN-CAST COAL MINE, CASE STUDY: PIPELAYERS . . . . .	118
Farkaš B., Hrastov A. COMPARATIVE ANALYSIS OF THE MINING WORKS PERFORMANCE ON THE QUARRY “TAMBURA” . . . . .	125
Nedkov M. THE NEW PRACTICE FOR PRODUCTION OVERVIEW AND CONTROL AT ELLATZITE OPEN PIT MINE – WITH A SMART PHONE APPLICATION “ACMO MOBILE” . . . . .	132
Milanović N. CREATION OF CASSETTES FOR THERMOGENIC WASTE AT HEIGHT BENCH OF OPEN CAST MINE TAMNAVA – WEST FIELD. . . . .	141
Chevalier E., Agbaba G. QUARRY DESIGN EVALUATION TOOL – STUDY CASE FROM CARMEUSE OPERATIONS . . . . .	146
Đukanović D., Đokić N., Tokalić R., Crnogorac L., Gutić K. PREDICTION OF ROADHEADERS PERFORMANCE IN SERBIAN UNDERGROUND COAL MINES . . . . .	153
Trajković S., Bajić S., Radosavljević M. DETERMINATION OF SAFE DISTANCE AT THE SEISMIC EFFECT OF BLASTING. . . . .	168
Doneva N., Despodov Z., Mirakovski D., Hadzi-Nikolova M., Mijalkovski, S. APPLICATION OF PIPE UMBRELLA SUPPORT TUNNELING SYSTEM IN UNDERGROUND MINES IN NORTH MACEDONIA. . . . .	178
Šporin J., Vukelić Ž. SELF SHARPENING MECHANISM OF ROLLER CONE DRILL BIT . . . . .	184
Tošović R. GEOLOGICAL-ECONOMIC MONITORING IN IMPROVEMENT OF BUSINESS CONDITIONS AND EFFECTS OF MINERAL SECTOR COMPANIES . . . . .	196

Tošović, R. OF EXPERT ECONOMIC EVALUATION AND SYSTEMS OF THE MINERAL-RAW MATERIAL BASE OF THE COUNTRY . . . . .	204
Vakanjac B., Rutherford N., Ristić Vakanjac V. HISTORICAL AND RECENT DRILLING EXPLORATION OF URANIUM AT NAARST AREA (SOUTHEAST MONGOLIA) . . . . .	214
Şafak Ş., Taha Altiparmak B. EVALUATION OF SECONDARY SOURCE OF RARE EARTH ELEMENTS AND CURRENT SITUATION (TECHNOLOGICAL & ECONOMIC ASPECTS) . . . . .	221
Vučković B., Životić D. GEOLOGICAL EXPLORATION OF LIGNITE IN THE KOLUBARA COAL BASIN, 85 YEARS OF GEOLOGICAL OPERATION. . . . .	226
Ivković, Z., Dramlić D., Branković B., Tošić D., Ivković M. THE IMPORTANCE OF COAL IN SERBIAN ENERGETICS . . . . .	232
Vučković B., Životić D., Dimitrijević B., Stojković H. ENERGY POTENTIAL OF LIGNITE IN THE KOLUBARA COAL BASIN. . . . .	240
Prifti I., Jorgji V., Ymeri A., Zymi V. GENERAL CONSIDERATIONS OF BITUMINOUS SANDSTONES IN ALBANIA. . . . .	246
Kapageridis I., Apostolikas A., Kamaris G. CONTACT PROFILE ANALYSIS OF RESOURCE ESTIMATION DOMAINS: A CASE STUDY ON A LATERITE NICKEL DEPOSIT . . . . .	257
Ardian A., Kumral M. INVESTIGATION OF INTERACTIONS BETWEEN UNCERTAIN VARIABLES IN MINING VENTURES . . . . .	269
Iordanidis A., Asvesta A., Kapageridis I., Vasileiadou A., Koios K., Oikonomidis S., Kantiranis N. CHARACTERIZATION OF THE COARSE FRACTION OF LIGNITE BOTTOM ASH SAMPLES FROM GREECE . . . . .	278
Doneva B., Dimov G., Blazev K., Delipetrev M. NON – METAL RAW MATERIALS IN KRATOVO – ZLETOVO VOLCANIC AREA . . . . .	285
Bolundut I. L. GOLD: PROPERTIES, MINERALS, ALLOYS AND USES (I). . . . .	292
Bolundut I. L. GOLD: PROPERTIES, MINERALS, ALLOYS AND USES (II) . . . . .	298
Chanturiya V.A., Bunin I.Zh., Ryazantseva M.V. THE INVESTIGATION OF THE DIELECTRIC BARRIER DISCHARGE INFLUENCE ON THE EFFICIENCY OF THE FLOTATION SEPARATION OF PYRITE AND ARSENOPYRITE . . . . .	303



Jovanović V., Todorović D., Ivošević B., Radulović D., Milićević S., Mihajlović M. LIMESTONE PROCESSING – PROBLEMS . . . . .	309
Jovanović V., Todorović D., Ivošević B., Radulović D., Milićević S., Mihajlović M. PELLETING PROCESS, REQUIRED EQUIPMENT AND BENEFITS OF USE . . .	314
Radulović D. S., Ivošević B., Todorović D., Jovanović V., Stojanović J., Milićević S. SCIENTIFIC EXPERT VALIDATION OF PB-ZN SLAG FROM TOPIONICA – VELES (NORTHERN MACEDONIA), BASED ON PHYSICO-CHEMICAL AND MINERALOGICAL TESTS OF SLAG SAMPLES FROM THE LANDFILL . .	321
Konc Janković K., Lazić D., Stjepanović P., Nešković J., Milojković N. CREATION AND DEPOSITION OF GYPSUM FROM THE DESULFURIZATION OF TPP KOSTOLAC B FLUE GAS AT DRMNO OPEN-PIT MINE . . . . .	329
Stoqnchev G., Dachev G., Dermendjiev K., Cvetkov G. RESEARCH ON THE POSSIBILITIES FOR IMPROVING THE EXTRACTION OF GYPSUM IN THE MINE KOSHAVA . . . . .	338
Nešković J., Stjepanović P., Milojković N., Lazić D., Konc Janković K. SOLIDIFICATION / STABILIZATION TECHNOLOGY OF BY PRODUCTS (ASH) FROM POWER PLANTS . . . . .	345
Stjepanović P., Nešković J., Čorluka S., Milošević D., Polavder S., Jovanović I. THE INFLUENCE OF ADDITIVE QUANTITY ON THE TEMPERATURE CHANGE IN ASH AND SLAG MIX FOR SOLIDIFICATION PURPOSES . . . . .	355
Radulović D. S., Jovanović V. D., Todorović D., Ivošević B., Milićević S., Božović D. M. POSSIBILITY OF USING LIMESTONE FROM VUČIĆA BRIJEG – ULCINJ DEPOSIT AS FILLER IN VARIOUS INDUSTRY BRANCHES . . . . .	364
Čolaković V., Čanović V., Vlajić D. EXPLORATION OPERATIONS SPECIFITIES OF AHS AND SLAG DISPOSAL AREA MIDDLE KOSTOLAC ISLAND REMEDIATION . . . . .	372
Janković N. Z., Čantrak Đ. S., Kokotović B. M. RECONSTRUCTION OF CENTRIFUGAL PUMP IMPELLER . . . . .	377
Vutov V., Ivanov V. METHODOLOGICAL ASPECTS OF GEOENGINEERING DESIGN IN MINING AND GEOTECHNICAL CONSTRUCTION . . . . .	384
Ivanov V., Barishnikov V. GEOMECHANICAL RESEARCH FOR LOGISTICS OF THE DESIGN OF THE CHAIRA UNDERGROUND POWER STATION . . . . .	391
Čebašek V., Gojković N., Rupar V., Pribičević M. GEOMECHNICAL RESEARCH FOR THE NEW BUCKET WHEEL EXCAVATOR TESTING AT OPEN PIT FILIJALA . . . . .	400

Kotaran R., Bijelić V., Kesić A., Nikolić N. THE IMPACT OF THE DYNAMICS OF MINING WORKS DEVELOPMENT ON THE STABILITY OF NORTH FINAL SLOPE AT OPEN PIT – KOP 2 IN STANARI . . . . .	413
Tošić D., Majstorović S., Malbašić V., Negovanović M. SELECTION OF ANCHOR SUPPORT OF THE DRIFT IN BAUXITE MINE . . .	425
Dachev G., Kutsarov K. ANALYSIS OF THE GEOMECHANICAL STATE OF INTER-ROOM PILLARS IN MINING . . . . .	433
Trivan J., Kostić S., Šalović M. CALIBRATION OF EXCAVATOR CUTTING FORCE AND ENERGY CONSUMPTION CONSIDERING THE IMPACT OF THE OVERBURDEN MECHANICAL PROPERTIES . . . . .	441
Trivan J., Kostić S. ASSESSMENT OF EXCAVATOR ENERGY CONSUMPTION AND CUTTING RESISTANCE BASED ON CUT AND SLICE GEOMETRY AND EXCAVATION VELOCITY . . . . .	448
Božić D. USE AIRBORNE VEHICLES IN ANALYSIS OF LANDSLIDES OF OPEN-PIT LIGNITE MINES DRMNO . . . . .	455
Kahraman S. INDENTATION HARDNESS TEST TO PREDICT THE ABRASION RESISTANCE OF ROCK AGGREGATES . . . . .	463
Kahraman S., Rostami M., Fener M. THE EFFECT OF MICROWAVE HEATING ON THE STRENGTH OF AMASYA LIMESTONE . . . . .	469
Penzov T., Petrov P. NEW TECHNICAL MEANS FOR CONTROL OF GRINDING PROCESS . . . . .	476
Ankara H. DETERMINATION OF SLAKE DURABILITY INDEX (SDI) ON SPHERICAL SAMPLES WITH WATER-BASED COPOLYMER TREATMENT . . . . .	483
Polomčić D., Bajić D., Ristić Vakanjac V., Šubaranović T. QUANTIFYING THE IMPACT OF TAMNAVA- WEST FIELD DRAINAGE SYSTEM OF THE SURFACE PIT ON GROUNDWATER REGIME OF KALENIĆ REGIONAL LANDFILL . . . . .	488
Čanović V., Maksimović S., Boševski T., Čolaković V., Filipović D. HYDRODYNAMIC MODEL OF THE COAL MINE SUVODOL . . . . .	495

Jenić D., Janković V. PRELIMINARY CONCEPTUAL DESIGN OF A POSSIBLE PERMANENT REGULATION OF THE MALI PEK RIVER FOR THE LONG – TERM MINING DEVELOPMENT OF THE MAJDANPEK COPPER MINE . . . . .	503
Bakrač M., Therese Hortmann M., Wilke M., Breytenbach M. DESIGN AND USE OF GEOSYNTHETIC TUBES IN TAILINGS DAMS . . . . .	511
Gjorgjievski B. A SYSTEM OF SERIALY CONNECTED PUMPS FOR PROTECTION OF SURFACE WATER INFLOW AT MINING PRODUCTION UNIT – MINING POWER COMPLEX BITOLA . . . . .	520
Božić D. THE SLUDGE REMOVAL METOD ON THE INERNAL LENDFILL OF OPEN PIT TAMNAVA-WEST FIELD . . . . .	527
Sandra Petković, Marko Pavlović, Ana Radojičić, Ana Knežević, Ivana Jocić STUDY OF ENVIRONMENTALLY – FRIENDLY COAL DUST SUPPRESSANT: ENVIRONMENTAL POLLUTION PREVENTION AND CONTROL . . . . .	535
Kovacs A., Garaliu-Bușoi B., Vasilescu G., Rus D., Jitea C. ANNALISE ON THE CAUSES OF ACCIDENTS GENERATED BY INADEQUATE MANAGEMENT OF EXPLOITATION OF MINERAL RESOURCES WITH EXPLOSIVES . . . . .	545
Părăian M., Păun F.A., Gabor D.S., Popa M.C. IGNITION RISK ASSESSMENT OF EXPLOSIVE ATMOSPHERE IN MINES FROM BELT CONVEYORS . . . . .	560
Șimon-Marinică A.B., Ghicioi G., Vlasin N.I., Colda C., Cioclea D. INCREASING THE LEVEL OF SAFETY IN THE UNDERGROUND WORKPLACE OF GASSY COAL MINES BY MONITORING THE ATMOSPHERE AND PROCESS AUTOMATION. . . . .	567
Kovacs A., Garaliu-Bușoi B., Vasilescu G., Laszlo R., Rus D., Miron C. RISK ASSESSMENT AT DEMOLITION ACTIVITY OF MINING FACILITIES WITH THE HELP OF EXPLOSIVES . . . . .	574
Savić D. GROUND CONTROL MANAGEMENT PLAN - THE BASIS FOR SAFELY AND EFFECTIVELY MANAGING GEOTECHNICAL UNCERTAINTY IN THE UNDERGROUND COAL MINES. . . . .	582
Thanas J., Hoxha E., Bode A. SURFACE EXPLOITATION OF INDUSTRY MINERALS AND THE NEED FOR THE REHABILITATION OF THE EXPLOITED LAND SURFACES . . . . .	589
Goskolli E. THE PRESENCE OF HYDROGEN IN THE BULQIZE MINE AND RELATED PROBLEMS WITH THE MINE VENTILATION . . . . .	601

Milošević D., Radosavljević M., Praštalo Ž., Đerisilo A. ANALYSIS OF SURFACE MINING IMPACT ON OPEN – PIT MINE AREA SREDNJA STRANA AT NOVI BEČEJ . . . . .	616
Iordanidis A., Asvesta A., Kapageridis I., Vasileiadou A., Koios K. THE EFFICIENCY OF LIGNITE-FIRED POWER PLANTS AS EVIDENCED BY BOTTOM ASH ANALYSIS . . . . .	625
Chiuzan E., Cioclea D., Matei A., Gherghe I., Drăgoescu R. RECLASIFICATION OF PRAID SALT MINE BY STATE OF GAS EMISSION. . . . .	631
Cioclea D., Gherghe I., Rădoi F., Ianc N., Chiuzan E. NEW METHOD FOR DETERMINING THE EFFICIENCY OF THE VENTILATION NETWORKS . . . . .	637
Hristov V., Topalov S. DATA MINING METHODS IN FINE DUST POLLUTION ANALYSIS NEAR TO LARGE OPEN PIT MINE . . . . .	652
Cioclea D., Gherghe I., Matei A., Drăgoescu R., Cămărășescu A. VENTILATION TROTUȘ SALT MINE ANALYSIS REGARDING THE POSSIBILITY OF REVERSE. . . . .	660
Vasilescu G., Iliăș N., Offenbergl I., Radu S.M., Vochitioiu H. HOLISTIC ASSESSING OF ENVIRONMENTAL DISTURBANCE BY GENERALIZED GRAPHIC-ANALYTICAL MODEL. . . . .	676
Offenbergl I. HOLISTIC KNOWLEDGE, MINING LANDSCAPES AND ENVIRONMENT . . . . .	691
Cvejić J., Jovanović B., Praštalo Ž. RECLTIVATION OF POST MINING LANDSCAPE BASED ON LANDSCAPE-ECOLOGICAL APPROACH – CASE STUDIES OF CLAY OPEN PIT MINES SREDNJA STRANA AND GARAJEVAC ISTOK IN NOVI BECEJ . . . . .	701
Malić N., Lončar S., Matko U. EXPERIMENTAL AND PRODUCTION RESULTS OF BIOLOGICAL RECLAMATION OF STANARI COAL BASIN. . . . .	708
Maksimović M., Milošević D. FOLIAR RESEARCH IN BLACK PINE CULTURES ON MINING DUMPS AFTER LAND FERTILIZATION . . . . .	724
Maksimović Z., Maksimović S., Šarac R. REDUCTION OF HARMFUL EXHAUST GASES AND WASTE LUBRICANTS USING INNOVATIVE TECHNOLOGIES IN MINING MECHANISM . . . . .	732
Anastasova Y., Yanev N. MODERN FORMATS AND TECHNOLOGIES FOR DATA QUALITY IN INFORMATION SYSTEMS USED IN THE MINING INDUSTRY . . . . .	744

Mati S., Sevgen S. EFFECTS ON MINING BUSINESS OF ROYALTY TAX .....	752
Cvijić R., Milošević A., Kovačević Ž., Čelebić M. CONCESSIONS IN THE FUNCTION OF BOSNIA AND HERZEGOVINA MINERAL RAW MATERIAL BASIS REPRODUCTION .....	771
Malbašić V., Mikanović R. APPENDIX TO THE DEVELOPMENT OF THE MONITORING MODEL AND MANAGEMENT OF SAFETY AND WORK PROTECTIONS AT MINE OPERATIONS .....	781
Vukelić Ž., Šporin J. STUDY COURSES IN MINING AT UNIVERSITY OF LJUBLJANA FROM 1919 TO TODAY .....	798



## LIMESTONE PROCESSING – PROBLEMS

DOI: 10.25075/BMC.2022.37

Jovanović V., Todorović D., Ivošević B.,  
Radulović D., Milićević S., Mihajlović M.

INSTITUTE FOR TECHNOLOGY OF NUCLEAR AND OTHER MINERAL RAW MATERIALS,  
BELGRADE, SERBIA

[v.jovanovic@itnms.ac.rs](mailto:v.jovanovic@itnms.ac.rs)

**Abstract:** *Limestone is a versatile commodity used to create products for agricultural, environmental, and industrial purposes. Cement, paint, soil amendments, and even breakfast cereals all contain this resourceful mineral. Of course, mined limestone is not naturally found in a suitable form for many of these products. Therefore, various processing systems are needed to transform raw limestone rock material into a useful product. Common limestone processing methods that prepare the material for subsequent manufacturing stages include drying, calcining, pre-conditioning, and pelletization. The following information highlights limestone processing issues associated with these techniques, as well as general material challenges associated with limestone manufacturing.*

**Key words:** LIMESTONE, PROCESSING, PELLETIZING, DRYING, CALCINATION

### INTRODUCTION

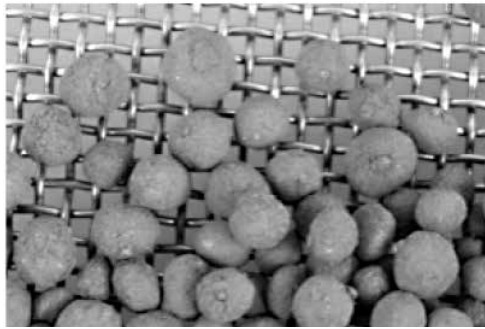
#### **What does a typical limestone pelletizing process look like?**

Pelletization is an agglomeration process whereby material fines are “grown” through a tumbling motion in the presence of a liquid binder or water. While all agglomeration processes can be customized to suit the unique needs of the material being processed, in general, it follows these sequential steps:

- 1) Material fines can be pre-conditioned in a pin or paddle mixer. Not all pelletizing processes use a pre-conditioning step, but those that do see added benefits such as reduced binder use, increased production, and an improved end product.
- 2) After pre-conditioning, the material moves on to the disc pelletizer. For those that do not pre-condition, this is where the pelletization process begins. Here, material is continually fed to the disc pelletizer and wetted by a liquid binder spray.

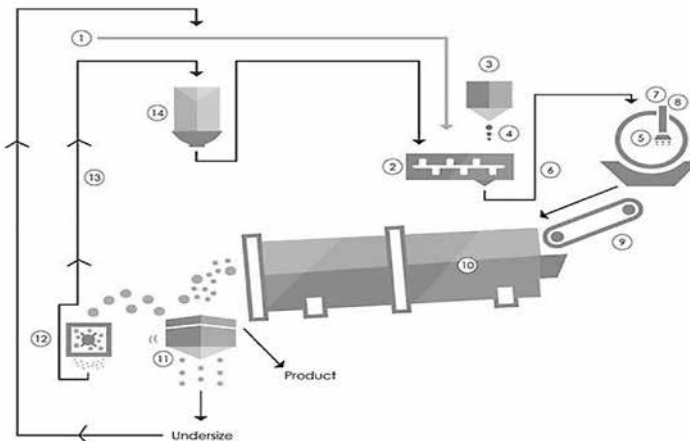
The disc's rotation causes the wetted fines to form small, seed-type particles (nucleation). The seed particles “snowball” by coalescence into larger particles until they reach their desired size and exit the pan. When a pre-conditioning step is used, seed pellets form in the mixer, and are enlarged and further rounded and refined on the disc pelletizer.

3) Finally, a belt conveyor transports the pellets to a rotary dryer if moisture removal is necessary. While reducing the moisture content, the dryer can also polish pellets into their final, hardened form.



*Picture 1. Typical appearance of limestone consolidation products by pelletization process*

The flow diagram in a picture 2. below is a visual representation of the pelletization process:



*Picture 2. Visual representation of the pelletization process*

**LEGEND:** 1.Raw Feed, 2.Paddle/Pin Mixer, 3.Binder Feed, 4.Spray Rate, 5.Disc Pelletizer; 6.Feed Onto Pelletizer, 7.Binder Feed, 8.Liquid Spray System, 9.Transfer Conveyor; 10.Rotary Dryer, 11.Vibrating Screen, 12.Oversize Mill, 13.Recycle, 14.Surge Hopper

## LIMESTONE DRYING

### **Limestone processing issues: Abrasive and prone to clumping**

A drying process is often used to precondition limestone rock for subsequent manufacturing steps. Like most rocks, limestone is abrasive as a raw material. As a result, heavy-duty rotary dryers are recommended to handle limestone's abrasive characteristics.

Drying processes may also be used on powdered limestone, with the recommended equipment again being rotary dryers. Many limestone manufacturers address moisture issues and prevent material clumping by utilizing a drying process before storing powdered limestone for extended periods of time.

In both cases, rotary dryers are the ideal choice for their ability to handle fluctuations in feedstock size and moisture content.

## CALCINATION OF LIMESTONE

### **Limestone processing issue: Emission control**

Rotary kilns are most often used to produce lime products in the United States. Hot combustion gases and limestone move counter currently within the refractory-lined drum of the rotary kiln, applying a high-temperature process that ultimately changes the raw material into a high-calcium lime or dolomitic lime. Particle matter pollutants are a common issue with rotary kilns, requiring the application of a particulate control system in order to counteract this problem. Some equipment manufacturers also offers special burners to limit air pollutant emissions such as NO<sub>2</sub> and CO.

## LIMESTONE PELLETIZING

### **Limestone processing issue: Moisture**

Pelletization resolves a number of issues associated with limestone processing, from uniformity to nutrient delivery. Limestone pellets offer reduced dust, more accurate application, improved handling, and less product lost to dust. Fortunately, with such great benefits, limestone pelletization is a fairly straight-forward process.

However, there are still limestone processing problems that must be considered. For example, moisture is an important element in effectively pelletizing limestone. Throughout preconditioning, pelletization, and drying, moisture levels should be monitored and maintained to ensure optimal products are created through every stage of limestone processing.



**Pre-conditioning:** A pin mixer imparts a powerful rotating motion upon limestone and its binder, creating an evenly distributed mixture with a moisture level best suited for pelletization. A successful pre-conditioning process creates an easily controllable mixture for forming limestone pellets on the subsequent disc pelletizer. Additionally, the material densification is greater than that of a disc pelletizer alone. However, pin mixers require special abrasion resistant pins due to the potential for accelerated wear when processing limestone. Consequently, proper maintenance is important to avoid equipment breaks and prevent costly downtimes.

**Pelletization:** A disc pelletizer gradually grows the pre-conditioned mixture into limestone pellets using a binder and the motion of the rotating disc. Monitoring the material's moisture level is critical at this stage, because pellet characteristics such as size and strength are secured by monitoring moisture ratios during this process.

**Drying:** A drying process is utilized to control moisture levels within the pelletized limestone. As an added benefit, drying adds pellet strength and prevents clumping related issues. Rotary dryers are recommended for their ability to uniformly dry pellets, handle a large throughput of material, and naturally polish the limestone as it tumbles through the drum. The resulting product is also easier to handle and store. Knocking systems are available to reduce material clumps by dislodging material build-up inside the drum.

### **Build-up**

Limestone build-up has the ability to wear down equipment parts if left untreated. In order to prevent limestone maintenance issues, consistent material build-up removal (as part of an equipment's regularly scheduled maintenance plan) is necessary.

### **Clumping**

Another potential limestone processing issue is clumping. Fortunately, a number of solutions are available to prevent limestone clumping issues:

- As previously mentioned, a drying process reduces material clumping while adding a number of benefits to the final product's quality.
- Material handling equipment can also be used to correct material clumps. Screw conveyors, for example, use a flinging motion in their feed trajectory that naturally breaks apart material as it moves between equipment.
- Anti-caking additives are available in a variety of forms based on material characteristics and desired product results. A paddle mixer or rotary coating drum is used to apply the additive to the limestone mixture/pellets.

## CONCLUSION

Limestone processing problems are not unlike the challenges faced by many other naturally occurring materials. In addition to build-up and clumping problems, limestone composition can also vary from one region to another. Limestone's composition, porosity, and texture can vary for a number of reasons, especially when the material is mined from different regions around the world. Consequently, most of the equipment manufacturers recommend testing limestone before moving forward with processing strategies.

## REFERENCES

1. Albert K.B, Langford D.: *Pelletizing Limestone Fines*, Mars Mineral, Pennsylvania. 1998, pp. 12-29.
2. Feeco international, *Agglomeration handbook*, <https://feeco.com/literature/>
3. Boyd C. E.: *Use of agricultural limestone and lime in aquaculture*, CAB Reviews, Vol. 12(015), 2017, pp. 1-10.
4. Silva A. C, Silva. E. M. S, de Barros. M. R, Marinho. D. Y.: *Limestone fines reuse for agriculture through briquetting*, *Tecnologia em Metalurgia, Materiais e Mineração*, Vol. 13(4), 2016, pp. 365-372.
5. Jovanović V., Knežević D., Sekulić Ž., Kragović M., Stojanović J., Mihajlović S., Nišić D., Radulović D., Ivošević, B., Petrov, M.: *Effects of bentonite binder dosage on the properties of green limestone pellets*. *Chem. Ind*, Volume 10, 2016, pp. 135-144, doi: 10.2298/HEMIND160210023J.