Briquetting. Problems and Prospects

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Briquetting? Is it Required? Alternatives.

- Fluidized Bed

- DC Furnaces

- Reduction Smelting

- 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**.
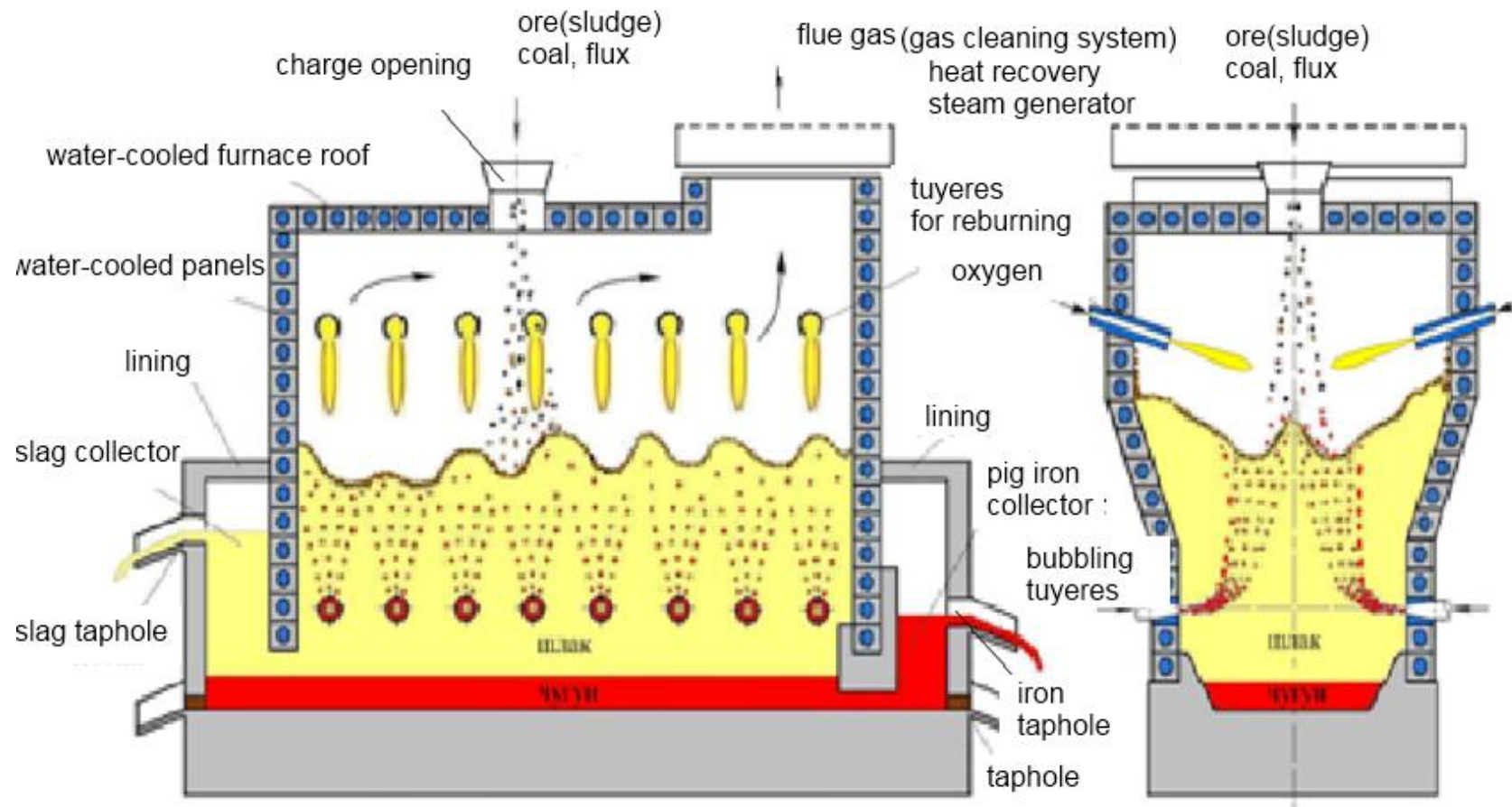
Briquetting? Is it Required? Alternatives.

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.

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Briquetting? Is it Required? Alternatives.
ROMELT

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**.
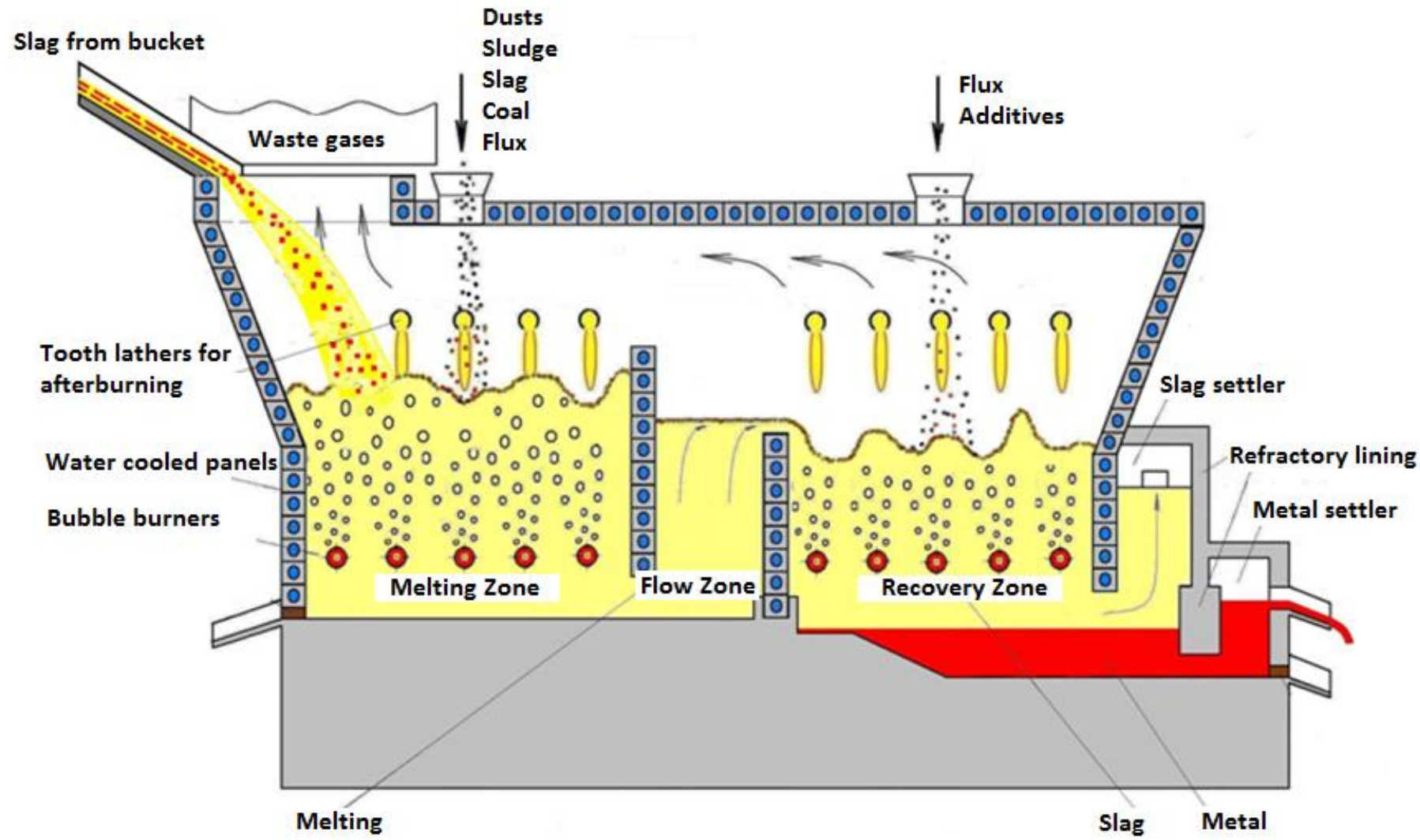
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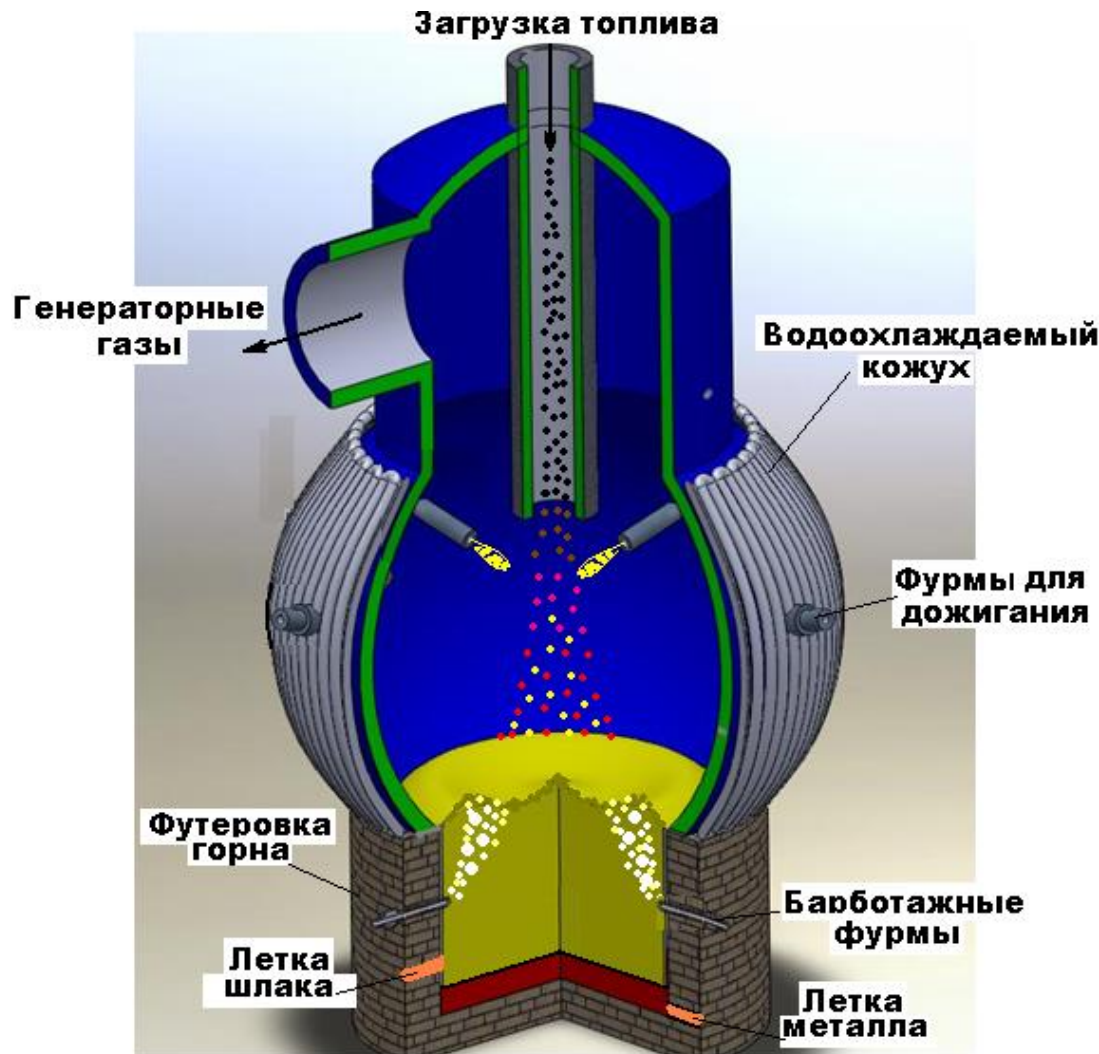
Reduction Smelting

- 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.

Poly-fuel gas generator PM 5

Загрузка топлива

Генераторные газы

Водоохлаждаемый кожух

Фурмы для дожигания

Футеровка горна

Барботажные фурмы

Летка шлака

Летка металла

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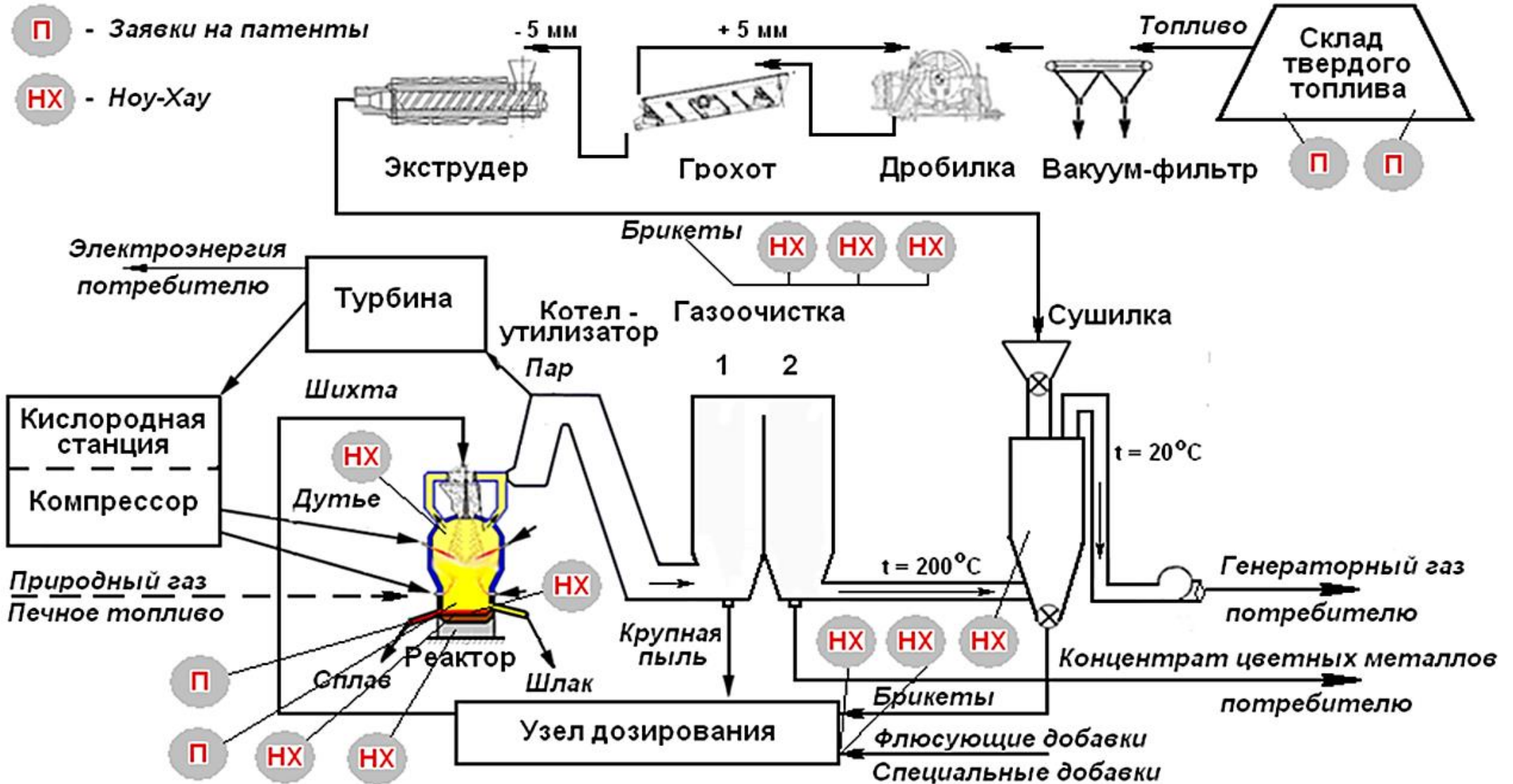biomass;
oil refining waste;
municipal solid waste.
Processing Products:
generator gas;
slag;
metal alloy;
   steam of energy parameters

Briquetting? Is it Required? Alternatives.

Scheme of installation of poly-fuel gas generator

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 ×6×3cm^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

- ENVIRONMENTAL ASPECTS

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, POLIPLAST, etc.)

Briquetting. Problems and Prospects. Charge Preparation. Pulverization.

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.

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

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

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

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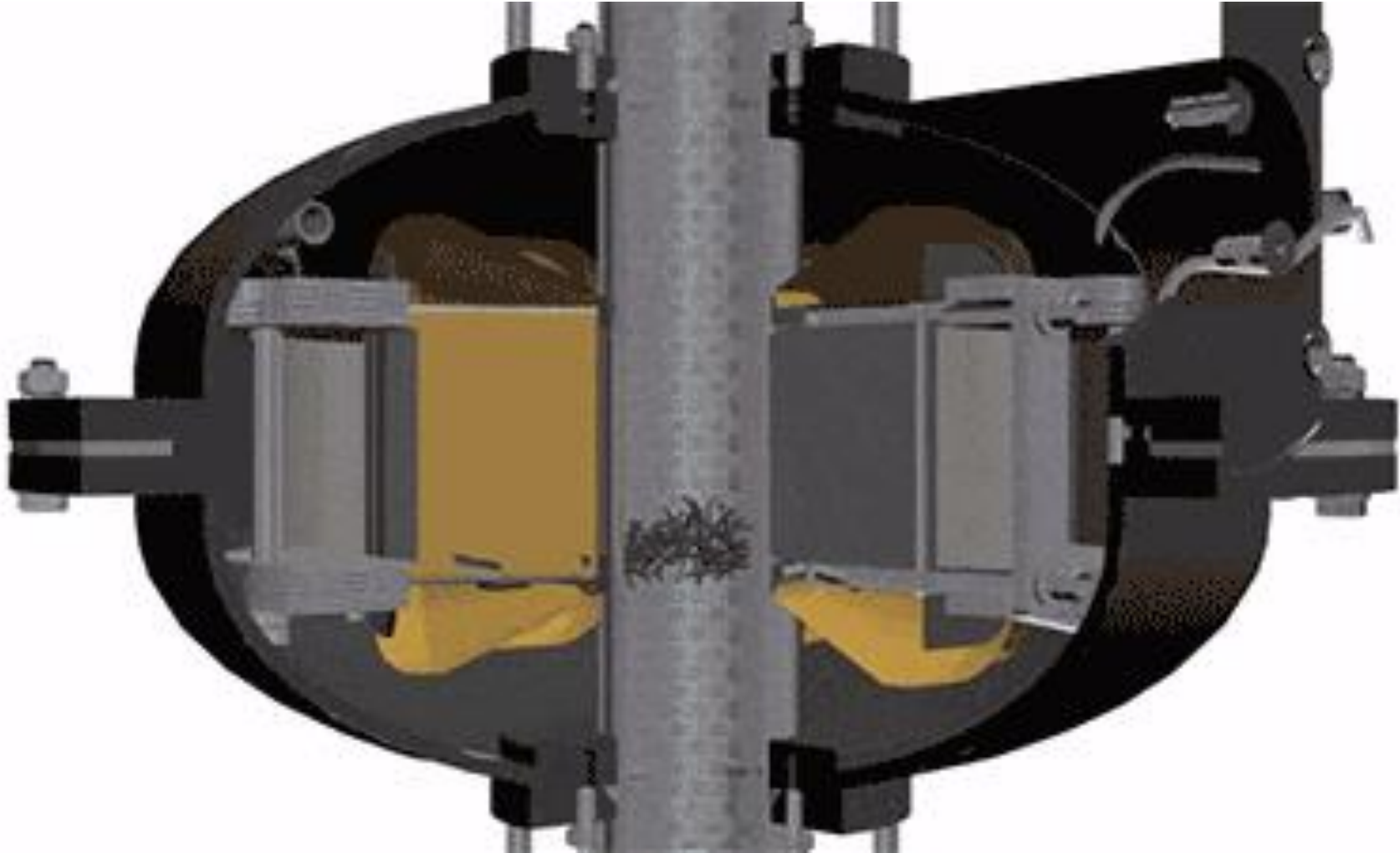
Briquetting. Problems and Prospects. Charge Preparation. Selective withdrawal of elements.

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

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

Briquetting. Problems and Prospects. Production of Briquettes.

- Equipment

- Transportation and Stockpiling

- Testing

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.
- Changing certain geometrical proportions can increase the productivity of extruder.
- The frequency variations of the vibropresses can also significantly affect the properties of briquettes.

$$\rho(A^2\omega^3 l^3/N^2; \ A^2\omega^2/\tau_0; \ A\omega l/\beta\nu)=f$$
$$(Nt/\tau_0 \ l^3; \ Nt^2/\nu \ l^3; A\omega^2/g \ ; A\beta)$$
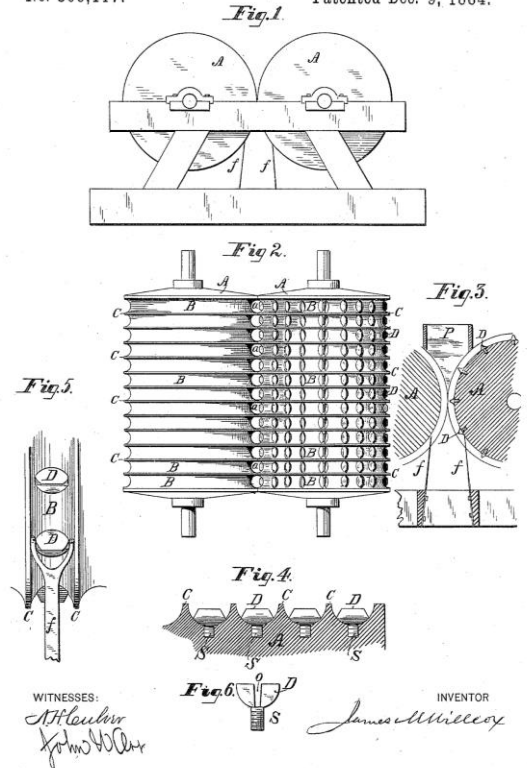
Briquetting. Problems and Prospects. Testing.

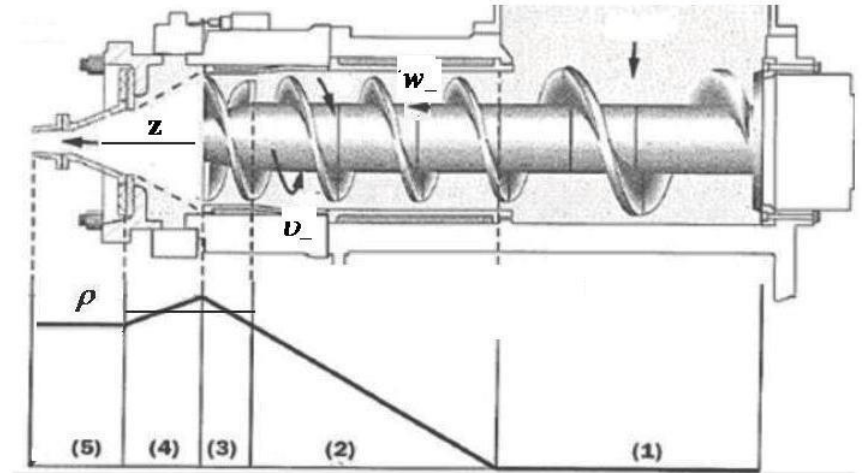## Spiral Couette-Poiseuille Flow in Simplified Model of Extruder

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

$$+ \frac{-p_z a^2}{\mu(4-\alpha)}\left(\frac{\varepsilon^{\gamma_+} - \varepsilon^2}{\varepsilon^{\gamma_+} - \varepsilon^{\gamma_-}}\left(\frac{r}{a}\right)^{\gamma_-} + \frac{\varepsilon^{\gamma_-} - \varepsilon^2}{\varepsilon^{\gamma_-} - \varepsilon^{\gamma_+}}\left(\frac{r}{a}\right)^{\gamma_+} - \left(\frac{r}{a}\right)^2\right)$$
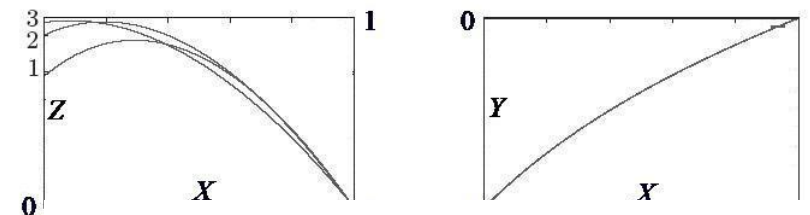
$$\gamma_{\mp} = \frac{\alpha}{2} \mp \sqrt{\left(\frac{\alpha}{4}-1\right)\alpha} \qquad \left(\frac{\alpha}{4}-1\right)\alpha > 0$$

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

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

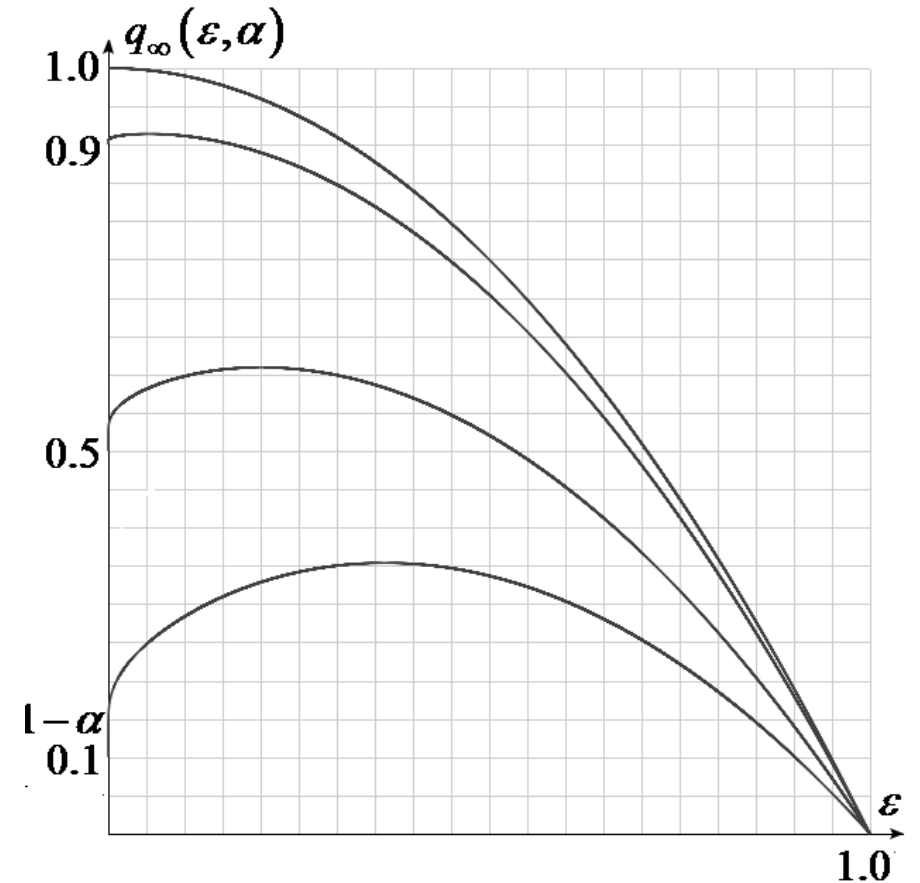1 conveying, 2 densifying, 3 – metering, 4 pressure distributing, 5- die
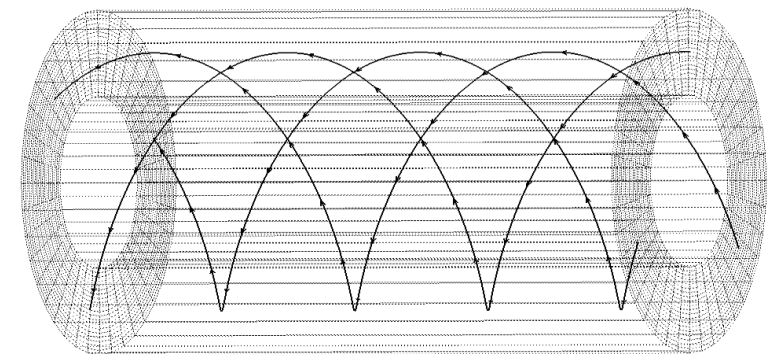
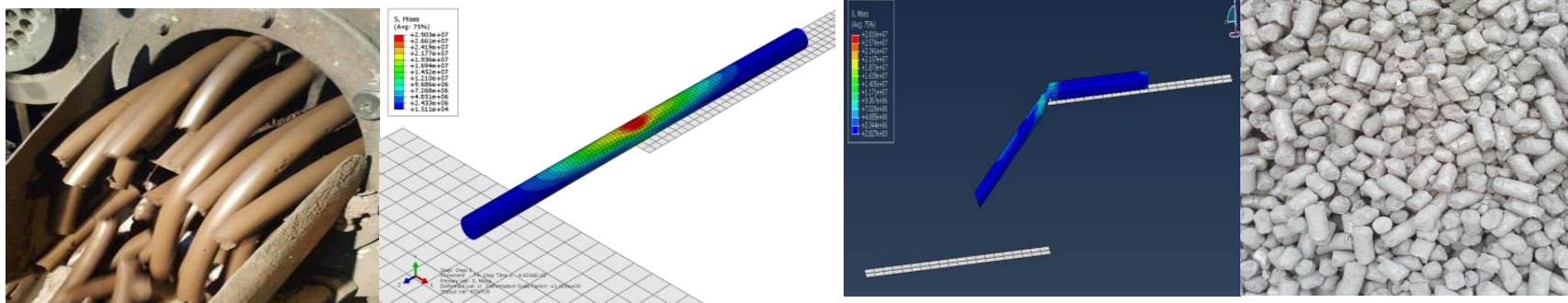# Briquetting. Problems and Prospects. Testing.

Spiral Couette-Poiseuille Flow in Simplified Model of Extruder

$$q[\infty] = q_\infty(\varepsilon, \alpha) = 1 - \varepsilon^2 + \alpha \left(\dfrac{1-\varepsilon^2}{\ln(1/\varepsilon^2)} - 1 \right)$$
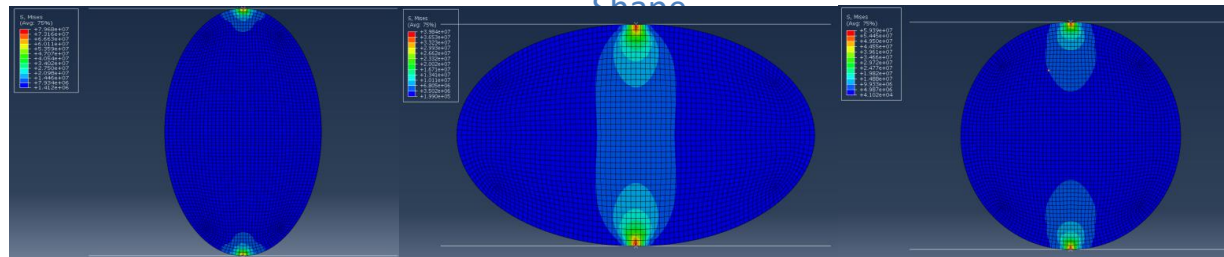
Briquetting. Problems and Prospects. Testing.

Length

Shape

39.8 MPa   79.6 MPa   59.3 MPa

Methods for measuring briquette strength

- Drop strength

- Compressive strength

- Tumble testing

Drop Strength Testing

- – Dropping a batch of briquette samples:
  - Batch 1-4 kg; height 1.5-2.0 m; fines yield 5, 10- or 25-mm fractions;
  - Large briquettes (+100mm) 1-2 times; 25-30 mm 4-5 times.
  - It is believed that the quality of the briquettes is satisfactory if not more than 5, 10 or even 15% of the fines are formed.
- – Sequential dropping of a single briquette sample:
  - from a sample of 2-4 kg, each single briquette (at least 10-15 pieces) is dumped from a height of 0.5 meters, 1 meter or 1.5 meters.
  - the number of falls that the briquette can withstand until complete destruction is considered an indicator of its strength.
  - briquette strength is considered high if it can withstand more than **10 drops from 1.5 meters** and satisfactory if it can withstand more than **10 drops from 0.5 meters**, at least **6-7 drops from 1 meter** or **4-5 drops from 1.5 meters**.
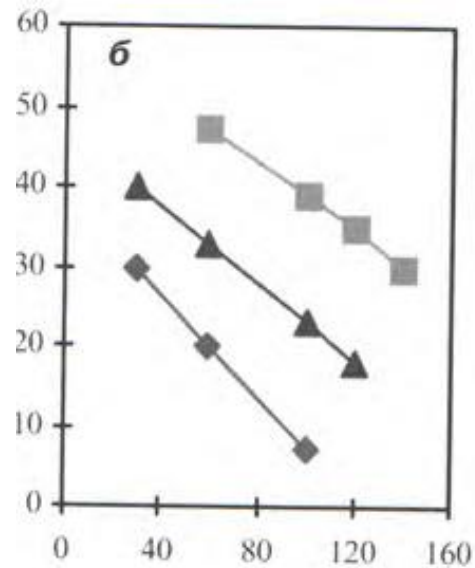
Drop Strength Testing
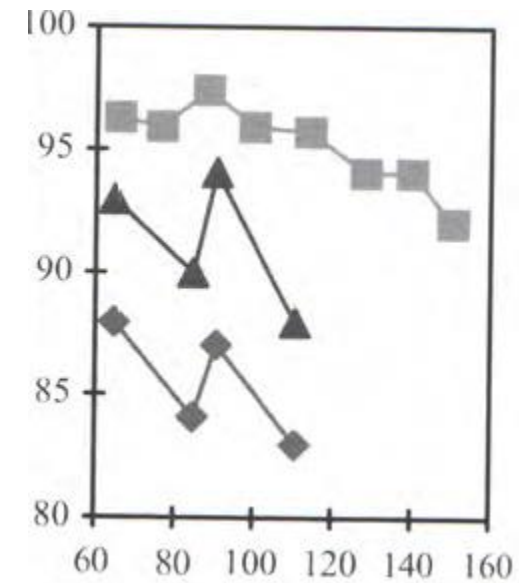
single briquette sample sequential dropping

dropping a batch of briquette samples
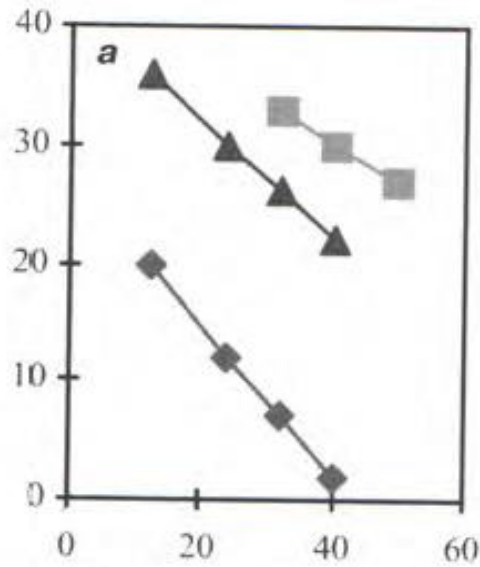
Briquette volume, cub.cm

Briquette mass, g

Briquette mass, g

◆   chromite concentrate and liquid glass

■   ferrosilicon and oil pitch

▲   copper concentrate and sulphite-alcohol bard

Drop Strength Testing

- Thus, it is seen that dropping strength is determined by several factors and significantly depends on the type of briquetted material and binder, on the method of organization of the test fall.

- This obviously requires the establishment of a differentiated rejection limit for such tests of briquettes of various nature, mass and volume. Otherwise, confusion and conflict may arise in assessing the suitability of the briquette.

- The manifestation of impact strength is required only at the stage of briquette delivery to the metallurgical unit or, in the case of commodity briquettes, to the final remote consumer. To achieve the necessary hot strength in a shaft furnace, a noticeably smaller amount of binder is required than to overcome multiple drops from a height.

- It is necessary to bring the drop test in line with the actual logistics for the delivery and acceptance of agglomerated raw materials and, if possible, create a new logistic trajectory for such delivery with the minimum possible amount of drop from a great height.

Compressive Strength

- In case of difficulty in choosing the rejection limits for the strength of briquettes by dropping, as a rule, indicators of their compressive strength are used. However there is no unambiguous a priori correlation between drop strength and compressive strength.
- The brick can withstand considerable compressive forces but is easily destroyed after 2-3 falls from 1.5-2 meters.
- The values of compressive strength depend on the pressing forces and the type of binder.
  - briquettes on bentonite and bituminous binders withstand significant shock loads, but with relatively low compressive forces, they deform and crumple.
  - liquid glass briquettes having a high resistance to compression, are prone to cracking when dropped.

Compressive Strength

- For fluxed pellets, compressive strength is 1.5-2 kN per pellet. For non-fluxed ones - 1.8-2.5 kN per pellet. Based on this some 'specialists' draw the wrongful conclusion that the compressive strength of the briquette must be at least 250 kgF/cm^2.
  - in the bunker, the pressure of the vertical layer of pellets (16mm diameter and 8.3 g each) with a height of 40 meters (2500 pellets, 40: 0.016) to the lower pellet is equal to **20.7 kgF** only (203.1 N).
  - In the bunker of the same height (40 m), the pressure of the vertical layer of briquettes with a diameter of 30mm and a mass of 30g each (1399 briquettes) on the bottom briquette is 39.66 kgF or about **2 kgF/sq.cm**.
  - NLMK full-scale testing: CCS of vibropressed briquettes was in the range of **30-50 kgF/cm²**
- In a high shaft blast furnace, the pressure of the overlying layers of charge on coke does not exceed **3-5 kgF/sq.cm**.

Compressive Strength

The compressive strength of briquettes is determined in dynamic conditions, ignoring the directly proportional relationship between the speed of the pressure plate and the final fixed value of the breaking load.


Liquid glass

bitumen
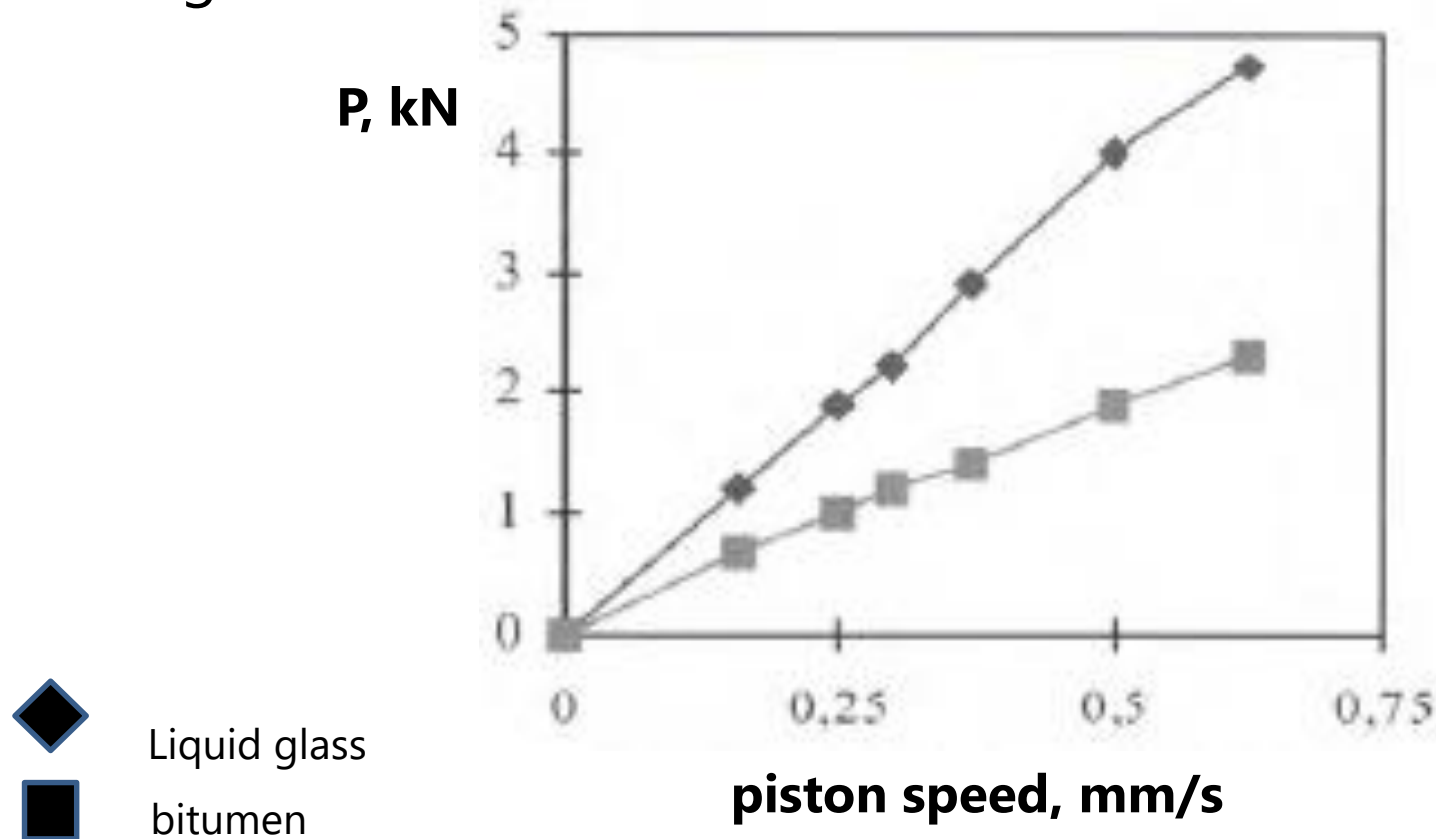
Tumble Testing

- 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.**

- 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.

- Test methods adopted for iron ore pellets in the drum are usually automatically and without any reason transferred to the briquettes.

Tumble testing

- This approach does not consider significant differences in the structure of these agglomerated products (indurated 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.

- 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, 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.

Tumble testing. Numerical Simulation
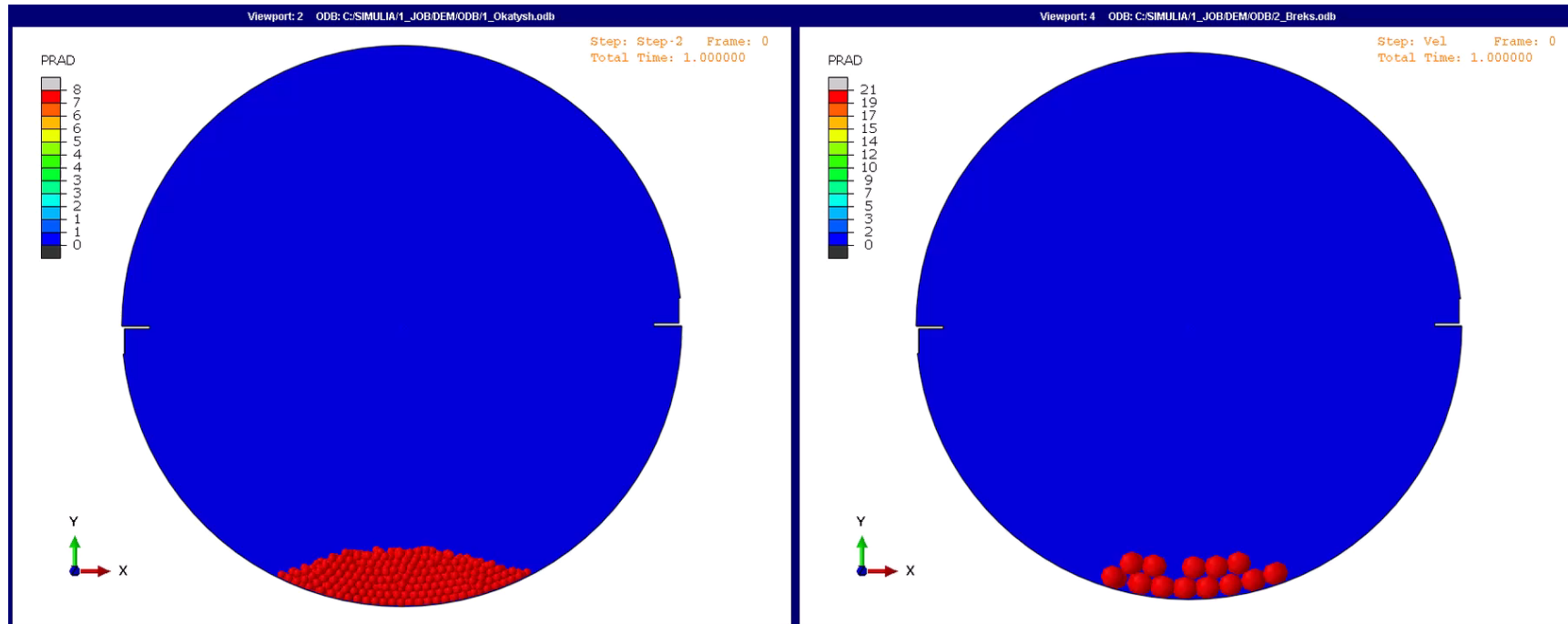
Tumble testing. Numerical Simulation
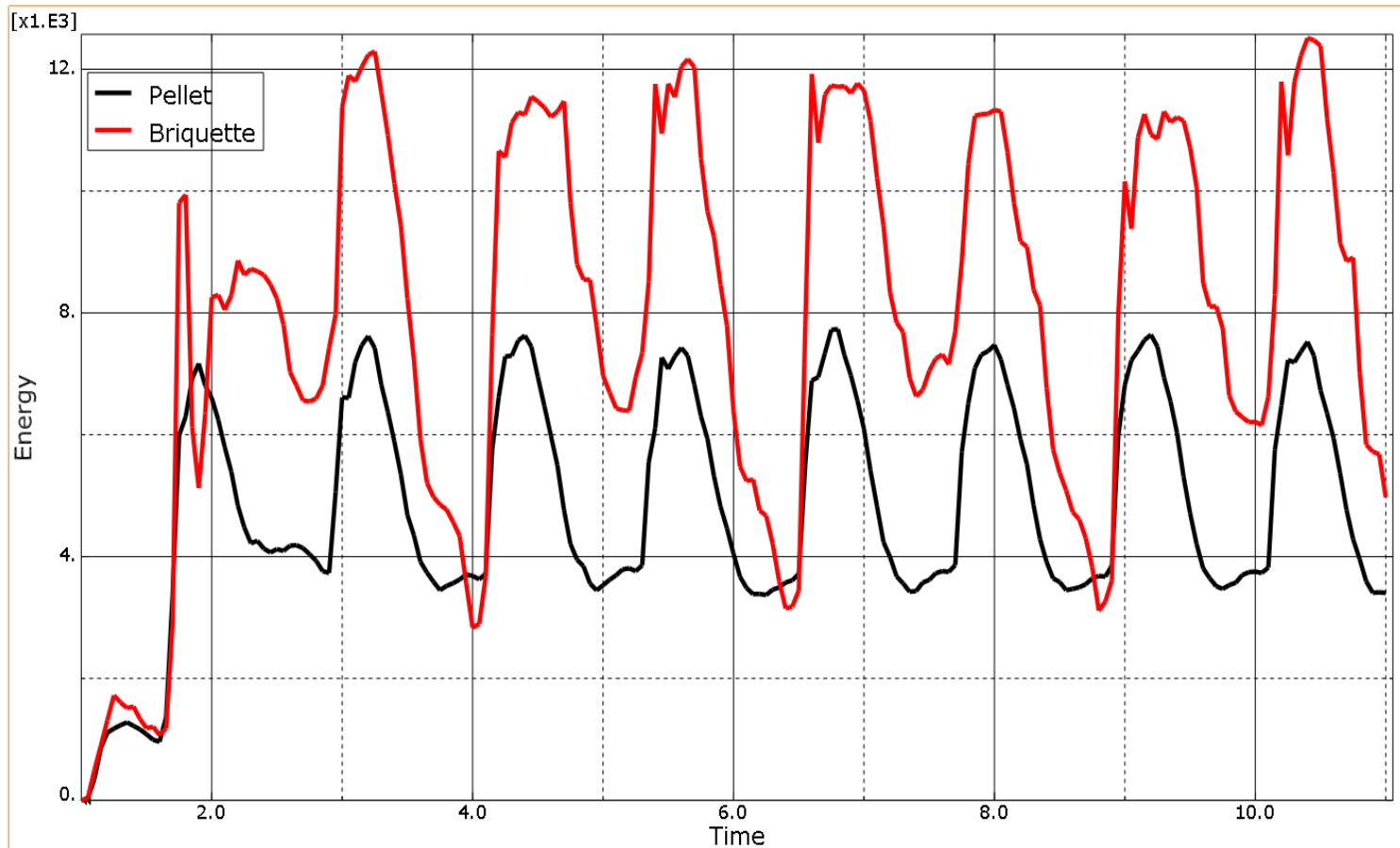
Change in the kinetic energy of particles; red – briquettes, black - pellets

Cold Strength and Hot Disputes

- 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**.

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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.
- Thermal briquetting

Briquetting. Problems and Prospects. Processing of green Briquettes.

Thermal briquetting

- When briquetting ore-coal mixtures, the coal component of the charge, heated to a plastic state, played the role of a binder. In modern literature, this method is also called hot briquetting, which often leads to confusion and embarrassment. More precisely, the essence of such a method is defined by the term "thermal briquetting".
- The basis of the method known from the practice of continuous coking is the formation of a solid from coal of plastic mass upon reaching a certain
- In experiments on thermal briquetting, various iron ore concentrates were used with an iron content of 65-68% and mixed with peat or black coal. The prepared mixtures, with or without the addition of fluxes (from 5 to 15% hydrated and quicklime), were heated in electric molds to 300-430 ° C.
- The mechanical strength of such briquettes decreased with a decrease in the content of the fuel component in them.

- To obtain such briquettes on a roller press, their special - high-temperature modification is required. Such modifications are made by Köppern and Sahut Conreur. By the method of stiff extrusion, it is possible to obtain such crude briquettes for subsequent heating to plasticization temperatures of coal by methods used in the ceramic industry.

Briquetting. Problems and Prospects. Processing of green Briquettes.
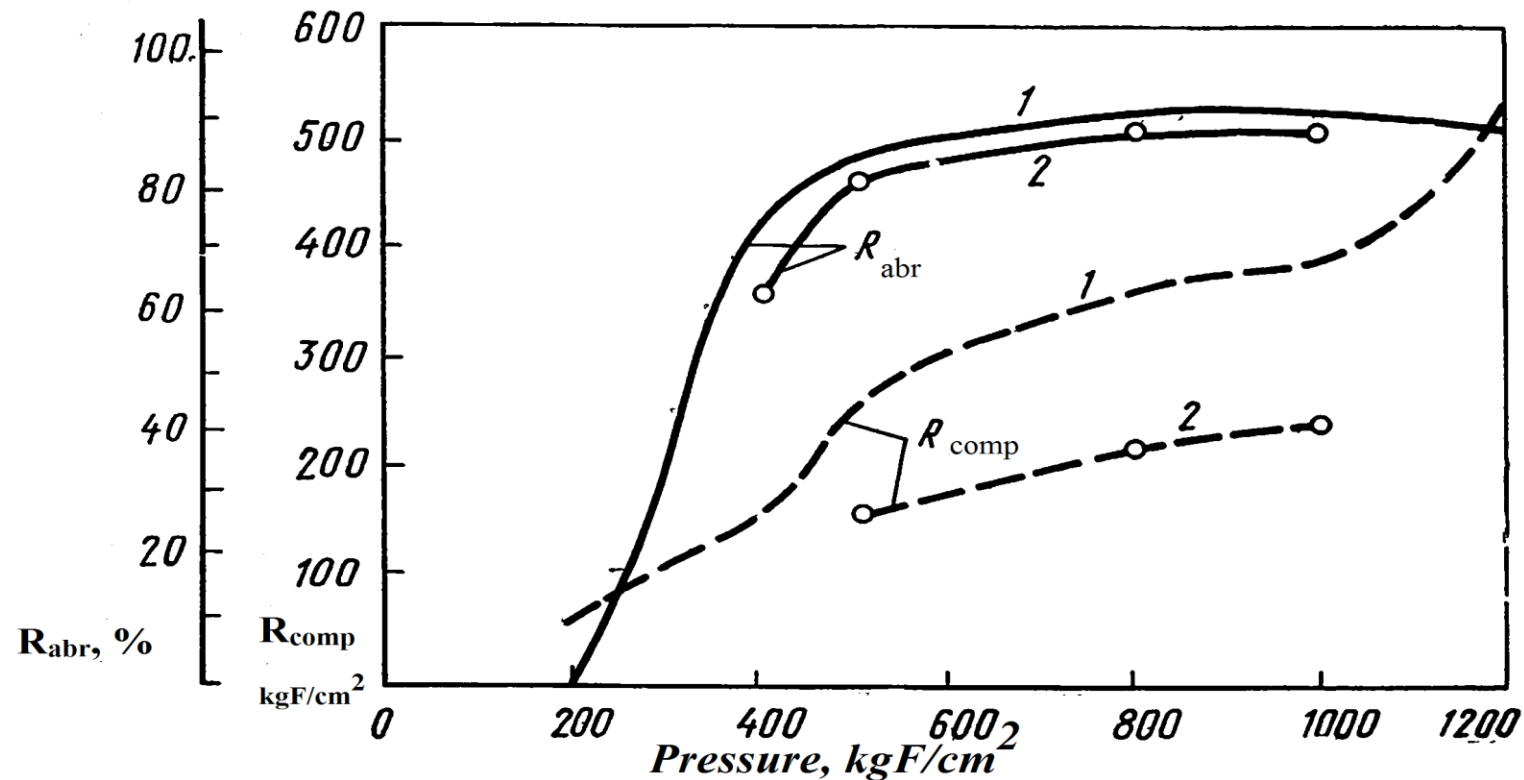
Influence of pressure on the mechanical strength of thermal briquettes (1 - briquettes with peat, 2 - briquettes with coal, R_{abr}- abrasion resistance, R_{comp} - compressive strength).

Briquetting. Problems and Prospects. Environmental aspects

Stiff extrusion briquetting as a BAT

- Pyrometallurgical technologies of agglomeration are associated with the formation of essential emissions.
- The technology of briquetting by the method of stiff vacuum extrusion is devoid of such disadvantages. The technology does not require heat treatment of raw briquettes, it allows to obtain a durable material.
- The main sources of environmental impact in the production of BREX are the following:
- - warehouse of raw materials (unloading operations of charge materials, storage and feed into the technological process);
- - Department of dosing, mixing, extrusion;
- - brex unloading, stacking and handling of stacks (the attrition of the fine fraction. shipment to consumers);
- - aspiration system of brex making unit.
- The main component of emissions into the atmospheric air in the production of brex is inorganic dust. According to the assessment, the specific emission of inorganic dust in the production of brex does not exceed 0.05 kg/t.

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Briquetting. Problems and Prospects. Environmental aspects.

#	BAT criterion	Agglomerated iron-containing material		
		Sinter	Pellet	Brex
1	The minimum level of impact on the environment, kg/t:			
	- dust	≤1.2	≤0.6	0.05
	- nitrogen oxide	≤0.55	≤0.535	0
	- sulphur dioxide	≤4.0	≤0.5	0
	- carbon oxide	≤14.0	~0	0
	Total emissions, kg / t:	≤20	≤2	≤0.05
2	Resources consumption:			
	- solid fuel, kg/t**	23.6-48.9	0	0
	- gaseous fuel, m³/t	2.45-6.3	9.5-15.0	0
	- Electricity, kWh / t	23.0-48.7	29.0-48.5	15.0-33.0
3	Investments, USD/t***	~5000	~5500	~2000
4	Implementation period, years****	3	3	2

Briquetting. Problems and Prospects. Environmental aspects.

In 2017 Stiff Extrusion has been included into the List of Perspective Agglomeration Technologies of Russian Manual of BAT (Chapter 7., p. 7.1)

Briquetting. Problems and Prospects. Environmental aspects.

- The effectiveness of BREX in the charge of large blast furnaces was estimated by the method of mathematical modeling of blast furnace smelting using the **DOMNA** program.

- The blast furnace smelting in a furnace with a volume of 4297 m^3, operating under the conditions of NLMK, is modeled.

- Simulation of blast-furnace smelting was carried out for a mixture consisting of 3 components - **sinter, pellets and brex**.

- The share of pellets is determined by the capacity of the pelletizing plant (Stoilensky GOK, **6 million tons of pellets per year**).

- The basicity of a brex made from iron ore concentrate and low caking coal is determined on the basis of the content of cement (6%) and bentonite (1%) in the composition of the brex, taken on the basis of the results of preliminary tests, and also taking into account the content of coal in the mixture. At the indicated contents of cement and bentonite, the basicity of brex (B2) is **0.50 - 0.55**.

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Briquetting. Problems and Prospects. Environmental aspects.

- The basicity of the sinter is determined based on the accepted concept of replacing the sinter with BREX and their basicity.

- When replacing 50% of the sinter in the blast furnace charge with BREX, the basicity of the sinter should be between **2.8 and 3.2**.

- It should be noted that with such basicity in the structure of the sinter the phases predominate, providing an increase in its strength compared to the sinter with basicity in the range of **1.5–1.7** characteristic of the sinter, produced in NLMK.

- The coal content in BREX was determined by the method developed based on the results of studying the structural composition of brex after heating in a reducing atmosphere to 1400 ^{o} C, when, after reaching almost complete metallization, unreacted coke breeze particles remained in the BREX structure due to its excessive content in the mixture for briquetting.

Briquetting. Problems and Prospects. Environmental aspects.

BF operation parameters	Basic variant	Variant 1	Variant 2
Sinter consumption B2 = 1.7, kg/t	1109	-	-
Sinter consumption B2 = 3.0, kg/t	-	557	575
SGOK pellets consumption, kg/t	546	557	541
Brex consumption , kg/t	-	557	575
SGOK iron ore consumption, kg/t	-	17	-
Fe content in charge, %	58.2	57.45	57.15
Coke rate, kg/t	391	354	284
Natural gas consumption, nm^3/t	125	125	35
Pulverized coal consumption, kg/t	-	-	160

- The results showed that due to the carbon contained in the BREX, the coke consumption for hot metal production is reduced compared to the base case by **10%**.
- When pulverized coal is injected with a flow rate of 160 kg/t of hot metal, coke consumption of **284 kg/t** of hot metal is achieved.
- When blowing natural gas with a consumption of 125 m^3/t of hot metal, coke consumption of **354 kg /t** of hot metal is achieved.

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- A negative impact on pelletizing has a fraction of 0.2-1.6 mm (intermediate), which is not involved in the work. In a granular mixture, the grains of this fraction are distributed in the gap between the lumps, reducing the porosity of the layer and the equivalent diameter of the channels.

- Studied sintering mixture consists of fractions: -0.4 mm (70.4%), 0.4-1.0 mm (11.7%), 1-5 mm (8.3%), 5 -10 mm (6.8%), +10 mm (2.8%), i.e. the ratio between its crumpled, crumpling and intermediate parts is approximately **70:15:15** and is characterized by a relatively small number of pelletizing centers. As a result of the inefficient process of pelletizing, the granulated mixture contains up to **34%** of fractions **0.5-1.0 mm**, reducing the gas permeability of the layer, and up to **14%** of aero active fractions less than **0.5 mm**, which leads to a significant reduction performance of sinter process.

- The problem can be solved by introducing large fractions of any materials or waste suitable for agglomeration into the mixture. In practice, the solution is to use medium fractions (from 4-6 mm to 9.5 mm) of crushed converter slag or raw pellets. This direction also includes the use in the mixture of small fractions of sinter (less than 5 mm).

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- Utilization of extruded embryos made it possible to:
- increase the productivity of the sintering plant by 4–5% compared to sintering of mixture with granules or crushed briquettes;
- increase the strength of granules by 8-32%;
- improve crumpling ability of the charge by 10.0-29.4% and increase productivity of sintering machine by 14.8-25.6%.

Pellets

Extruded briquettes

Crushed briquettes

Initial State

Briquetting. Problems and Prospects.

- Material Processing based on New Technologies

- Accurate Simulation of the Processes

- Adjustment of the Testing Procedures

- Thermal Briquetting

- Integration to BAT Lists

- Synergy with Sintering

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