



COAL TECHNOLOGIES WITH GOOD PROSPECTS



Volodymyr Biletskyi

Doctor of Technical Sciences, Professor of the Department of oil, gas and gas-condensate production, National Technical University “Kharkiv Polytechnic Institute”, Ukraine

ukcdb@i.ua



Tetiana Shendrik

Doctor of Chemical Sciences, Professor, Chief Researcher of the L.M. Lytvynenko Institute of Physical-Organic Chemistry and Coal Chemistry of the National Academy of Sciences of Ukraine, Ukraine

shendriktg@gmail.com

There is a number of traditional technologies of mineral processing which at present time are exhausted, from the point of view of achieved selectivity of separation. At the present time the losses of useful component of fossil fuel are rather big. The higher level of selectivity can be achieved by utilizing the quality and principled new technical decisions based on oil agglomeration of coal: “coal – gold”, “agglomeration – hydrotransport of coal”, “demineralization – agglomeration of salty coal”, oil agglomeration of coal – preparation of fuel coal-oil suspensions and others. In Ukraine are developed the technological bases of these processes.

Perspective of exhausting natural reserves of petroleum and gas and increase of coal consumption have conditioned an elevated interest of world scientists to coal technologies. Especial attention is given today to studying special processes of coal preparation and ennobling, that open new possibilities of processing low grade raw materials to conditional ecologically clear products. The past 30 years the process of coal selective oil agglomeration is quickly developed. The interest to this problem is considerable not only of specialists in fossils ennobling, but also coal chemists, heat-power engineers, transport workers. The oil agglomeration of coal is considered by we as a perspective high efficient mean of preparation low qualitative coal to coking, burning, pyrolysis and also as poly-functional process of coal preparation to its liquefaction. Besides, some investigators have demonstrated

advantages of utilization of these techniques and technologies in main hydrotransport systems of energetic and coking coal. For a period of 1980 – 2014 years in Ukraine have carried out a series of scientific-investigative works related to applied and theoretical aspects of the coal oil agglomeration process. The investigations were carried out in Donetsk State Technical University and L.M. Lytvynenko Institute of Physical Organic Chemistry and Coal Chemistry of National Academy of Sciences (NAS) of Ukraine, institutes UralVTI, VNIPIHidrotruboprovod, LenNIikhimmash, Kharkiv Polytechnical Institute, Institute of Biocolloid Chemistry NAN of Ukraine and also on coal preparative factories and thermoelectric power stations of Donbas. Theoretical and practical elaboration's have been made, experimental results have been obtained.

Theoretical bases of the process of selective coal oil agglomeration are developed on the bases of modern state of physical chemistry, physical-chemical hydrodynamics, adhesion theory, solid fuel chemistry. The necessary and sufficient conditions for aggregate-forming coal and oil components in water have been formulated. The central problem of “coal – reagent” interaction during coal aggregation has been solved. A presence of chemical bonds, H-bonds in a “coal-oil” interphase zone, the changes in a super-molecular structure of coal during pelleting it have been established (on the example of Ukrainian salty coals). Made a mathematical description of processes for forming coal-oil aggregates including kinetics of the process. Analysis of factors which influence on the process and on its mathematics models has been realized.

Rational conditions of pelleting of energetic and coking coal, coal row material and products of coal preparation plants, electric power stations, hydrotransport systems have been determined. Results of complex study of technologic properties of coal aggregates as objects of dewatering, hydrotransportation, consumption, coking, pyrolysis and carriers at gold adhesive preparation have been presented.

The elaborated theoretical principles and experimental data served as a basis for creating about 40 new methods and devises, that permit realize the process of coal selective oil agglomeration. The universality, polifunctionality and simplicity of realizing the process of selective oil agglomeration, possibility of oil aggregation of all ranks coals has been demonstrated.

Microscopic investigations allow to confirm a penetration of a binder in pores and fissures of coal substances. It is obviously, this process is accompanying by infiltration phenomena, during which light fractions of binder penetrate into micropores and more heavy ones remain on surface of coal grains. Last promote the formation border solvate layer of binder on coal surface. As the result, the cohesion of binder pellices is raised, and the stability of aggregates (agglomerates, granules) is increased.

The most interesting is the determination of intensively of effect of hydrogen and chemical connections between sinters ingredients. For this purpose we have investigated coal of various kinds, binders and their sinters by method of IR-spectroscopy in the wave number band $3800 - 400 \text{ cm}^{-1}$. There have been

studies the coking coal of Donetsk coal field and its sinters obtained on the basis of oil and coal. The character of change in spectrum of sinter as compared with spectra of coal oil enables to determine that along with physical interactions the H-bonds are established in the interphase zone.

This proves the change of the relative intensity of absorption peaks at 3460 and 3200 – 3100 cm^{-1} , belonging to the stretching vibration of OH-groups, linked by the intermolecular H-bonds. The disappearance in agglomerate-spectrum of medium-intensity absorption peak at 2730 cm^{-1} , which occurs in spectrum of binder according to data can be explained by the breakage of intercomplex H-bonds in oil during the interaction between linked OH-groups functional groups of coal.

Industrial testing. The elaborated theoretical principles and experimental data served as a basis for creating new methods and devices, that permit realize the process of coal selective oil agglomeration. The oil agglomeration process was run at a demonstration plant a capacity 3 t/h, also a industrial plant a capacity 6 t/h (on PJSC “Avdiivka Coke and Chemical plant”) and 30 – 40 t/h (on the “Kotliarevska” Mine Plant SE “Selydivvuhillia” (Donetsk-region). Results see in Table 1.

Table 1 – Some results of researches for oil coal agglomeration

Object	Coal	Granulate (agglomerate)	Reject
Demonstration plant	0 – 0.2 mm 14 – 16% 60 – 70%*	0.5 – 5 mm 6 – 15% *	0 – 0.2 mm 75 – 90%* 15 – 18%**
PJSC “Avdiivka Coke and Chemical plant”	0 – 1 mm 60 – 80%*	0.2 – 1.2 mm 11.3 – 18,7%*	0 – 1 mm 73 – 86%*
“Kotliarevska” Mine Plant	0 – 6 mm 53%*	0.2 – 6.3 mm 18 – 23% *	0 – 0.2 mm 76 – 77%* 19 – 20%**

* A^d , %; ** W^r_t , %

Agglomeration – hydrotransport of coal. We have investigated six major technological alternatives (schemes) in hydrotransport. Analysis and summarizing of investigation results allow to draw a conclusion as to obvious attractiveness of the hydrotransport – agglomeration technique.

Utilization of oil granulation technique for conveyed long-distance hydrotransport system (LHS) allows the following:

- to decrease moisture content of sedimentation centrifuge cake by a factor of 2 – 3 at a transportation distance of 250 – 1700 km;
- to substantially reduce losses of coal fines in sedimentation centrifuge at the LHS end terminal and ensure that ash content of a solid phase be > 80%;
- to maintain technological properties of coking coals while transportation in water flow at a distance 500 km.

Therefore, oil agglomeration is a perspective-process for coal preparation and long-distance hydrotransport.

The technology “Oil agglomeration of coal – preparation of fuel coal – oil suspensions”. Due to stable ash content of coal-oil granules (6–8%), high dispersivity and homogenate of solid phase (0–100 mcm) the process of oil agglomeration of coal is advantageous in technologies of fuel suspensions preparation. The oil agglomeration is considered by us as a perspective high efficacious mean of preparing low qualitative coal to obtained fuel coal-suspensions.

The technology of “demineralization – agglomeration” eliminates the losses of fine classes of coal (in traditional technology they reach up to 10–15%) and increases radically the effectiveness of mechanical dewatering (~ in 2 times). However, for salty coals (SC) that high parameters are achieved only at special treatment of raw material with oil agent (know-how).

Without special treatment coal surface, cowing with binder, is fluctuated between 0–5% only. This fact can be interpret as a low natural ability of SC to agglomeration.

Ukrainian technology “coal – gold” compares favorably with famous australasian ones, for example, the concentration depth-practically up to “0”. That proved the expect results and demonstrated the possibility of its industrial use. The extraction of the most difficult micrometer classes of gold with its content of outcome 72 g/t, when it reaches not less than 80%. The technological advantages of “coal – gold” technology in compare with traditional leaching are very essential. This technology can be used for other hydrophobic materials, diamonds for example.

Conclusions. This work shows the actuality of not-traditional methods for the processing of row materials with oil agglomeration. It been showed the necessity of utilization of oil agglomeration in the technology of gold processing, in ennobling, dewatering of coal hydrotransported, demineralization of coals and preparation of fuel suspensions. This technology was successfully probed in the industry and the pilots conditions.