



RELO

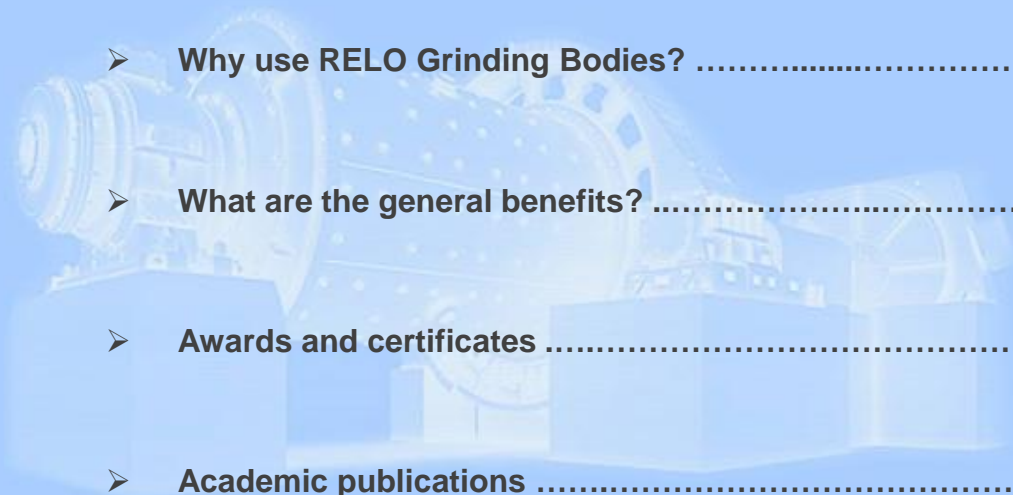
**ENERGY EFFICIENT
GRINDING BODIES**

RELO GRINDING BODIES

www.relogrindingbodies.com

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Introduction:



- **Over 30 million tons** of metal grinding bodies are being produced annually worldwide. This ranks them among **the most popular metal products in the world**. Over the past 150 years the grinding of ores, cement, coal, building materials, waste etc. is carried out by grinding bodies **mostly with spherical shape**.
- One of the **main disadvantages** of the spherical bodies used today is their **smallest contact surface**, which is the reason for **low efficiency and effectiveness** both in comminution and grinding.
- **RELO Grinding Body** is a **revolutionary innovation in the global market**, which will very soon **completely replace** the currently existing inefficient spherical balls.
- **The specific tetrahedral shape** of RELO Grinding Bodies creates a combination of **edges and vertices**, which results in a **100% increase of the productivity in comminution** of more coarse particles of the materials as well as in **two times more efficiency in grinding**. The result is **over 97% greater efficiency and effectiveness** in operation, and with total of **more than 40% lower production costs for electricity per ton** compared to the spherical bodies used so far.



What is RELO Grinding Body?



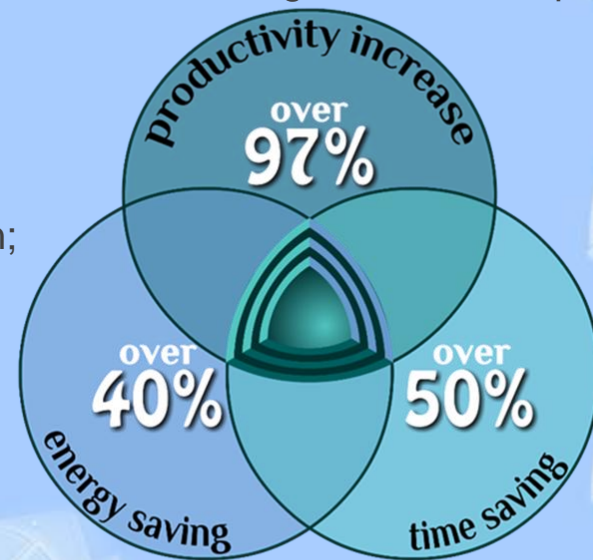
- The RELO Grinding Body is a **new industrial design – protected global innovation** honored with international **awards and certificates**, which **radically changes the processes of grinding in the mills**, and leads to **two times greater productivity with lower costs**.
- RELO Grinding Bodies are **industrially tested and certified products**.
- The family of RELO Products differs with the **advantages** of its technical **parameters**, much **higher economy, effectiveness, quality, productivity, capacity, applications, environmental impact** and others. And also – with a **variety of derivative designs specialized in the processing of various types of ores and materials**.



History of creation (1):

- **The sphere** is an appropriate geometric body for **grinding**, but it is **not effective enough** in the **comminution** of the more coarse particles of the materials entering in the mill. Because of this **uncustomary** for the sphere activity – to comminute before grinding, when put in the same conditions with the sphere, RELO Grinding Bodies have proven to significantly decrease:

1. **The consumption of grinding bodies** per ton;
2. The consumption of **electricity**;
3. **The time** for grinding.



- During the past **150 years** the spherical bodies have been **practically fully examined**. **All possible** high performance technologies for mass production of high-quality grinding bodies have already been **developed and implemented**. **The ceiling of the capabilities** of the spherical grinding bodies **has been reached!**

History of creation (2):



- The inventors of RELO set themselves the task to develop a **new grinding body** which grinds **more effectively and efficiently without increasing the final price**. Furthermore, the new body had to keep **the same volume and weight** as the currently used spheres.
- For this purpose they created a **new form of grinding body** for ball mill – similar to the shape of the geometric body “**Spheroidal tetrahedron of Reuleaux**” (Figure 1). The experts came to the conclusion that the grinding bodies with the exact shape of a tetrahedron of Reuleaux are **non-technological for mass production** and developed a technologically suitable form of similar grinding body to be produced by **die forging, casting or rolling** (Figure 2). They named the grinding bodies with this form “**RELO GRINDING BODIES**” after the German engineer Franz Reuleaux (1829-1905).

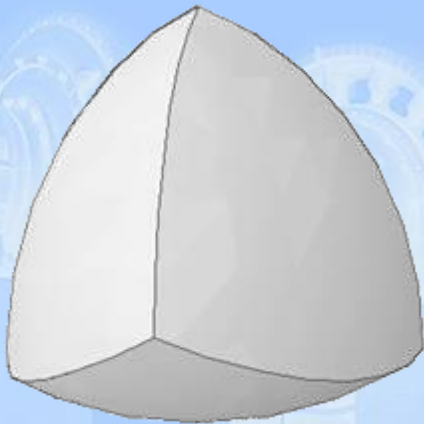


Figure 1. Tetrahedron of Reuleaux (Relo)

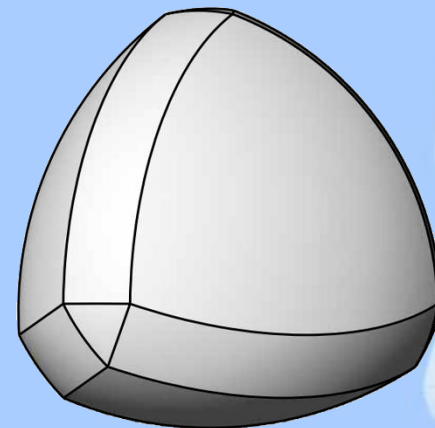
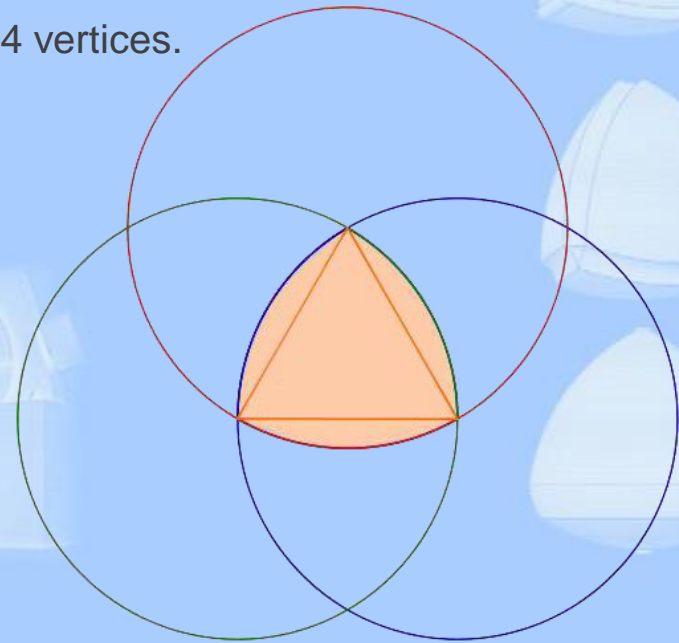
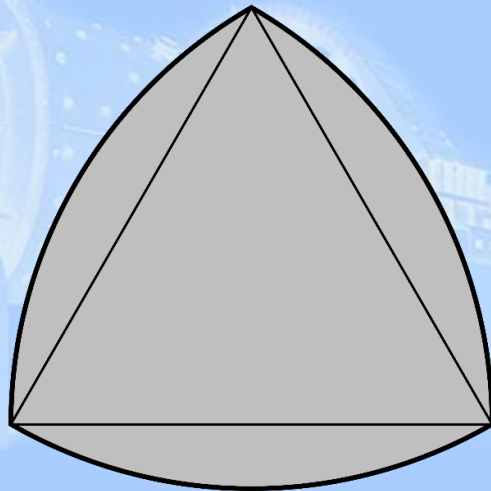


Figure 2. The new model RELO M 1.1

History of creation (3):

- Spheres have no edges and to this day they comminute the more coarse particles with their spherical surfaces, which is an **uncustomary for them activity**. **This is an enormous cost for the producers!**
- The four parts of the new body form **6 curved edges and 4 vertices**. The availability of edges and vertices leads to **two times bigger increase of the productivity**, due to the **combinatorial function of the grinding body** – with **4 grinding** spherical surfaces and **10 (16) comminuting elements** – 6 (12) edges and 4 vertices.

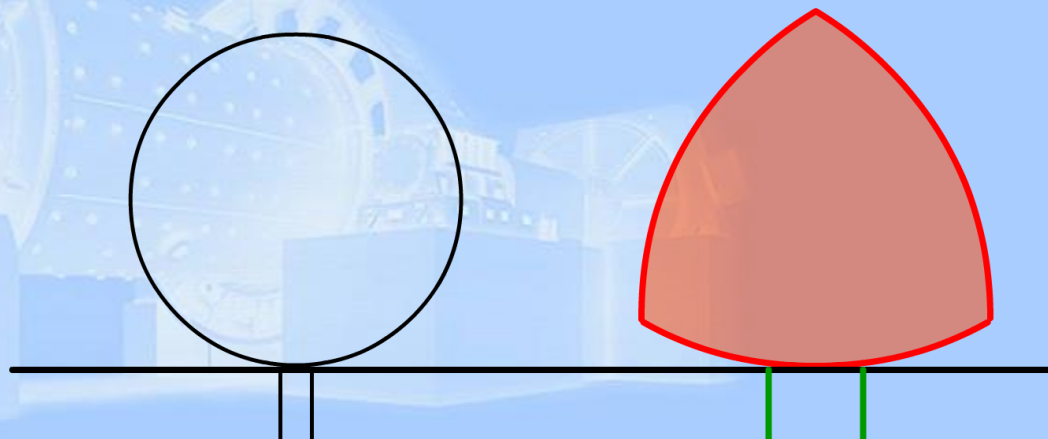


History of creation (4):



- Geometrically speaking, the RELO Grinding Body is composed by **parts of four spheres**. Thus, it has **about 214% larger radius** than the radius of the spheres with analogical volume. Therefore, the **outer surface is with 9,4% greater** than the surface of the analogical spheres with equal volume and weight.
- **The productivity in grinding** is increased by the larger outer surface, because a **larger area of grinding surface** will now be involved in the grinding. And the more sloping surface of the sides creates a **larger area of contact with the material**.

9.35% LARGER GRINDING SURFACE

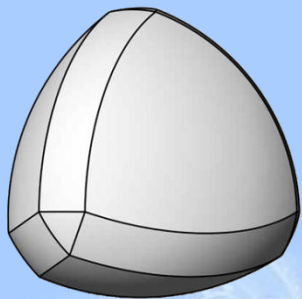


LARGER CONTACT SURFACE

Product range of the family of RELO Grinding Bodies (1):

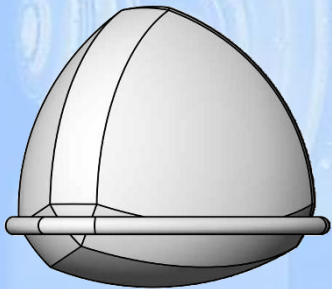


- The family RELO includes **eight basic models** of RELO Grinding Bodies, **protected with more than 300 patents in more than 65 countries**, which are **specialized** in the processing of **different types of ores**:



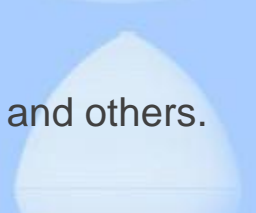
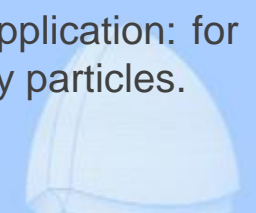
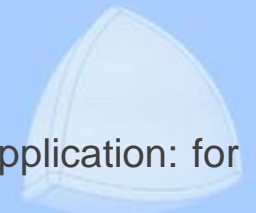
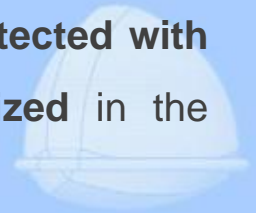
Model RELO M-1:

- Model RELO M-1.1 – closely rounded splayed edges. Application: for monolithic materials with predominantly large crystals.
- Model RELO M-1.2 – widely rounded splayed edges. Application: for conglomerate materials composed of smaller and crumbly particles.

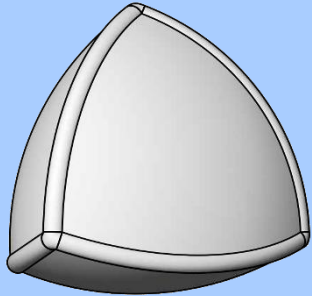


Model RELO M-2:

- Production: only by forging.
- Application: suitable for soft structures such as limestone and others.

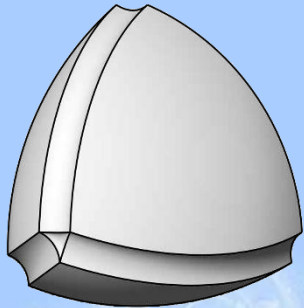


Product range of the family of RELO Grinding Bodies (2):



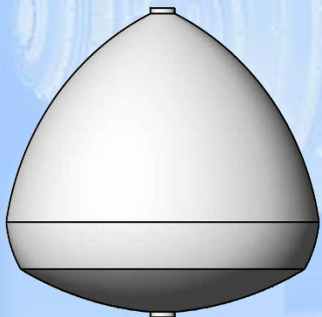
Model RELO M-3:

- Application: for solid materials.



Model RELO M-4:

- Application: for brittle materials and fine grinding.



Model RELO M-5:

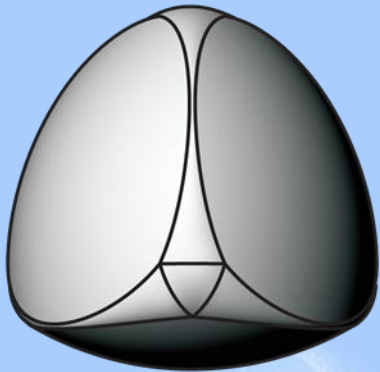
- Model sparing the lining.
- Application: grinding of porcelain, amber, etc.



Product range of the family of RELO Grinding Bodies (3):

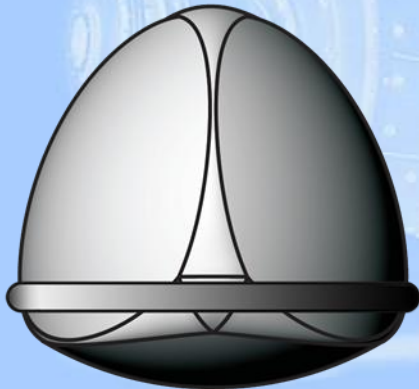


- **Model RELO C** – this model is specially **designed for grinding of cement, clinker, coal, lime, limestone, petroleum coke** and other materials that are being “dry”-ground:



Model RELO C-1:

- Application: for dry grinding.



Model RELO C-2:

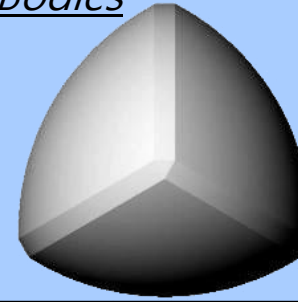
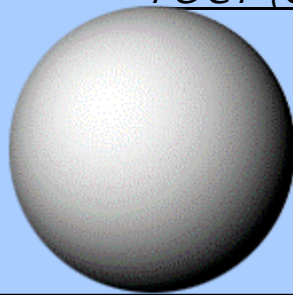
- Production: only by forging.
- Application: for dry grinding.



Comparative table for RELO Grinding Bodies:



Comparative table between the specifications of spherical grinding bodies according to TOCT (GOST) and RELO Grinding Bodies



Standard for SPHERICAL BALLS				Standard for RELO GRINDING BODIES			
N:	MODEL	NOMINAL D - F	VOLUME MM/3	N:	MODEL	HEIGHT MM	VOLUME MM/3
1	Sphere	15,00	1 766,25	1	Tetrahedron	15,512	1 766,25
2	Sphere	20,00	4 186,67	2	Tetrahedron	20,683	4 186,67
3	Sphere	25,00	8 177,08	3	Tetrahedron	25,853	8 177,08
4	Sphere	30,00	14 130,00	4	Tetrahedron	31,024	14 130,00
5	Sphere	40,00	33 493,33	5	Tetrahedron	41,365	33 493,33
6	Sphere	50,00	65 416,67	6	Tetrahedron	51,706	65 416,67
7	Sphere	60,00	113 040,00	7	Tetrahedron	62,048	113 040,00
8	Sphere	70,00	179 503,33	8	Tetrahedron	72,389	179 503,33
9	Sphere	80,00	267 946,67	9	Tetrahedron	82,730	267 946,67
10	Sphere	90,00	381 510,00	10	Tetrahedron	93,071	381 510,00
11	Sphere	100,00	523 333,33	11	Tetrahedron	103,413	523 333,33
12	Sphere	110,00	696 556,67	12	Tetrahedron	113,754	696 556,67
13	Sphere	120,00	904 320,00	13	Tetrahedron	124,095	904 320,00
14	Sphere	130,00	1 149 763,33	14	Tetrahedron	134,436	1 149 763,33
15	Sphere	140,00	1 436 026,67	15	Tetrahedron	144,778	1 436 026,67
16	Sphere	150,00	1 766 250,00	16	Tetrahedron	155,119	1 766 250,00
17	Sphere	160,00	2 143 573,33	17	Tetrahedron	165,460	2 143 573,33

Why use RELO Grinding Bodies? (1)

- **Zero investments** in putting into service – **without additional investments or time to put into service**. May be added in the ball mills together with the conventional consumable **until complete replacement**;
- **Double (over 97%) higher productivity** compared to spherical grinding bodies under the same operating conditions;
- **Reduction of over 40% of the production costs for the electricity** for the drum mills for the same quantity of processed material;
- **Reduced in half (over 50%) time for processing** of one ton of ore;
- **Lower Wi – Bond Index** for all models of the family with **SGS certificates**;
- **100% increase of the efficiency in comminution of the more coarse particles** – due to the **combinatorial function** of the grinding body with 4 grinding spherical surfaces and **10 (16) comminuting elements – 6 (12) edges and 4 vertices**.

Why use RELO Grinding Bodies? (2)



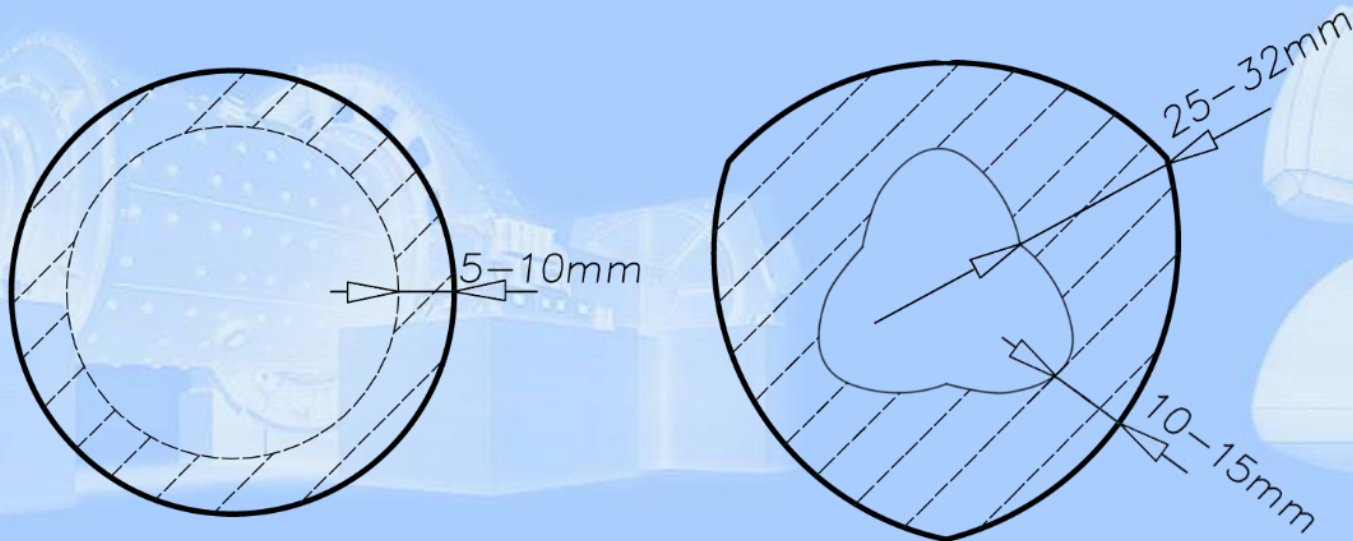
- **Increase by about 10% of the finely ground particles below 75 microns, which helps to increase the extraction of valuable materials** in the flotation process;
- **World innovation without an alternative** – the best product on the global market;
- Improved self-cleaning – **without expenses for cleaning chemicals**;
- **Without special training** of the staff for exploitation;
- **Improved dry grinding**;
- **Keep their form**;



Why use RELO Grinding Bodies? (3)

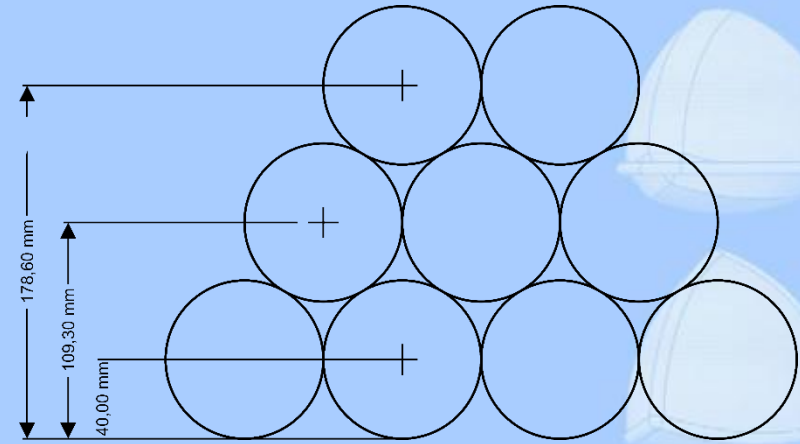
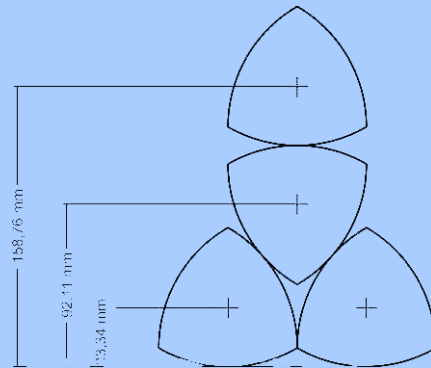


- **Design, accommodated to mass production** – suitable for production by traditional methods such as **casting, rolling, forging**;
- The technology of the RELO Grinding Bodies allows **grinding by comminution** – also suitable for **grinding of elastic materials**;
- **Higher quality production with casting** compared to the conventional products – **the gas abscesses are concentrated in the center of the bodies**;
- **Three times higher wear resistance and durability in operation** due to the tetrahedral form which leads to **61% bigger quantity of hardened volume** than the spherical bodies;

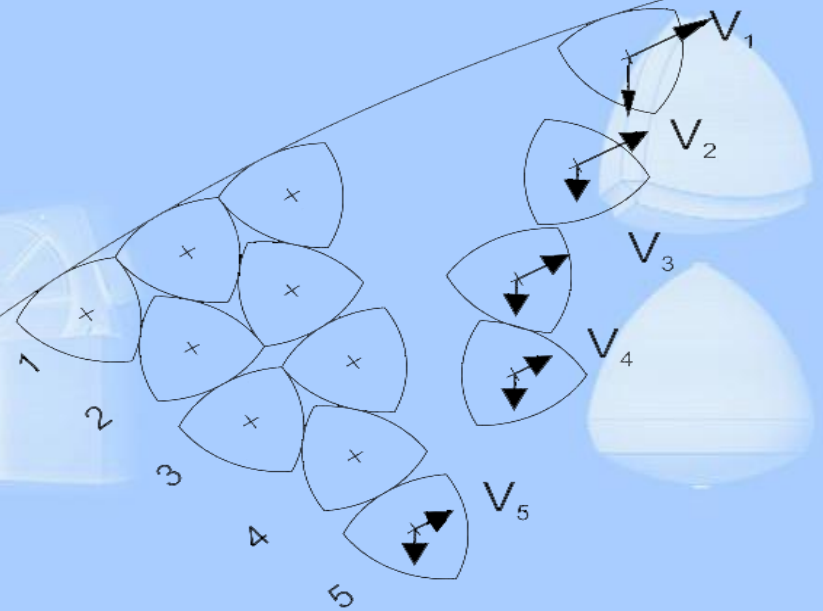


Why use RELO Grinding Bodies? (4)

- They occupy less volume – the better “stuffing” allows to add **up to 12-15% more bodies** in the mill;



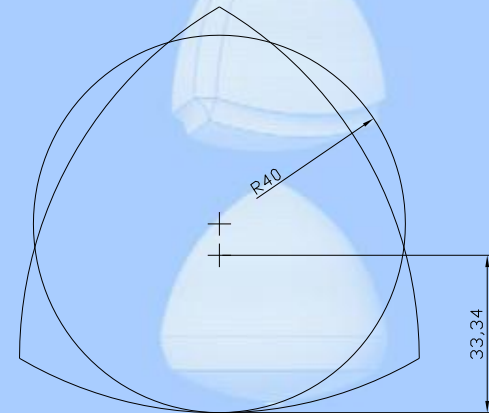
- Sparing the lining of the mill – same values of wearing out the lining of the mill – at the beginning of the free flight the grinding bodies are oriented with the spherical surface or with vertices **down** until hitting the particles being ground;



Why use RELO Grinding Bodies? (5)



- Shape of spheroidal tetrahedron – gives **up to 9,35% more grinding surface**;
- **The larger contact area** with the walls of the mill premises a fall from a greater height and greater kinetic energy upon hitting;
- **The lower center of gravity** accelerates and makes **higher kinetic energy** while falling, which leads to a **faster, better and more uniform milling** of the particles;
- **Increasing the total grinding surface** in the mills from 8,4 to 21,4%;
- **15% higher compactness** of the product during exploitation, transportation and storage;
- **Ecological effect of the reduced by over 40% energy costs**;
- **Up to 22% higher degree of grinding**;



What are the general benefits? (1)



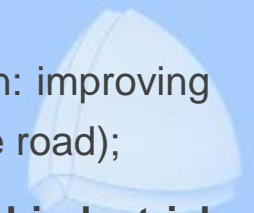
- **Reducing twice the time for processing of 1 ton material**, which leads to **significantly lower production costs** and to the possibility for **more competitive conditions and prices** on the market.
- The new form of RELO Grinding Bodies for drum mills, other things being equal with the spheres, provides a **radical change in the process of grinding** which **increases two times the productivity in the drum mills**. And **reduces with over 40%** the amount of energy expended per ton.
- Reducing the energy consumption in grinding is accompanied by **reducing the amount of fuels burned**, which are the main source for electricity production and in parallel **reducing the sulfur compounds, nitrogen and carbon oxides etc. discharged into the atmosphere**.



What are the general benefits? (2)



- The new bodies also allow a possibility of **introduction of entirely new applications and productions** in various economic sectors of usage:
- contribute to a better and more qualitative **grinding of coal** for the needs of the furnaces in the thermo-electric power-stations;
 - in **chemical industry** for the production of paints, varnishes and others;
 - in **livestock breeding** for the production of chalk for **animal fodder**;
 - in **agriculture** for **phosphate fertilizers** (phosphates and apatites);
 - in **construction industry** for the production of raw and other materials and also in the production of **cement**;
 - in **processing and recycling of used tires** (applicable in road construction: improving the traction in rain, the abrasion resistance and reducing the noisiness of the road);
 - in **processing and recycling** of rubber, plastics and other **household and industrial waste**,
- by which the economies of the countries can **save enormous resources**, and will create opportunities for **new jobs** and also offer a **qualitative environmental policy**.



What are the general benefits? (3)



- In such a high-energy process as the grinding in drum mills, **reducing the energy consumption even** by a few percent will have a **significant economic result** for the mining industry in general. And in particular, it will **save hundreds of millions of dollars of costs each year of its customers.**
- The **positive results** of the implementation of the new grinding body will manifest right away both **in economic and in environmental terms** and will affirm the economy among the **market leaders.**



Awards and certificates:



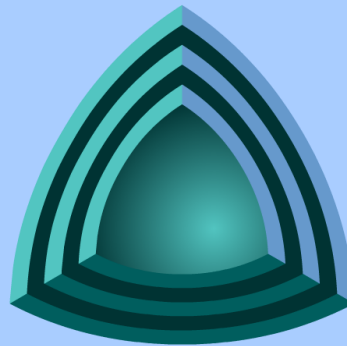
- **Gold medal at the 39th International Exhibition of Inventions – Geneva, 6 – 10 April 2011:**
 - **785 inventors from 45 countries** participated in the exhibition.
 - **More than 1000 inventions** were presented.
 - The prize was awarded by a **83-member international jury**.
 - The invention won **the Gold medal and Diploma of the exhibition**.
- **The Grand Prize of the Union of the Bulgarian inventors (UBI) – “Inventor of the Year” for 2011:**
 - National Exhibition “**Inventions, technologies, innovations**”, Sofia, 9-11 November, 2011.
 - The invention won **the Grand Prize of UBI** for achievement in the inventiveness, for successful use of intellectual property and for best performance.
- **SGS Certificates – for conduction of Industrial and Laboratory/ Bond tests;**
 - SGS is a leading world company for **inspection, verification, testing and certification**.
 - The SGS certificates are **global benchmark for quality**.



Academic publications:

22

- Prof. Phd. Dipl. Eng. P. Bodurov, V. Genchev, **Industrial Tests with Innovative Energy Saving Grinding Bodies**, Journal of Multidisciplinary Engineering Science and Technology (JMEST), ISSN: 2458-9403, Vol. 4 Issue 1, 2017, January, Bulgaria ([publication](#));
- Prof. Phd. Dipl. Eng. P. Bodurov, V. Genchev, **New and More Effective Grinding Bodies for Drum Mills – Alternative of the Spherical Grinding Bodies**, JMEST, ISSN: 3159-0040, Vol. 2 Issue 9, 2015, September, Germany ([publication](#));
- Prof. Phd. Dipl. Eng. P. Bodurov, Prof. T. Penchev, Prof. L. Tzotzorkov, Prof. L. Kuzev, **Comparative studies on ball versus spheroidal tetrahedrons working media to ore grinding in an industrial drum mill**, XXV International Mineral Processing Congress (IMPC), 2010, 6-10 September, Brisbane, Australia ([publication](#));
- Prof. Phd. Dipl. Eng. P. Bodurov, Prof. L. Tsotsorkov, Prof. T. Penchev, **Theoretical studies on new spheroidal tetrahedron shaped grinding media**, Proceedings of PROCEMIN, 2012, 25-27 November, Santiago, Chile ([publication](#));
- Prof. Phd. Dipl. Eng. P. Bodurov, Prof. T. Penchev, **Comparative Analysis of the Parameters of Spherical and RELO Body Balls for Drum Mills**, Proceedings of the International Conference on Mining, Material and Metallurgical Engineering, 2014, 11-12 August, Prague, Czech Republic ([publication](#));
- Prof. Phd. Dipl. Eng. P. Bodurov, Prof. T. Penchev, Prof. N. Kemilev, **Investigation of milling balls form influence on their hardness after hardening**, 26th International Scientific Conference “65 years Faculty of machine technology”, 2010, 13-16 September, Sozopol, Bulgaria ([publication](#));
- L.S. Chitalov, A.V. Fadina, E. E. Andreev, V. V. Lvov, **New effective grinding media for drum ball mill**, National Mineral Resources University (Mining University), 2013, Saint Petersburg, Russia ([publication](#)).



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Thank you for the attention!

Contact: office@relo.asia

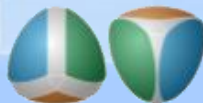


ABV Technology

ТЭРРА ТРЕЙД ХХК



TERRA TRADE LLC



RELO-B Ltd.



SGS