Dr. Aitber Bizhanov

Briquetting. Problems and Prospects

Briquetting? Is it Required? Alternatives.

- Fluidized Bed
- DC Furnaces
- Reduction Smelting
- Encapsulation
- Mold casting

Briquetting? Is it Required? Alternatives.

Fluidized Bed

- In such units, in contrast to shaft furnaces, the charge particles randomly move in a certain volume and, with correctly chosen values of the gas flow rate, do not leave the working chamber. And if in the shaft furnace the charge particles are in direct contact with each other, which determines the specificity of heat and mass transfer processes in a dense layer, then in a fluidized bed conditions such processes occur individually for each particle.
- Restrictions on the grain size distribution of iron ores. In the well-known FINMET process, the proportion of ore particles with a size of less than 0.15 mm should not exceed 20%.
- The degree of metallization achieved on plants commissioned in 1999 and 2000 in Australia and Venezuela based on this process reached 92% with an average carbon content of 1.3%. Natural gas consumption was 13-16% higher than in shaft furnaces. In 2005, the plant in Venezuela ceased to exist, and the plant in Australia has not yet reached its design capacity.

Briquetting? Is it Required? Alternatives.

Fluidized Bed. CIRCORED

- This process has also used agglomeration. For effective metallization of fine materials (gas cleaning dust), their preliminary agglomeration was necessary, for which the company Outokumpu developed and patented a process to produce micro granules.
- The only industrial installation operating under the CIRCORED process was commissioned in **May 1999** in Trinidad. The actual annual production of the metallized product was 360 thousand tons, with the project capacity being 500 thousand tons. The plant was shut down in **2005**.

Briquetting? Is it Required? Alternatives.

DC Furnaces

- **Aktobe Ferroalloy Plant** (Republic of Kazakhstan). The construction of the workshop was started in **2010**.
- The new production consists of four **DC furnaces** of new generation with a total capacity of **440 kty** of high-carbon ferrochrome. The total cost of the project is about **843 million dollars**.
- During the operation of the furnaces, the following indicators were achieved - the consumption of fine chromium ore is **3850 kg/ton** of chromium, the consumption of reducing agent (coal) **is 950 kg/ton** of chromium, which practically corresponds to the performance of the process on alternating current.
- The specific energy consumption was higher than that of AC furnaces - **7552** kWh/ton of chromium versus **6640** kWh/ton of chromium. This is due to the open arc burning on the surface of the bath and, accordingly, to large heat losses by radiation on the walls and roof of the furnace.
- Unfortunately, so far, the furnaces have not reached their design capacity, which indicates the absence of convincing arguments in favor of working on un-agglomerated raw materials.

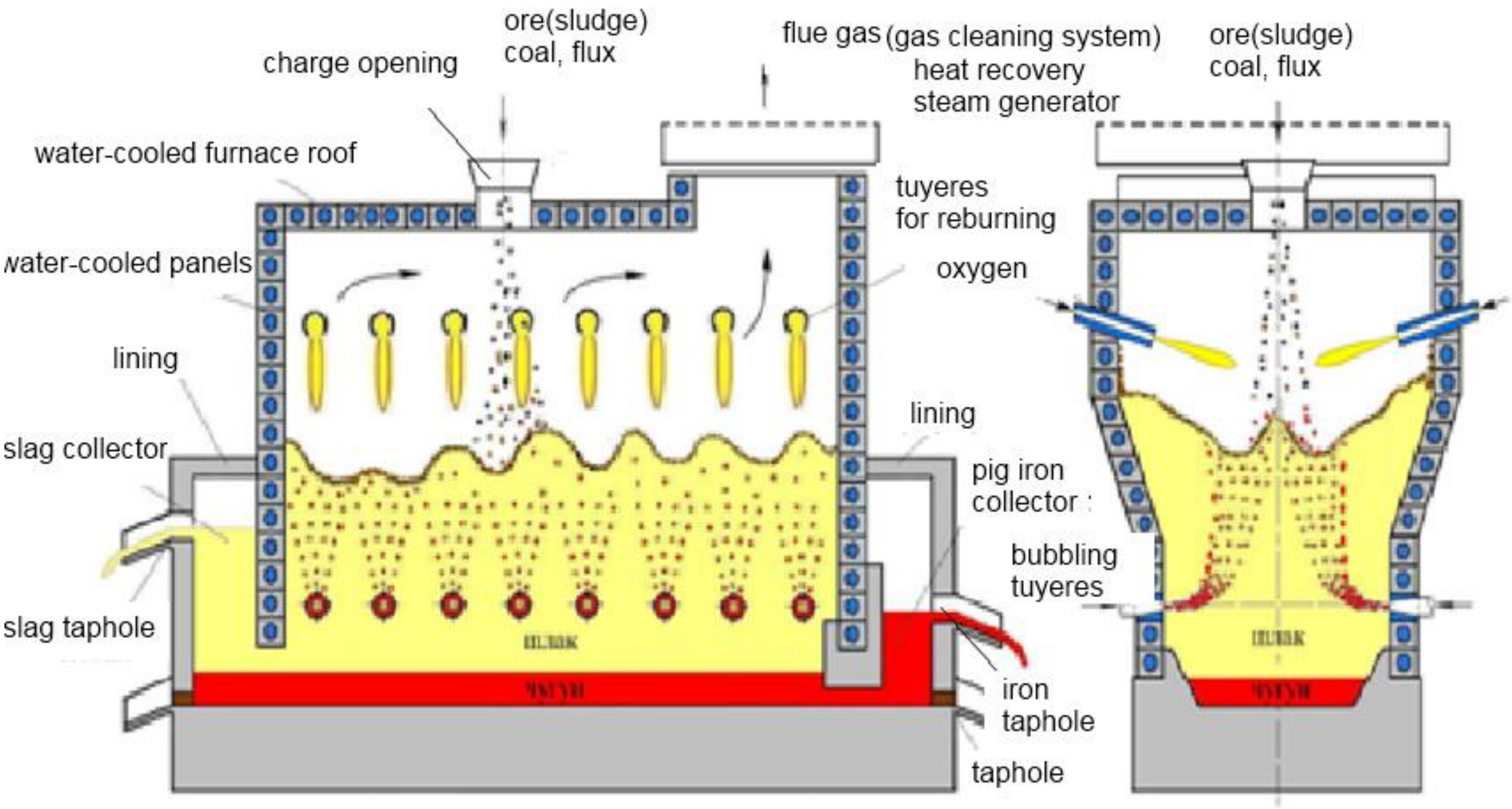
Briquetting? Is it Required? Alternatives.

Reduction Smelting. ROMELT

- An attempt to avoid agglomeration as part of the reduction smelting process was undertaken in connection with the development of the well-known **ROMELT** process, developed in 1979 by employees of the Moscow Institute of Steel and Alloys (Romenets V.A. and others) and implemented in 1985 as large-scale pilot plant at the Novolipetsk Steel Company (NLMK). This technology, unfortunately, did not receive wide distribution as well.
- **ADVANTAGES**: Production of pig iron in one stage from unprepared iron ore materials, without the use of coking coal and natural gas. The possibility of selective, integrated processing of waste metallurgical processing. The possibility of burning low-grade coal grades to produce conditioned generator gas and power generation.
- **DISADVANTAGES**: High specific energy consumption, low quality of produced iron, loss of valuable non-ferrous metals with slag. One of the reasons for the failure of the project was the formation of a significant amount of dust.

Briquetting? Is it Required? Alternatives.

ROMELT

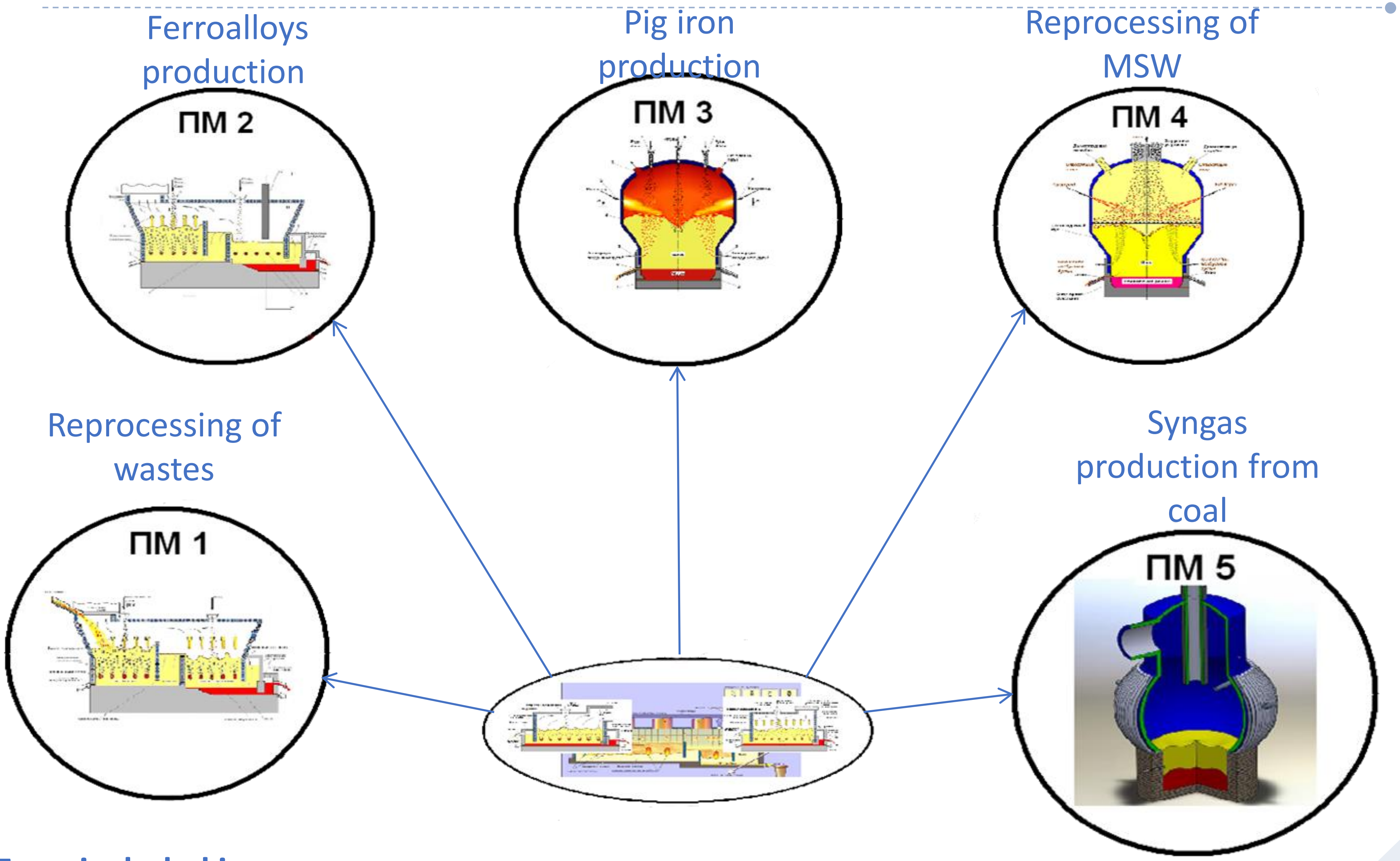


Briquetting? Is it Required? Alternatives.

Reduction Smelting

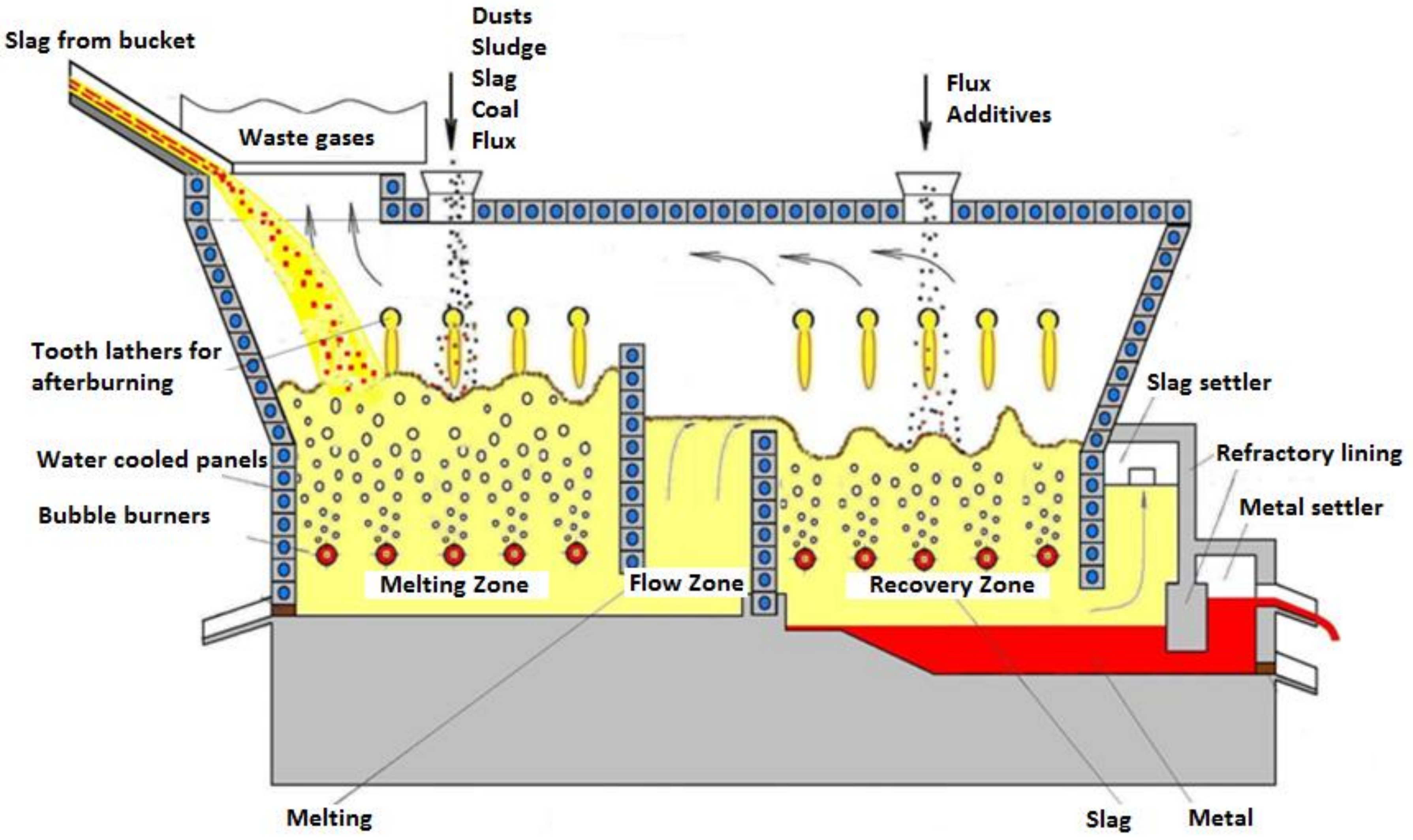
- BARBOTAGE (BUBBLING) Technology: In barbotage technologies main processes are carried out in a molten pool where materials bubbled with oxygen containing gas.
- Barbotage technologies are applied: in the chemical industry, ferrous and nonferrous metallurgy and energy industry.
- High intensity, flexibility, high specific capacity, high selectivity of separation of useful components to industrial products, final products are in a single unit, energy efficiency, environmental friendliness, opportunities for recycling industrial wastes, low specific investment and operating costs.

Briquetting? Is it Required? Alternatives.

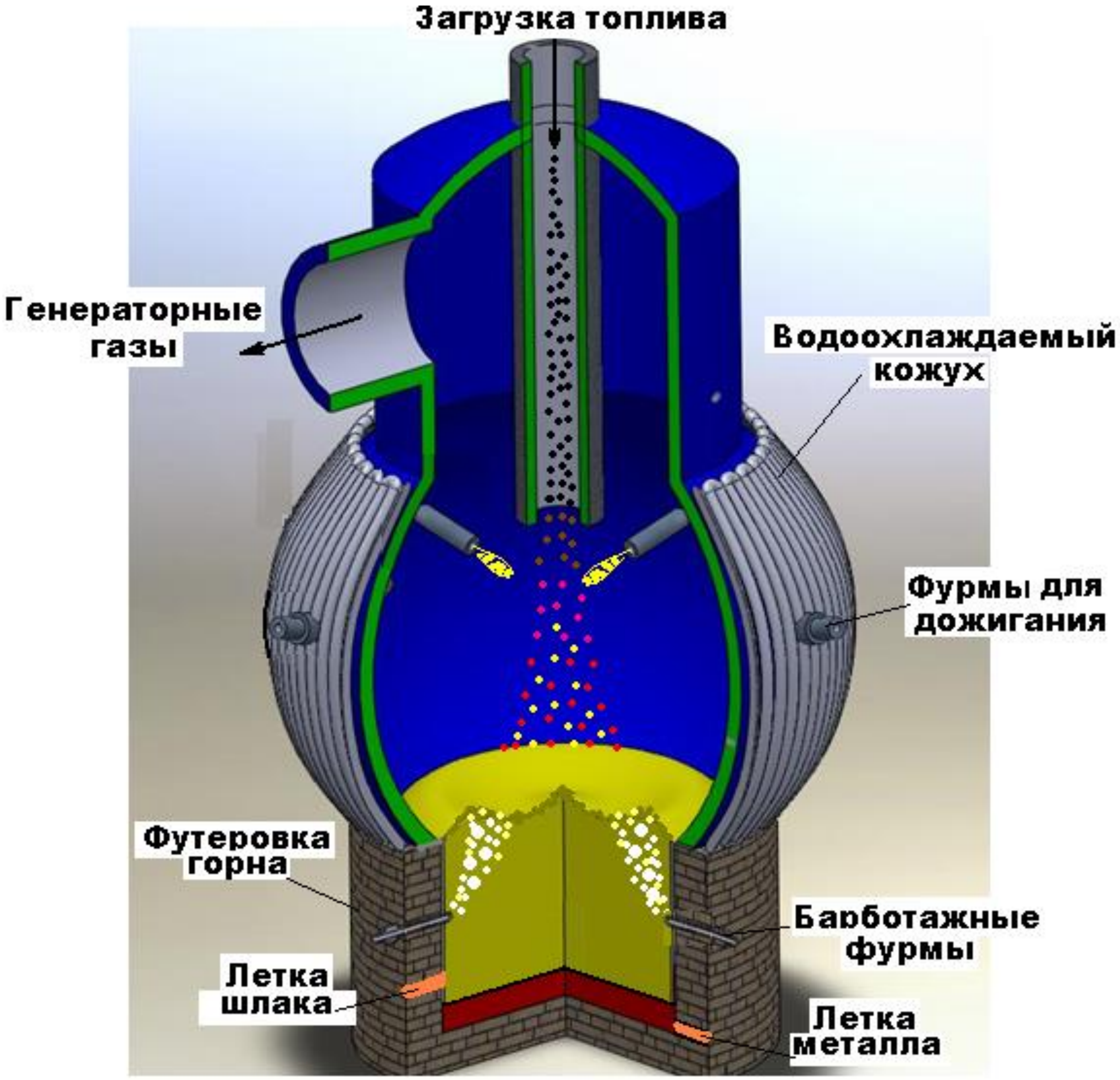


PM 1 and PM 5 are included in BAT in Russia

Briquetting? Is it Required? Alternatives.

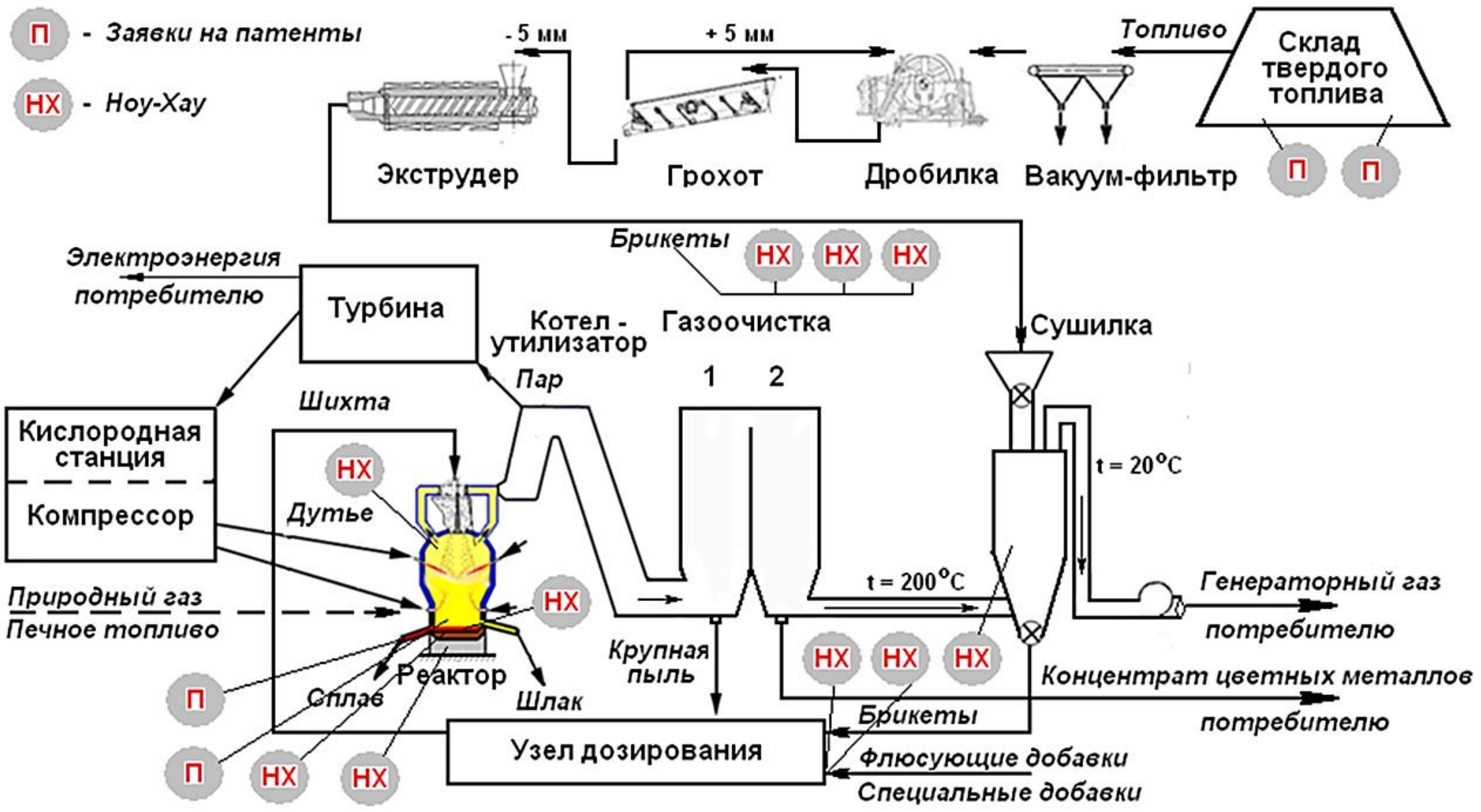


Poly-fuel gas generator PM 5



Types of solid fuel:
any brand of coal;
coal processing waste;
peat;
oil shale;
woodworking waste;
biomass;
oil refining waste;
municipal solid waste.
Processing Products:
generator gas;
slag;
metal alloy;
steam of energy parameters

Scheme of installation of poly-fuel gas generator



Scheme of installation of poly-fuel gas generator

Comparison of the main gasification methods (per 1 ton of MSW, Q = 1670 kcal)

Parameter	MSW Processing Technologies		
	Burning	Plasma	PM 5
Temperature, ºC	1200	1500	1500
Exhaust gases volume, nm^3	3833	1421	1375
Exhaust gases heat			
Sensible, MJ	7590	3295	3662
Chemical, MJ	0	12809	10381
Total heat of gases, MJ	7590	16104	14043
Electricity generation at efficiency of steam turbine = 21%, MJ	1579	3382	2949
Electricity costs for own needs, MJ	540 -720	2340	900 - 1080
Electricity supply to the side, MJ	859 - 1039	1042	1869 – 2046
Electricity supply to the side, MW/h	0.24 – 0.29	0.29	0.52 – 0.57

Briquetting? Is it Required? Alternatives.

BUBBLING TECHNOLOGY. FULL-SCALE TESTING. 2019.

Developer – Dr. Gennady Podgorodetsky
NUST MISIS
podgs@misis.ru
+79653141141

Briquetting? Is it Required? Alternatives.

Encapsulation

It was suggested to pack concentrates in ... tin cans. And even laboratory experiments seemed to confirm the fundamental possibility of introducing un-agglomerated material into the charge of the ore-smelting furnace, but a simple calculation showed that for a similar recycling of the resulting dispersed material would require construction, next to the ferroalloy plant, a separate cannery…

Briquetting? Is it Required? Alternatives.

Mold casting

Pouring prepared water mixture of briquetted material with cement (up to 20%) into molds for subsequent curing.

- Briquette was placed in temperature-resistant silicone molds ($10.5 \times 6 \times 3 cm^3$) and stored at room temperature (20 °C) for **96 h** to ensure an appropriate mechanical strength
- Low hot strength of briquette. Destruction at 700-800 degrees Celsius.

Briquetting. Problems and Prospects.

- CHARGE PREPARATION
- PRODUCTION OF BRIQUETTES
- PROCESSING OF GREEN BRIQUETTES

Briquetting. Problems and Prospects. Charge Preparation.

- CHARGE PREPARATION
  - CHOICE OF MATERIALS
    - Chemical composition
    - Physical properties
    - Mineralogy
    - Choice of Binders
    - Briquettes composition
  - MATERIALS PROCESSING
    - Drying
    - Pulverization
      - Grinding
      - Vortex bed apparatus
    - Souring (Homogenization)
    - Selective withdrawal of elements
      - Vortex bed apparatus
      - Dezincing
      - De-Oiling

Briquetting. Problems and Prospects. Charge Preparation.

CHOICE OF BINDERS

- Binderless
- Inorganic
- Organic
- Polymeric (BASF, AMBERSHAW)

Briquetting. Problems and Prospects. Charge Preparation.

BRIQUETTE COMPOSITION

- The selection of the composition of the briquette should be based on the need to process the entire set of dispersed natural and anthropogenic materials.

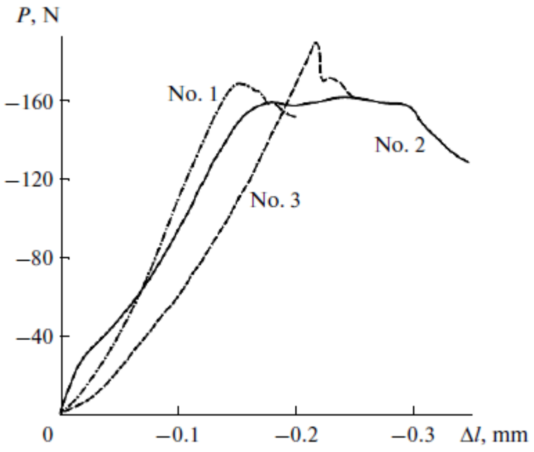
- It is necessary to consider the specific features of the briquetted materials and to achieve compliance of the chemical composition of the briquette obtained with the requirements of the metallurgical processing (content of the main element, cold and hot strength , basicity, etc.).

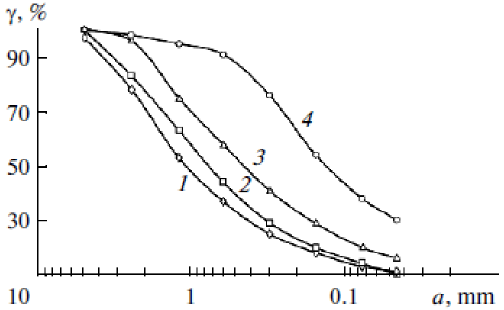
- In some cases it is advisable to choose several different compositions of briquettes.

Briquetting. Problems and Prospects. Charge Preparation. Pulverization.

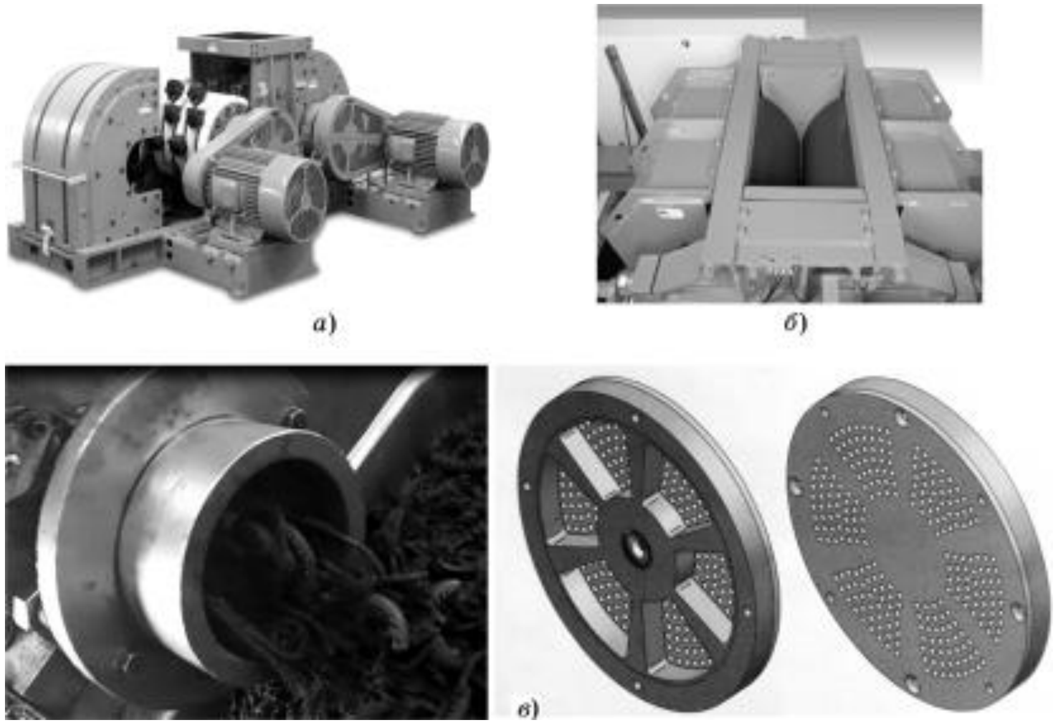
Extruded briquettes made of coke breeze(94%; 5% PC; 1% Bentonite.

- No.1 – roll crusher
- No. 2 – double extruded
- No. 3 – hummer milled





Granulometric composition of coke breeze in the following states: (1) initial and (2–4) after additional grinding in a hammer mill, in a roll crusher, and double extrusion in an extruder. respectively.



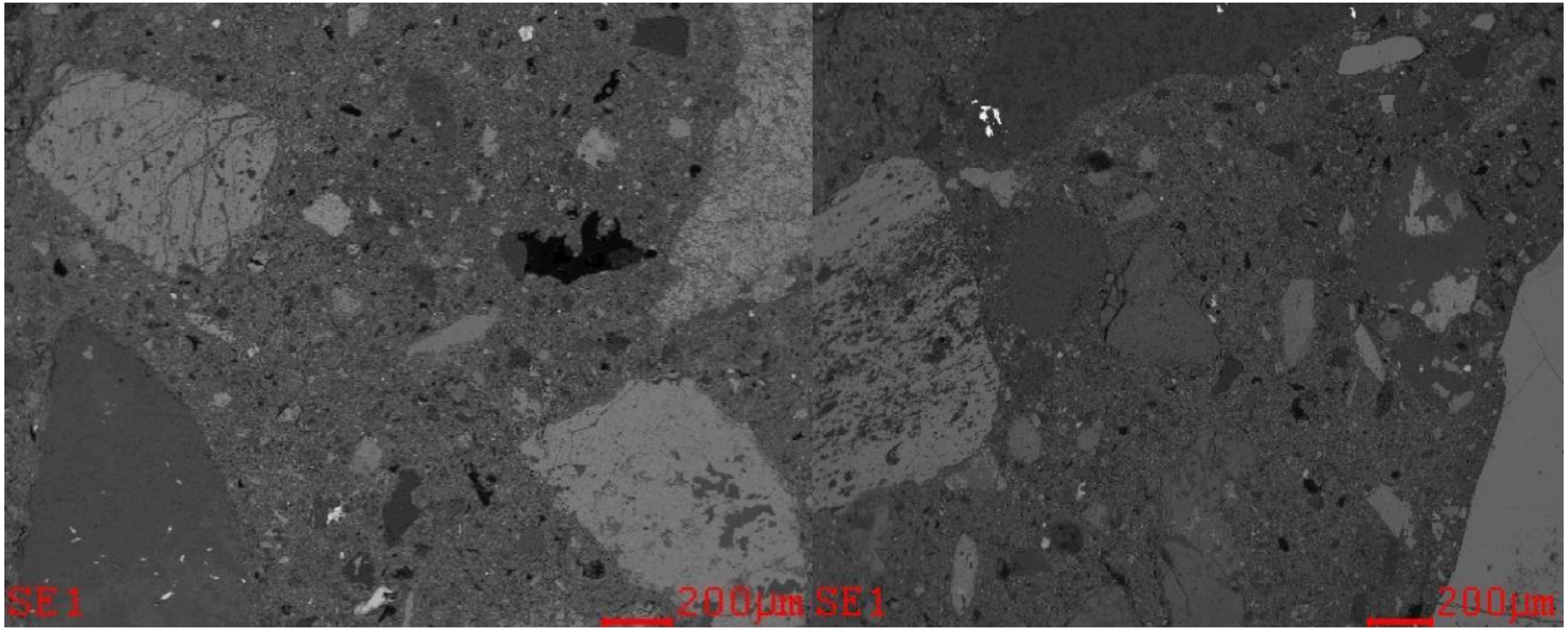
Briquetting. Problems and Prospects. Charge Preparation. Souring.

- Souring (Homogenization) consists of souring of the mixture with the addition of a plasticizer and subsequent storing of such a mixture for some time before further processing.
- The sheared mix was subjected to the souring over the course of 4 hours.
- The increase in compressive strength a week after manufacturing:
- 14.2% for brex No.1;
- 7.62% for brex No.2;
- **54.5%** for brex No. 3**.**

Composition of brex	No.1	No.2	**No.3**
Manganese ore concentrate	80	66	**56**
Bag house dust	14	28	**38**
Portland cement	5	5	**5**
Bentonite	1	1	**1**

Strength/ brex No	**No.1**	**No.1 – soured**	**No.2**	**No.2 – soured.**	**No.3**	**No.3 – soured**
Day 1 (MPa)	**2.97**	**2.76**	**2.69**	**5.76**	**4.10**	**6.17**
Day 3 (MPa)	**4.86**	**4.86**	**6.07**	**7.83**	**6.10**	**10.20**
Day7 (MPa)	**6.67**	**7.62**	**13.13**	**14.34**	**10.17**	**15.72**

Briquetting. Problems and Prospects. Charge Preparation. Souring.



Structure of the brex No.2 structure. Left - without souring; right - with souring during 4 hours after shearing.

Briquetting. Problems and Prospects. Charge Preparation. Selective withdrawal of elements.

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2617086

Способ селективного извлечения оксида железа и оксида цинка из шламов и пылей газоочисток металлургических агрегатов

Патентообладатели: ***Бижанов Айтбер Махачевич (RU), Фарнасов Геннадий Алексеевич (RU)***

Авторы: ***Фарнасов Геннадий Алексеевич (RU), Ковалев Виктор Иванович (RU), Курунов Иван Филиппович (RU), Бижанов Айтбер Махачевич (RU), Вершинин Игорь Николаевич (RU)***

Заявка № **2016108792**
Приоритет изобретения **11 марта 2016 г.**
Дата государственной регистрации в Государственном реестре изобретений Российской Федерации **19 апреля 2017 г.**
Срок действия исключительного права на изобретение истекает **11 марта 2036 г.**

Руководитель Федеральной службы по интеллектуальной собственности

Г.П. Ивлиев

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2521165

СПОСОБ ОЧИСТКИ ОТ МАСЛА ЗАМАСЛЕННЫХ ЧУГУННОЙ/СТАЛЬНОЙ СТРУЖКИ И ОКАЛИНЫ ШЛАМОВ ПРОКАТНОГО ПРОИЗВОДСТВА

Патентообладатель(ли): ***Фарнасов Геннадий Алексеевич (RU)***

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Заявка № **2012142453**
Приоритет изобретения **05 октября 2012 г.**
Зарегистрировано в Государственном реестре изобретений Российской Федерации ***29 апреля 2014 г.***
Срок действия патента истекает **05 октября 2032 г.**

Руководитель Федеральной службы по интеллектуальной собственности

Б.П. Симонов

Briquetting. Problems and Prospects. Charge Preparation. Selective withdrawal of elements.

- **BF and BOF Sludge**– *dezincing.*

- *Hydrometallurgy (ammonium chloride, electrolysis - Metals Recycling, EZINEX; leaching in sulfuric acid - Zincex, ZincOx).*

- *Pyrometallurgy (Waelz process, plasma furnaces Tetronics, Plasmet, Zinc Iron Plasma Process (ZIPP); dust briquetting with less than 2% zinc (Imperial Smelting process, OxiCup, PIZO).*

- ***The proposed method allows us to move the leaching process in the kinetic region and significantly speed it up (cycle - minute instead of 42 hours), which is achieved by using an electromagnetic field.***

- *NLMK sludge test results:*

The zinc content in the blast furnace sludge prior to testing is ***0.85%****, after leaching with the use of e/m field -* ***0.043%****; in the converter sludge before the tests -* ***2.17%****, after -* ***0.088%****.*

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Briquetting. Problems and Prospects. Charge Preparation. Selective withdrawal of elements.

Mill Scale (before testing)					
Sample, mass, g	Water mass, g	Without Water, g	Oil mass, g	Scale without oil mass, g	Time, minute
97	13 (13%)	84	24	60	-
1st test					
300	22 (7,3%)	278	2	276	1
2nd test					
100	7 (7%)	93	2,8	90,2	3
3rd test					
100	12 (12%)	88	1,2	86,8	3

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Руководитель Федеральной службы по интеллектуальной собственности

Б.П. Симонов

Briquetting. Problems and Prospects. Production of Briquettes.

- Equipment
- Transportation and Stockpiling
- Testing

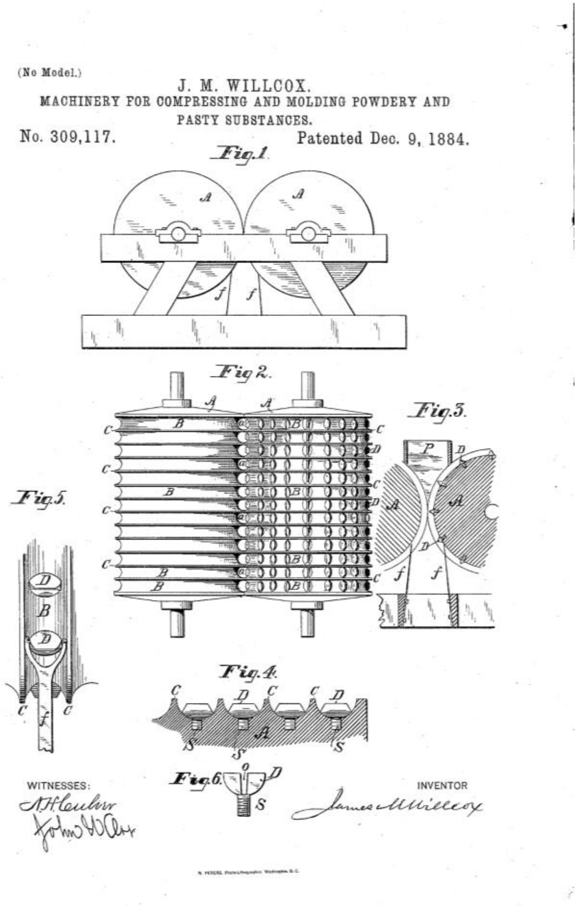
Briquetting. Problems and Prospects. Equipment.

- For the briquetting of dry materials with organic binders, when the achievement of high hot strength of briquettes is not required, **roller-press briquetting** allows to obtain mechanically strong briquettes due to the application of high pressure (**up to 150 MPa**).
- **Vibropressing** allows agglomeration of a mixture containing a substantial part of large fractions (**up to 10 mm and more**) but requires special measures to preserve the strength of raw briquettes (moving on pallets, heat and moisture treatment) and does not allow moisture of the briquetted mixture to exceed **12-15%**.
- **Stiff extrusion** is irreplaceable when agglomerating fine materials and allows to agglomerate:
  - mixtures with a moisture content of up to **20%** at compacting pressures an order of magnitude lower than in a roller press (**3.5 MPa**).
  - EAF dust and gas cleaning dust of ferroalloy production, which practically could not be briquetted with either roller presses or vibropresses.
- The possibility of stiff extrusion agglomeration of wet materials allows either to completely abandon the drying of raw materials, or to significantly reduce the cost of such drying.

Briquetting. Problems and Prospects. Equipment.

- Of all the known modern methods of briquetting only roll is specially designed for briquetting, although it resembles the rolling technology. In the design of roller presses a significant problem is associated with the formation of a significant amount of fines that does not fall into the working volume between the rollers. The properties of briquettes worsens the air pressed inside.
- Vibropressing and extrusion are borrowed from the building materials industry. None of these technologies has yet been modified to fully consider the specifics of briquetting.
- A recent example of stiff extrusion has shown that changing certain geometrical proportions can increase the productivity of a shearing extruder significantly.
- The frequency variations of the vibropresses can also significantly affect the properties of briquettes.

$$\rho(A^2\omega^3 l^3/N^2;\ A^2\omega^2/\tau_0;\ A\omega l/\beta\nu)=f(Nt/\tau_0\, l^3;\ Nt^2/\nu\, l^3;\ A\omega^2/g\ ;\ A\beta)$$



Briquetting. Problems and Prospects. Transportation and Stockpiling.

- Usually it is required that the transportation of briquettes is carried out along the existing logistic trajectories of the metallurgical enterprise. In this case, there may be a need for a significant amount of loading-unloading operations and repeated dropping of briquettes from a considerable height.
- In such a situation there is a contradiction in the requirements for strength and value of the briquette, as a component of the charge, since increasing the content of the binder reduces the curing of the main component in the briquette (iron, manganese, chromium, etc.). The briquette may have enough strength for its transportation to the furnace but be too strong for the metallurgical process.
- In our opinion, it is necessary to build new “sparing” ways of transporting briquettes to the furnace, which will make it possible to fully use the metallurgical value of the briquette. An alternative may be an additional heat treatment of the briquette, as is done during vibropressing.
- It does not make sense to transport the briquette, knowing that it, having good hot strength, will collapse on the way before being fed into the furnace.

Briquetting. Problems and Prospects. Testing.

- Drop strength
- Tumble testing
- Compressive strength

Briquetting. Problems and Prospects. Testing.

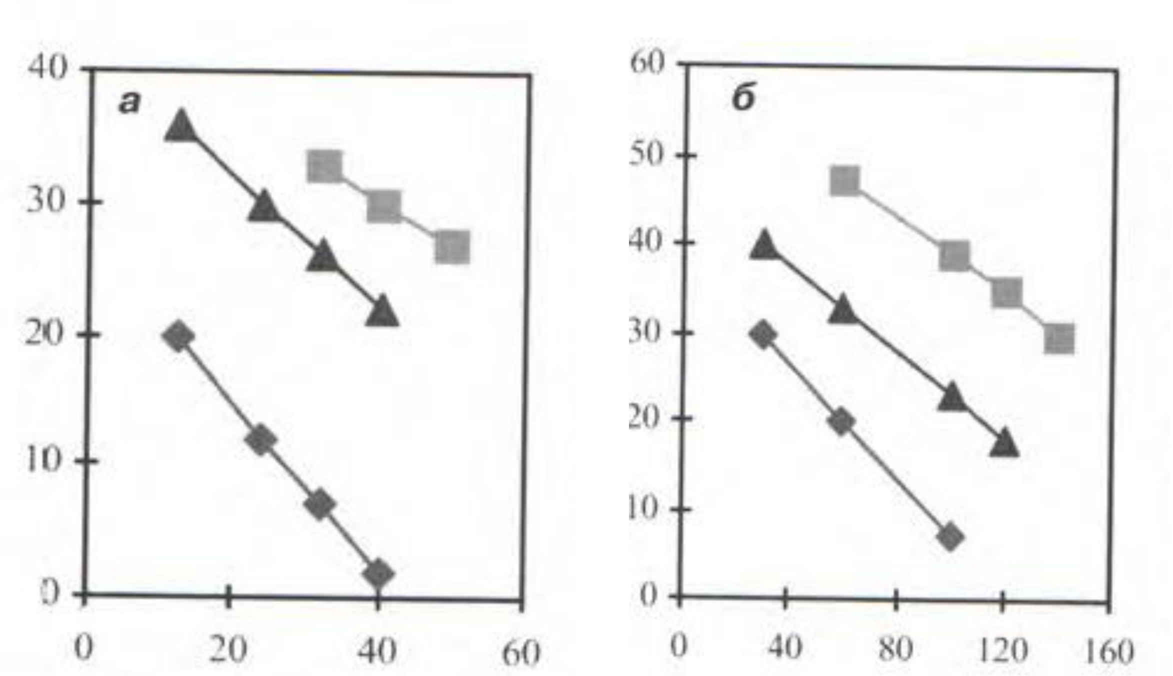
Drop strength

- depends on the type of binder used;
- depends on the volume (or mass) of the briquette;
- destruction is due to a critical number of structure inhomogeneities, which increases with increasing sample size. Even for the same material with the same concentration of structural defects, the probability of destruction with increasing volume increases exponentially.

◆ chromite concentrate and liquid glass

■ ferrosilicon and oil pitch

▲ copper concentrate and sulphite-alcohol bard



Briquette volume, cub.cm

Briquette mass, g

Briquetting. Problems and Prospects. Testing.

Drop strength

Briquetting. Problems and Prospects. Testing.

Compressive Strength

- The brick can withstand considerable compressive forces but is easily destroyed after 2-3 falls from 1.5-2 meters.
- For fluxed pellets, compressive strength is 1.5-2 kN per pellet. For non-fluxed ones - 1.8-2.5. Or **180-250 kgF/sq.cm.**
  - in the bunker, the pressure of the vertical layer of pellets (8.3 kg each) with a height of 40 meters (2500 pellets, 40: 0.016) to the lower pellet is equal to **20.7 kgF** only.
  - In the bunker of the same height (40 m), the pressure of the vertical layer of briquettes with a diameter of 30 mm and a mass of 30 g each (1399 briquettes) on the bottom briquette is 39.66 kgF or about **2 kgF/sq.cm**.
- In a high mine blast furnace, the pressure of the overlying layers of loading on coke does not exceed **3-5 kgF/sq.cm**.

Briquetting. Problems and Prospects. Testing.

Tumble testing

- The test result in the drum depends on the simultaneous action of **abrasive** and **crushing** forces. Depending on the design of the drum and the test conditions, the effect of these two factors on the same material is different.
- The testing of different materials in the same drum also differs both in intensity and in the predominance of one or another factor (abrasion and crushing).
- Therefore, despite the same type of transportation conditions for agglomerated raw materials (coke, pellets, agglomerate), the drum methods for their testing differ significantly.
- Testing of metallurgical coke and ore materials is carried out in devices of different overall dimensions (with the same diameter, the drum for testing coke is twice as long) and under different conditions.
- Drum speed, the test duration for pellets is twice as long, and the mass of the analyzed sample is three times less.
- There are more than 10 methods for determining the strength in a drum with different sizes, speed and duration.

Briquetting. Problems and Prospects. Testing.

Tumble testing

- With such a variety of drum methods, various limits of strength are established, although the quality of agglomerated ore raw materials is estimated in all cases according to the **particle size distribution** after the test (in classes less than **0.5 (0.6) mm** and more than **5 (10) mm**.
- Accepted for ore pellets drum test methods are automatically transferred to the briquettes.
- This approach does not consider significant differences in the structure of these agglomerated products (baked pellets and cold briquettes with a binder). Test conditions and their results may differ significantly from the real picture of the destruction of briquettes in the technological cycle.
- The pellets (**5-25mm**) and sinter (5-40mm) are quite heterogeneous in their particle size distribution and are distinguished by high porosity and fracturing. Since pellets and sinter are a granulated and then heat-treated mixture of ore and flux materials, they contain components that are different in their physical-mechanical properties.

Briquetting. Problems and Prospects. Testing.

Tumble testing

- A small volume (mass) of the pellets determines their high resistance to stress during drum testing. Therefore, for them, high values of rejection limits for abrasion (the share of classes less than **0.5 mm** is not more than **4-6%**, the share of classes more than **5 mm** is not less than **90-95%)** and strength are established.
- The sinter is a more easily destructible porous sponge-like material. Tumble testing for sinter after testing usually contains **55-65%** of a class **+5 mm** and **6-8%** of a class **-0.5 mm.**
- Unlike pellets and sinter, briquettes are homogeneous in properties, size and shape agglomerated products with higher density, smooth surface and uniformity of physical and mechanical properties in the whole volume.
- This determines the different nature of the destruction of the briquette in the tumble testing. Briquettes have a greater mass than pellets and sinter, therefore, they will experience a stronger impact-damaging effect. Moreover, in the accepted methods of drum testing, the amount of materials is **15 kg**. The number of loaded briquettes and the volume they generate is significantly less than when testing pellets.

Briquetting. Problems and Prospects. Testing.

Tumble testing

- Each briquette in the tumble testing experiences the same level of destructive loads, which significantly exceeds the degree of impact on pellets or sinter, which have a wider range of sizes and lower weight. Such a combination of conditions leads to more intensive destruction of briquettes and a decrease in the yield of a class of particles with dimensions greater than **5 mm**.
- There is a serious doubt in compliance with the destruction of briquettes in the tumble testing for pellets and sinter real production conditions. The test method must be adapted to the actual conditions of transportation of briquettes.
- It is known that after testing briquettes according to the method for coal briquettes with a binder (**GOST 21289-75**) in samples containing at least **80-85%** of a class of more than **25 mm** (rejection limit), the proportion of whole briquettes can be **65-70%** (mass.). That is, in tests only **30-35%** of the briquettes are destroyed. The content of fines with a particle size of less than **10 mm** usually does not exceed **15%** (on average 7-9%).
- Briquettes in a tumble testing are subjected to more crushing and not abrasive effects. Only destroyed briquette generates abrasion. To reduce the abrasion of briquettes, it is necessary to reduce their crushability, i.e. high overloads should be avoided.

Briquetting. Problems and Prospects. Testing.

- **The destruction of the briquettes due to shock and crushing load**. The effect of abrasive loads is manifested in destroyed briquettes. The mechanical properties of briquettes depend on the type and properties of the binder.
- The determination of the resistance of the briquette to dropping **can be carried out** according to the methods adopted for the **sinter and pellets**. The rejection limits should depend on the mass and size of the briquette.
- The method of determining the resistance to **compression** is not unified. The fixed values of compressive strength values depend on the intensity of the applied loads, therefore different results are obtained for the same material. The existing rejection limits for briquettes and pellets **are too high** and do not reflect the real load.
- Methods for determining the strength in a rotating drum, developed for sinter and pellets, **do not allow an adequate and objective assessment** of the strength properties of **briquettes**. The rejection limits (strength and abrasion) in quantitative terms for briquettes should be adjusted and not automatically transferred from the norms for **pellets**.
- Metallurgists should more reasonably approach the formation of requirements for the mechanical strength of briquettes and establish separate rejection rates for them.

Briquetting. Problems and Prospects. Testing.

Spiral Couette-Poiseuille Flow in Simplified Model of Extruder

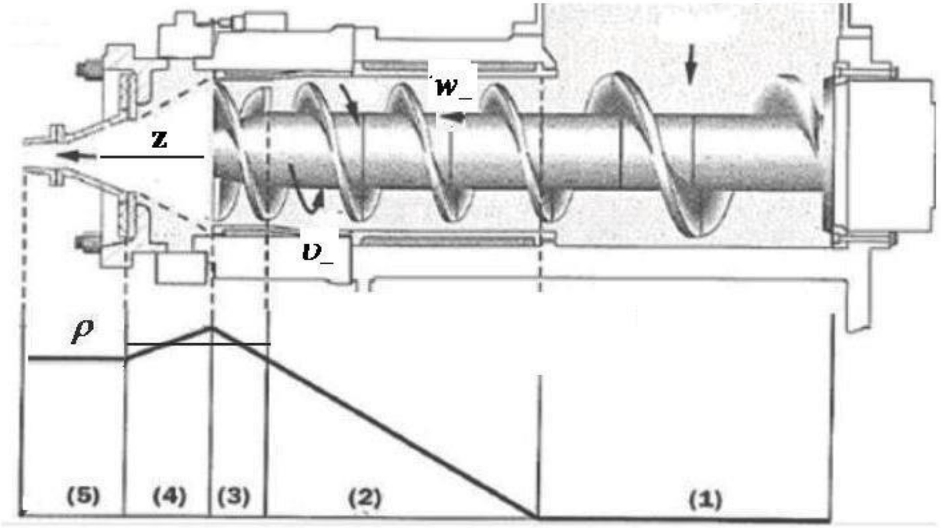
$$w=\frac{\varepsilon^{\gamma_+}w_+-w_-}{\varepsilon^{\gamma_+}-\varepsilon^{\gamma_-}}\left(\frac{r}{a}\right)^{\gamma_-}+\frac{\varepsilon^{\gamma_-}w_+-w_-}{\varepsilon^{\gamma_-}-\varepsilon^{\gamma_+}}\left(\frac{r}{a}\right)^{\gamma_+}$$

$$+\frac{-p_z a^2}{\mu(4-\alpha)}\left(\frac{\varepsilon^{\gamma_+}-\varepsilon^2}{\varepsilon^{\gamma_+}-\varepsilon^{\gamma_-}}\left(\frac{r}{a}\right)^{\gamma_-}+\frac{\varepsilon^{\gamma_-}-\varepsilon^2}{\varepsilon^{\gamma_-}-\varepsilon^{\gamma_+}}\left(\frac{r}{a}\right)^{\gamma_+}-\left(\frac{r}{a}\right)^2\right)$$

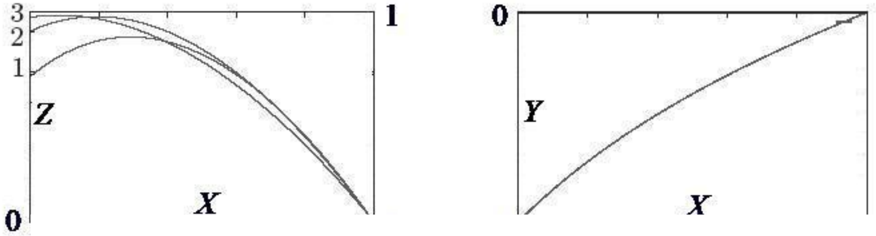
$$\gamma_{\mp}=\frac{\alpha}{2}\mp\sqrt{\left(\frac{\alpha}{4}-1\right)\alpha}\qquad\left(\frac{\alpha}{4}-1\right)\alpha>0$$

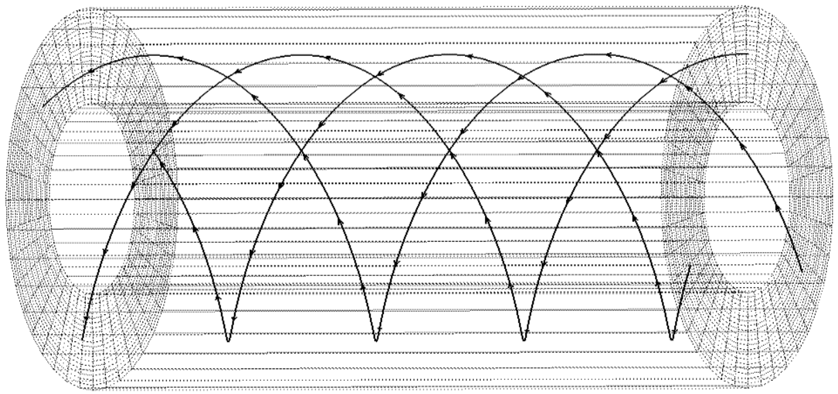
$$\upsilon=\frac{\varepsilon^{\beta_+}\upsilon_+-\upsilon_-}{\varepsilon^{\beta_+}-\varepsilon^{\beta_-}}\left(\frac{r}{a}\right)^{\beta_-}+\frac{\varepsilon^{\beta_-}\upsilon_+-\upsilon_-}{\varepsilon^{\beta_-}-\varepsilon^{\beta_+}}\left(\frac{r}{a}\right)^{\beta_+}$$

$$\beta_{\mp}=\frac{\alpha}{4}\mp\left(\frac{\alpha}{2}+1\right)=-\frac{\alpha}{4}-1,\frac{3\alpha}{4}+1$$



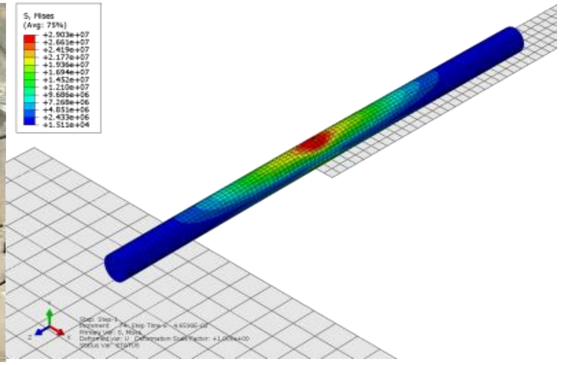
1 conveying, 2 densifying, 3 – metering, 4 pressure distributing, 5- die

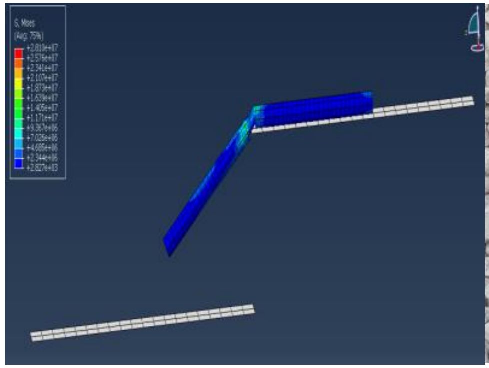




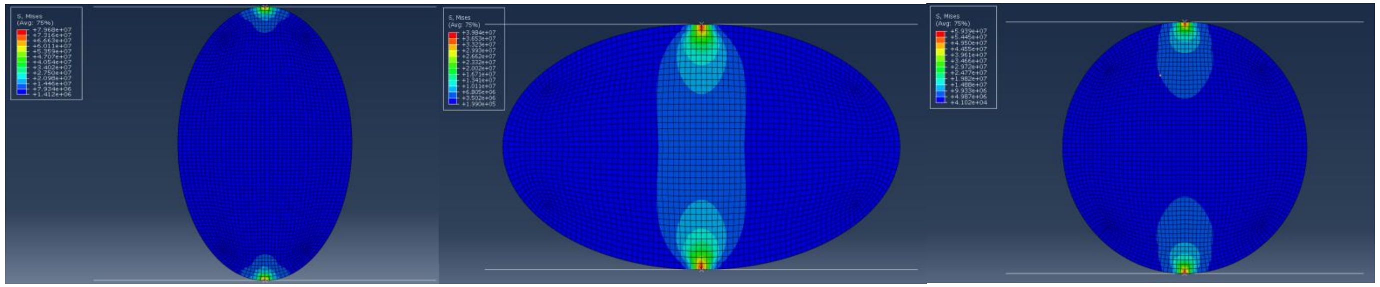
Briquetting. Problems and Prospects. Testing.

Length





Shape



39.8 MPa

79.6 MPa

59.3 MPa

Briquetting. Problems and Prospects. Processing of green Briquettes.

- Heat-Moisture Treatment (vibropressing);
- Drying (soft-extrusion);
- Carbonization
  - + Increasing the Hot Strength; Utilization of carbon dioxide;
  - - increasing Coke rate.
- Crushing

Briquetting. Problems and Prospects. Alternative Applications.

- Lightweight Aggregates
- Red mud
- Bauxite
- Gypsum
- Fly ash
- Bentonite

Briquetting. Problems and Prospects.

- Optimization of the equipment;
- Improving the wear resistance of materials;
- Search for better and cheaper binding materials;
- Optimization of the thermal processing of the green briquettes;
- Delivery of metallurgically valuable briquettes without destruction due to optimization of logistics
- Carbonization as a way of carbon dioxide utilization;
- Application of strong magnetic fields;
- Application of the ultrasound;
- Modification of materials properties (nanomaterials).

निमंत्रण और आपका ध्यान के लिए धन्यवाद।
जमशेदपुर की शताब्दी पर बधाई