RAW MATERIALS

INNOVATIVE ORGANIC BINDERS FOR METALLURGY AND THE REFRACTORIES INDUSTRY[1]

K. G. Zemlyanoi,[2] A. A. Kiik,[2] S. V. Markova,[3] and I. V. Kormina[3]

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Questions related to the use of binders for briquetting in industry are considered. Results of pilot-plant and industrial tests of domestically produced innovative binders are presented.

Keywords: briquetting, binder, strength, wastes, recycling

A large quantity of waste product always forms in production cycles in ferrous and nonferrous metallurgy and in the refractories and minerals industry. These wastes include dust, gas purification slag, coke breeze, assay button, shavings, turnings, and much else, on the whole representing up to 60% of the wastes per ton of finished product. Recycling of solid industrial wastes constitutes a complicated engineering problem, since immediate warehousing of the wastes and disposal at special sites are both an inefficient use of material resources, moreover, the presence of binding components in the wastes, such as resins and oils, presents ecological risks because of their physico-chemical properties.

Since most solid wastes have the composition of finished product, recycling for direct utilization in roasting or smelting units, for example, shaft-type units, accompanied by the production of commercial product represents a natural method of recycling. Because of their simplicity of design and implemented technology and the potential for control of the productivity of the unit over a relatively broad range with insignificant additional costs and low specific consumption of energy resources, shaft-type units (shaft roasting furnaces, blast cupolas) are becoming increasingly more popular in different branches of industry.

Based on the heat engineering features of a slicing instrument, reclaimed recycled material must possess a specific linear dimension of the block and exhibit uniformity of the fractional composition and sufficient mechanical strength to ensure that processes of softening and melting of newly produced material commence only when the high-temperature zone of the furnace has been reached and, consequently, do not disrupt the gaseodynamics of the layer. Pelletizing (granulation, briquetting) with the use of binder components [2] is the simplest and most efficient method of recycling fine wastes as well as satisfying the above properties.

Technogenic wastes or natural aluminosilicates, i.e., clays, are now generally used at enterprises as binding materials. The most widely used organic wastes generated in industry that do not alter the chemical or phase composition of recycled matter are molasses, sulfite-alcohol malt residue, and technical-grade lignosulfonates. However, these substances are becoming increasingly more expensive and in increasingly short supply in view of the overall decrease in the capacities of the paper and pulp industry of Russia and a reorientation in recycling of the wastes of the paper and pulp industry from lignosulfonates to biofuels. Moreover, these substances no longer meet modern requirements for technological service binders in industry. Thus, briquetting and sintering plants have found it necessary to use as binders more effective plasticizers, such as special additives that not only possess high glueing capacity, but also increased wettability [3] and enable adhesion of the particles of the briquetted material as well as take into account the specific requirements of each particular production process. There are only a few producers in the world today of such binders for the different branches of industry, such as Zschimmer & Schwarz, Nisco, and BASF. In Russia the only enterprise involved in the development and fabrication of high-efficiency

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[2] FGAOU VPO Ural Federal University, Yekaterinberg, Russia.
[3] OOO Poliplast Novomoskovsk, Novomoskovsk.

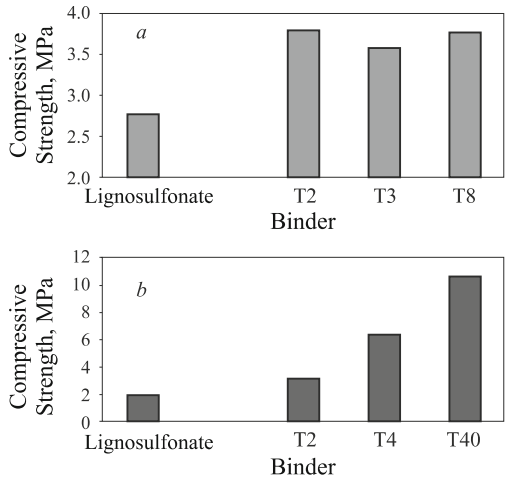

Fig. 1. Characteristics of the strength of bituminous coal briquettes (*a*) and of slag generated in nonferrous metallurgy (*b*) obtained with the use of Termoplast SV series binders.

binder (together with diluents, grinding intensifiers, etc.) for different branches of industry is OOO Poliplast Novomoskovsk.

Modified polymethylene naphthalene sulfonates are the basic product of the enterprise. Families of complex additives for metallurgy and the oil refining and construction industries and for the production of ceramic and other branches have been developed on the basis of polymethylene naphthalene sulfonates. In the area of additives for pelletizing (briquetting, extrusion, nodulizing), complex additives have been developed in the Termoplast series for improving molding properties as well as complex binding compositions in the Termoplast SV series and are now being in production. A number of different components of organic and mineral origin have been added to Termoplast SV(T) series additives to the base of the binder, i.e., surfactant, for the purpose of imparting required properties that are specific to the process of agglomeration. Thus some additives are used for high-temperature treatment of briquetted materials, while others are more effective in agglomeration of alkali-containing substances, while a third group increases the moisture absorption of vitreous materials, etc.

The OOO Poliplast Novomoskovsk scientific and technical center regularly conducts research to study the potential of recycling wastes generated by the metallurgical and refractories industries into basic production by means of briquetting as well as on optimization of this process. The creation of binder that takes into account the individual properties of material that has been subjected to agglomeration is the basic condition of this research. Thus, the enterprise has accumulated experience in briquetting a number of materials, such as the waste and substandard output of a number of different branches of industry, e.g., slag from nonferrous metallurgy, magnesial ore, copper-nickel concentrate, carboniferous material, and ores. The results of laboratory studies are presented in Table 1.

Laboratory tests on briquetting of a fine fraction of bituminous coal (Fig. 1*a*) based on Termoplast SV series binders yielded a 30% increase in the strength of the briquettes (from 2.8 to 3.8 MPa) by comparison with the strength of briquettes produced at a briquetting factory where lignosulfonate is used as the base of the binder substance. On the other hand, one-half the amount of complex binder additive (2.5%) by comparison with the quantity of lignosulfonate (5%) is needed to achieve a compressive strength of 2.8 MPa. Thus, with the use of Termoplast SV series additive it becomes possible to significantly reduce the enterprise's expenditures on binder materials.

Studies on agglomeration of poorly nodulized materials, such as slag generated in nonferrous metallurgy (Fig. 1*b*) were also carried out. As a result of the studies we were able to obtain samples with high mechanical characteristics, with compressive strength 10 MPa in tests on jettisoning from a height of 1.5 m a total of 50 times. Screenings of iron ore pellets as regards briquetting were studied and made it possible to expand the range of application of briquettes through a several-fold increase in mechanical strength. The compressive strength increased from 2 to 17 MPa while the jettisoning stability grew from 3 to 30 times (Fig. 2).

Binders produced by OOO Poliplast Novomoskovsk underwent laboratory tests at OAO Kola Mining and Metallurgical Company (Fig. 3*a*) and production tests at OOO Mednogorsk Copper Sulfate Combine (Fig. 3*b*), during the course of which it was confirmed that the use of these additives in briquetting is highly efficient. Moreover, Termoplast

TABLE 1. Results of Tests of Termoplast SV Series Binder

Briquetted Material	Binder	Compressive Strength, MPa	Jettisoning Stability, no. times
Carboniferous material	Lignosulfonates	2.8	—
	Termoplast SV	3.8	—
Nonferrous metallurgy slag	Lignosulfonates	2.0	3.0
	Termoplast SV	10.8	38
Iron-ore pellets	Molasses	1.5	0
	Termoplast SV	17.2	30

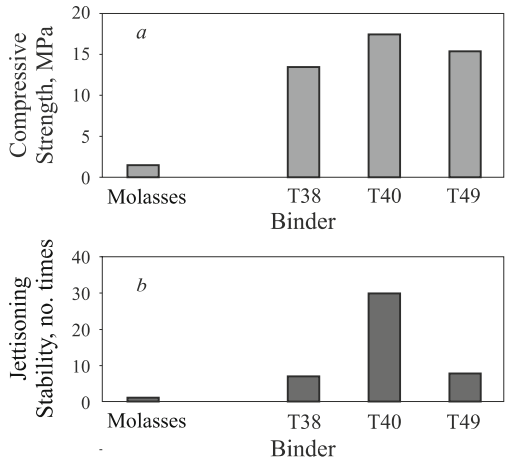

Fig. 2. Strength and stability characteristics of briquettes from screenings of iron ore pellets: *a*) compressive strength; *b*) jettisoning stability.

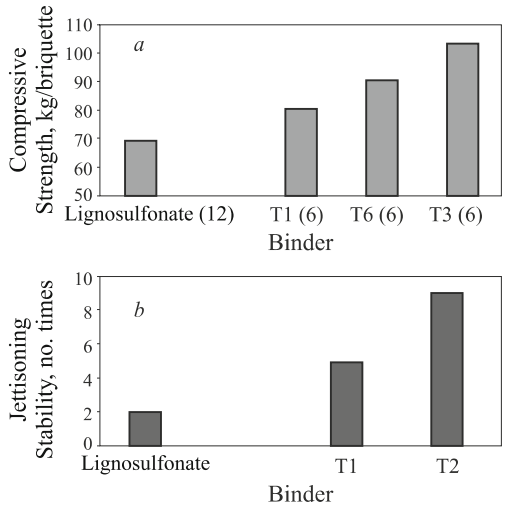

Fig. 3. Strength characteristics of briquettes of sulfide copper-nickel (*a*) and copper sulfate (*b*) concentrates. The content of binder is given in parentheses.

SV series binders are being successfully used at OAO Magnezit Combine as additives in briquetting of magnesia flux with carbon and iron-containing additives. According to the data of the Combine's laboratory, the compressive limit of samples molded with the use of OOO Poliplast Novomoskovsk binder grows 2.7-fold (from 20 to 54 MPa) as compared with the indicators of samples obtained with the use of lignosulfonate. The substantial increase in the mechanical strength of the briquettes underscores the value of replacing lignosulfonate by Termoplast SV series binder. Moreover, the quantity of binder decreases 31%. It is particularly worth pointing out that because of the low content of sulphur in the Termoplast SV series products, it is possible to produce magnesia flux with carbon and iron-containing additives with reduced sulphur content (≤0.17).

Thus, an individualized approach to the selection of binder for a particular material, taking into account its specific properties, makes it possible to not only obtain high-quality, strong and stable, and ecologically safe briquettes, but also reduces the quantity of binder utilized, which makes briquetting a more economically favorable resource-conserving and more efficient method of pelletizing.

REFERENCES

1. O. V. Matyukhin, V. I. Manyukhin, A. I. Tarasov, et al., Resource-conserving technology for total recycling of wastes of mineral production possessing an internal source of heat, in: *Collection of Studies from 5th Scientific and Practical Correspondence Conference, System of Management of Ecological Safety*, vol. 2, URFU, Yekaterinberg (2011), pp. 59 – 64.
2. Yu. N. Loginov, S. P. Burkin, N. A. Baybakov, et al., *Mechanics of Rolling Briquetting of Granular Materials* [in Russian], AMB, Yekaterinburg (2011), 304 pp.
3. Sh. Maerchak *Production of Pellets* [in Russian], Metallurgiya, Moscow (1982), 232 pp.