TEKA Kom. Mot. i Energ. Roln. – OL PAN, 2011, 11A, 258-265

APPICATION OF COMPLEX POWER FUEL MADE OF COAL-ENTERPRISES WASTES PRODUCTION TECHNOOGY USING NEW BINDING MATERIALS

Yuri Svinoroev, Vladimir Kostrub

Volodymyr Dahl East-Ukrainian National University, Lugansk, Ukraine

Summary: In conditions of ecological state worsening the necessity in raw materials and wastes, particularly coal wastes, recycling and fuel briquettes production becomes urgent. The article investigates technology of complex power briquettes production using lingo-sulphanates as ecologically clean binders.

Key words: fuel briquette, binding materials, technical lingo-sulphanates, power value.

ANALYSIS OF PROBLEM STATE

Coal-mining production is technologically accompanied by formation of considerable quantities of different anthropogenic wastes, reaching 37% of coal extraction [1]. With transition to collection of ecological taxes proportionally to volumes of factual production discharge including wastes disposal to technological dumping grounds, the most effective managers of enterprises began to realize that it is cheaper to exclude or reduce quantity of wastes at places of their formation than to pay out ecological tax. Such source-saving approach is the most actual nowadays [2, 3, 4, 15, 22].

AIM AND TASKS OF INVESTIGATIONS

Coal wastes fine-fraction and finely dispersed component briquettes are the most rational way of raw material secondary use. One of the major difficulties of briquettes production is the necessity of cheap, non-scare and ecologically safe binding material application. In connection with this, the use of modified technical lingo-sulphanates having better strength characteristics has been proposed.

PRESENTATION OF INVESTIGATION RESULTS

Culm and slime utilization is mainly performed on accumulators. Only preliminary specially prepared wastes can be used for the second time. Major technological difficulty in culm and slime recycling is their dehydration to 10-12% humidity. In connection with this, development of small- and middle-power compact productions engaged in culm and slime recycling into briquettes corresponding modern power processes requirements becomes very actual. Agglomeration is one of actual tasks in preparation coal wastes for use as an power fuel. To obtain sellable product fit for realization in the recoverable raw materials market, briquette should meet a number of requirements:

- should not contain harmful impurities exceeding permissible level;
- possess strength sufficient for its further transportation;
- retain strength while being humidified in transportation;
- possess strength at high temperatures;
- possess homogeneous chemical structure;
- possess homogeneous linear sizes of pieces;
- have comparable with traditional cost.

Piecing of finely dispersed culms and slimes provides enterprises not only with additional power resources of iron-containing materials but reduces ecological impact on environment and stabilizes the work of main stages - accumulation, raw material preparation, and recycling. Briquetting is the process of obtaining pieces (briquettes) with and without additive binding materials with further mixture compaction into briquettes of necessary size and form. The aim of small materials structural formation is not only to obtain pieces of definite size but to create complex specified physical and chemical characteristics in artificial structures. Thus, there is an appropriate cause-result relation of technical parameters of structure forming processes with qualitative characteristics of prepared materials [13]. Fine-fraction materials with 0-10 mm fractures have low gas permeability which limits their further application without preliminary preparation. Briquetting of fine grain and finely dispersed materials with binders is the most universal way of attracting valuable fuel, mineral raw components as well as some anthropogenic wastes not suitable for immediate use in technical processes and apparatus because of their aggregate state into recycling. Distinctive peculiarity of briquetting process is possibility to produce briquettes from charge mixture effective for main types of power complex units. Materials which can be briquetting and the sphere of their application are presented in table 1. It is necessary to point out that not only anthropogenic wastes but original fine fracture and finely dispersed raw materials may be briquetted.

Let’s consider technological process of coal briquettes production. “Cold” briquetting is the most economically profitable and ecologically safe method. Having analyzed operational qualities of briquettes with different binders and technology of their production use we consider the application of lingo-sulphonite binders the most economically profitable one. It is useful to analyze this method in more details because this problem is the weakest one in technology of briquette production.

Table 1. **Characteristics of technology and sphere of briquetting application**

Source of raw material	Materials being briquetted	Sphere of briquettes application
Coal production anthropogenic wastes: - «old» rock spoil heaps (with 30-40% content of coal crumb); - «tailing dumps» of central concentrating mills; - culm.	-coal, coal crumb for municipal and domestic needs according to ТУУ 10.1-33333494-005; -coal, grade К and Ж for dust-like burning according to ТУУ 10.1-23472138-158; - coal for dust-like burning according to ТУУ 10.1-32186934-003; - finely dispersed coal cock duct-like crumb.	Population domestic needs. Industrial enterprises boiler houses. Municipal enterprises boiler houses. Rail-road car boilers Heat power stations

One of the main reasons limiting spheres of application of lingo-sulphanates (LST) as a binding materials is their instable characteristics and low binding ability while this material is the cheapest, non-scare and ecologically clean of all nomenclature of binding materials. Works [5, 6, 7] provide ways to increase level of achieved results allow to speak about development of principally new binders based on LST.

In development of binders intended for technology of coal briquettes production the highest effectiveness has been observed when using complex modifiers containing components action of which has strictly defined functional orientation. In the process of working, one part of the complex initiates and speeds out the beginning of structure formation in charge mix while the other one undergoes a chemical reaction with oligo-dimensional LST molecules and coal dust particles which results in creation of tree-dimensional mesh polymer. Finally, this causes the increase of binding ability and decrease of hardening length and stabilizes binder characteristics thus allowing to use it effectively in the given technology.

It was stated that it is advisable to use binding complexes combining non-ionogeneous surface active materials (NISAM) with some mineral acids. In such cases we observed binding ability increase from 0.37-0. 51 МПа to 2.84-3.00 МПа and even higher, while hardening of developed binder composition in combined use of thermal activation (380-400^{0}C), decreased from 12-15 min, to 1–3 min. Normal hardening regime took place at temperature equal to 200-220 ^{0}C. A new binding material based on LST content of which changes depending on coal briquettes configuration and mass has been developed on presented investigations and offered for application.

The given paper may be used at present on the enterprises of Lugansk and Donetsk region having large massifs of anthropogenic wastes of coal mines and on concentrating mills. Expenses, caused by the process of original lingo-sulphonate binders modification, are not significant. The advantages are as follows:

- possibility of quick achievement of required operational strength;
- charge mixture compositions adaptability to manufacture;
- insignificant power-consumption for speeding up the process of getting briquette strength (temperature control up 220 C).

Characteristics of briquettes containing binders based on modified LST (LSTm) made of coke powder have been investigated and stated (see table 2). They contain twice as little binding material as compared with their analogues [18, 19, 20].

When developing technology of briquette production the following tasks are of priority [13, 21]:

- production of briquette with prescribed characteristics meeting client's requirements (suggested technology allows to produce a briquette with prescribed geometric sizes, configuration and physical characteristics);
- briquette component structure which defines its power value has been developed with the assistance of coal-mining enterprises' specialists and briquette consumers;
- provision of briquette production and application effectiveness got at expense of briquette producing installation placement close to sources of wastes generating and usually located on one and the same site;
- provision of high productivity, low equipment cost, minimal number of servicing personnel.

Table 2. **Briquettes quality indices**

Composition of carbon materials mixture , %	Consumption of binder (LST, m), %	Compaction pressuser, MPa	Briquet size		Strength of dried briquettes		Heat resistance %
			Diameter, mm	mass, g	For release, %	For compression, MPa	
Coal dust, screenings	4	30	50	80	94,5	8,53	97,1
Coal dust, screenings	3,8	100	50	80	97,9	12,02	98,9
Fractured cock briquette fines - 100	5,5	40	80	275	97,4	8,59	97,1
Fractured cock briquette fines - 85; anthracite - 15	5,5	40	80	275	96,8	8,6	94,9
Fractured cock briquette fines - 70; anthracite - 30	5,5	40	80	275	91,7	4,99	93,8
Fractured semi-cock screenings - 100	4,5	30	50	50	95,8	7,18	85,9

Technology of coal briquettes production includes the following process stages:

- delivery of raw material components to the production site;
- raw material components storage;
- raw material components measuring for charge mix preparation;
- preparation of raw material mixture in forced action mixer;
- charge mix transportation to the formation station;
- formation of briquettes on the roller presses;
- transportation of formed production to the drying furnace;
- drying and achieving strength;
- finished products packaging(when needed);
- transportation to the finished products ware-house (or loading to the means of transportation).

Technical solutions to selection of configuration of such measuring and mixing equipment providing exact measuring of linked materials within 1% and allowing to perform heir mixing regulating stirring intensity thus controlling maximally possible rate of charge mix homogenization are well known [8, 9,1 0]. High rate of homogenization favours decrease of binder consumption not less than by 1.5% compared to analogue binder consumption when traditional types of mixing equipment are used [11, 14]. Decrease of water consumption when preparing charge mix is usually provided by introduction of specific chemical additives (types of used additives depend on a specific briquette structural contents), which allowed to decrease the length of heat exposure on a briquette [12]. Besides, compact technological scheme of briquettes drying in continuous furnace aimed at the most effective use of heat-transfer agent heat value ability has been developed. Developments of technological schemes of finished briquettes unloading allowing to bring the briquettes accumulation at the intermediate industrial sites to minimum (or to eliminate this stage at all) are known. Instead of it these developments allow to load finished products into rail-way car or motor transport immediately from a conveyor. Carried procedures give reasons to state that at present there is a small-scale produced industrial equipment and technological schemes of its configuration allowing to process 50 thousand tons ÷ 500 thousand tons of wastes and more a year [14, 15, 16, 17].

Different requirements are made to the coal charge mix components such as: ability for softening, porosity, flaking off, mechanical strength, abrading, restorability etc. Obtained briquettes should meet requirements and specifics of technological process of their supposed use as to their raw material (chemical) contents, size (grain size) and strength. As briquettes chemical structure and size are defined prior to briquetting, one of the most important characteristics of briquette quality and briquetting technological process in general are indices of their mechanical strength. Knowledge of these indices allows to estimate briquettes ability to stand without destruction certain impact-rubbing, impact and crushing loads which they will undergo in operation. These are mechanical strength indices that largely determine their consumption value, and in general, the possibility of their use at different enterprises with their specific infrastructure.

On the basis of conducted investigations it was found out that briquettes in the process of operation first of all undergo impact loads at drop structures in loading of bins or other apparatus or in shipping briquettes to consumers and in the process of unloading. Briquettes undergo crushing loads in case of their accumulation in bins or in piles at warehouses and when transported in rail-way cars.

When the column height equals ~ 40 m (close to bins maximum height) load to the lower sample will reach ~ 3,1 kg/cm^2. The same picture may be observed when piece materials are in the shaft type metallurgical furnaces. For example, it was stated that even in a high-shaft blast furnace the pressure of layers placed higher on the coke do not exceed 3-5 kg/cm^2. Thus, briquettes destruction is mainly caused by impact loads exposure. To define the impact strength different methods are used. According to these methods briquettes batches are thrown on a metal plate with 1.5-2 m height. The strength is defined by input of obtained piece (grade class less than 5, 10 or 25 mm depending on the briquettes size). Large briquettes (maximum size ~100 mm) are thrown only 1-2 times, small size briquettes (~25-30 mm) - not less than 4-5 times. However, in all cases briquettes are considered to meet the strength to throw conditions

if quantity of small pieces does not exceed 5-10 %. It means that large briquettes should not undergo multiple transshipment and technological scheme of the process should be consistent with it.

Presently, there is no state normative and technical base regulating requirements to briquettes as an element of power charge mix. That is why enterprises producing and consuming briquettes are forced to develop technical conditions for each concrete briquette type.

Among obvious advantages of a briquette one may mention the following:

- briquettes have regular and alike predetermined form and fixed weigh;
- they posses higher strength and better transportation ability;
- they posses higher density;
- posses ecological safety due to waste-free character of manufacturing and absence of high temperatures in production;
- different components (culm, slime, filings, husk etc.) may be used in briquette in any relationship;
- all types of finely dispersed materials may be used in briquettes.

MAIN CONCLUSIONS AND RESULTS OF INVESTIGATIONS

On the basis of the abovementioned conclusions about technological possibility to implement described method of anthropogenic wastes or its perspective use for development of separate regions of Ukraine may be done with certain degree of reliability [15], and experience accumulated in this sphere may be successfully used on the enterprises of Poland and Russia.

From technological point of view the following should be stressed:

- sufficiently high mechanical strength of coal briquette, particularly crumbling 1.1%, with the norm equal to not more than 10 % has been stated. Following 20 times throw down on the cast-iron plate, the main piece (50% of the original weight) preserved compressive strength at the level 25 kg/cm^2;
- compressive strength equaled 8,7-9,3 MPa;
- impact strength and attrition meet the claimed requirements;
- heat of combustion, Q, kcal/kg - averaged not less than 4000…5346, which meets the generally accepted norms.

Further introduction of briquetting technology is advisable on the enterprises of industrial regions of Ukraine (Lugansk, Donetsk regions) to solve the problem of accumulated and current wastes utilization, having in mind the following aims:

- to decrease considerably and eliminate pollution of environment with industrial production wastes within 10-15 years by essential decrease of slime fields and different “burials”, thus clearing vast territories of useful lands and improving ecology of industrial regions;
- to practice economy of natural and power resources of the country at the expense of maximum use of industrial wastes into economic turnover;
- to use new ecologically clean and effective binding materials based on products of vegetation raw materials recycling - lingo-sulphonate materials.

From practical point of view, the following should be mentioned:

- coal briquettes are new slime material changing coal to some degree;

- briquettes have regular form and weight, possess high strength and good transportation ability;

- briquettes have necessary heat of combustion.

Analysis of data allowed to formulate the task which may be solved in two ways.

On the one hand, recycling and utilization of wastes, their usage as a relatively cheap raw material for power fuel, increase of their quality competitiveness, and which is more important, decrease of finished product cost for industrial enterprises as well as for municipal and domestic needs of population. On the other hand, there is solution of ecological problem connected with cleaning of regions where vast anthropogenic wastes deposits have accumulated as well as utilization of current wastes accumulations produced by the abovementioned enterprises. Thus, ecological problem of coal mining regions of Ukraine transforms into the task of practical development of anthropogenic wastes aimed at their inclusion into resource and power potential of the country.

Such approach allows to solve not only economic and ecological problems but social tasks connected with employment of population and creation of additional working places. Existing technologies of coal production wastes secondary use are not perfect and claim for further investigations and development.

CONCLUSIONS

As the result of present investigation a coal briquette has been produced with the use of untraditional binder based on lingo-sulphanate material for power fuel, that is, principally new composite charge mix the use of which may return industrial wastes as coal briquettes, and as a raw material having sufficiently high profitability.

Production of such briquettes will allow essentially improve technical and economic indices of enterprise production cost, thus improving ecological state of regions.

REFERENCES

1. Kamenik L.L. 2006.: Complex control of material resources. - K. - 238p.
2. Airapetove A.G. 1999.: Formation of resource-saving system: theoretical and methodological aspects SPb- : SPbGUEF Publishing House.-356p.
3. Voitolovsky V.N., Karlik A.E. 2001.: Production specific consumption of material: reserve and ways of reduction. - L.: Shipbuilding.-276p.
4. Anufriev V.P. 2006.: Theory and practice of powerand resource saving: Textbook / V.P. Anufriev, Yu.V. Lebedev, F.M. Chernomurov. – Ekaterinboorg: Nauka-service. - 405p.
5. Svinoroev Yu.A. 2005.: Theoretical preconditions for development of new ecologically clear binders based on technical lingo-sulphanates for cast shaping in production of food-processing industry equipment parts// Vestnik of East-Ukrainian National University named after V. Dahl. № 11 (93). – p. 186-189.
6. Svinoroev Yu.A. 2009.: Application of progressive methods of foundry binders treatment as a tool for technological processes resource-consumption decrease and solution of production and economic problems of regional enterprises// Vestnik of East-Ukrainian National University named after V. Dahl. № 2 (132). – p. 362-371.
7. Yu. Svinoroev, V. Kostrub, O. Klimova 2010.: New ecological binder materials based on vegetative raw aterials processintg products/Teka commission of motorization and power

industry in agriculture Lublin university of technology Volodymyr Dal East-Ukrainian national university of Lugansk, Volume XB, Lubin– p. 227 - 231
8. Ravich B.M. 1975.: Briquetting in ferrous and non-ferrous metallurgy. - M.: Metallurgy. - 232p. c.
9. M. P. Landow, Mark I. 2000.: Crawford and M.Martinez. Benefits of Recycling Blast Furnace Waste Materials at National Steel - Great Lakes Division by Cold Bonded Briquetting: 59th Ironmaking conference proceedings. Pittsburgh. Pennsylvania. March 26-29.2000 PP. 225-231.
10. Cupola furnace forthe recycling of steel mill waste materials to liquid hot metal/ KUTTNER: Presentation on occasion of the Russo-Ukrainian blast furnace conference. Kosice. June 18-24.2001.
11. Uhmylova G.S. 1981.: Modern state and development of compressed charge mix cocking processes abroad. M.: Chermetunformatiya. №15 (108), 44p.
12. A.c. 1645763 USSR, MKI5 F23G5/20. Installation for thermal rendering harmless as to combustion heat and humidity of wastes. / Guselnikov K.I., Kulagina N.V., Danilov O.I., and others.; Siberia branch of NPO Tehenergokhimprom. - N 4683599/33; Inventor's application. 24.04.89; Published. 30.04.91, Bul. N 16.
13. Sormatov M.I. 1954.: Elements of theory and calculation of presses for coal briquetting. M.: Ugletechizdat.-458p.
14. Bashilov N.M., Bogomazova L.M., Konstantinov G.A. 1999.: Rotor machine for solid wastes briquetting // Ecology and Industry of Russia. -June. - p.11-12.
15. Svinoroev Yu.A. 2011.: Resource-saving as a factor of stable region economic development //Materials of scientific and practical conference "Business and state regulation" 27-29 April 2011- Slavyansk.-p.321-327.
16. Garin V.M., Khvosticov A.G. 1999.: Trends in sovution of waste utilization problem. // Life safety. Labour and environment protection: collection of inter-institutes scientific works Issue 3 / Rostov-on-Don state academy of agricultural machinebuilding. – Rostov-on-Dony. - p.83-84. - Literature.: 5 pieces.
17. Demina L.A., Morozova T.F. 2002.: Once more about wastes // Energy: economics, thecnology, ecology. - N 10. - p.58-64.
18. *http://briket.zp.ua/pubs/*
19. *http://briket.tehnodoc.ru/briketir.php*
20. *http://www.unitek-ltd.ru/*
21. Lurie L.A. 1963.: Briquetting in metallurgy M.: Ugletechizdat.-238p.
22. Wasteless utilization of domestic and industrial wastes / Shantarin V.D., Artemieva T.V., Dvoinikova A.V. and others // Oil and Gas of West Siberia: thesis international scientific and technical conference, Tumen, 21-23 May, 1996. T.1. - Tumen, 1996.- p.49-50.

ПРИМЕНЕНИЕ ТЕХНОЛОГИИ ПОЛУЧЕНИЯ КОМПЛЕКСНОГО ЭНЕРГЕТИЧЕСКОГО ТОПЛИВА ИЗ ОТХОДОВ УГОЛЬНЫХ ПРЕДПРИЯТИЙ С ПРИМЕНЕНИЕМ НОВЫХ СВЯЗУЮЩИХ МАТЕРИАЛОВ

Юрий Свинороев, Владимир Коструб

Аннотация: В условиях ухудшающейся экологической обстановки возникает необходимость вторичной переработки сырья и отходов, в частности угольных отходов и получение топливных брикетов. В статье рассматривается технология получения комплексных энергетических брикетов с использованием в качестве экологически чистого связующего лигносульфонатов.

Ключевые слова: топливный брикет, связующие материалы, технические лигносульфонаты, энергетическая ценность.