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BINDING MATERIALS FOR CREATING COAL GRANULES AND THEIR COLLOID-CHEMICAL CHARACTERISTICS

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Abstract. This article examines binders necessary for formation of coal-resin granules and their colloidal-chemical characteristics. Data analysis shows that viscosity and coke residue are key parameters for binders. Optimum viscosity values ensure the required plasticity of the mixture for granulation, and a coke residue content of 9-15% contributes to the formation of carbon bridges without reducing adsorption activity.

High viscosity adhesives such as asphaltene and bitumen require the use of solvents to reduce viscosity. The use of auxiliary substances, such as heavy gas oil and diesel fuel, makes it possible to obtain formulations with low viscosity and optimal coke residue content.

Keywords: Coal, carbon bridges, coke, viscosity.

Introduction. The correct choice of binder in the coal granulation process is an important factor in obtaining a highly efficient coal adsorbent. The binder influences the structure and properties of the resulting material, which directly affects its adsorption capacity [1, 2]. It promotes the formation of a dense and porous granule structure, which provides a large contacting surface and increases the adsorption efficiency [3-5].

Most of the binders used in the production of granulated active coals are not Newtonian fluids due to the presence of supermolecular structures. Viscosity is highly dependent on the group composition of the product. For example, the presence of resins and asphaltenes leads to increased viscosity, while paraffin-based hydrocarbons and monocyclic arenas contribute to its reduction [7-9].

The viscosity and coke residue content (BC) [16] are the key characteristics of the binder, which provides for the forming of the coal and binder compositions into the granules and their strength during subsequent thermal modification. The optimum viscosity values of the binder ensure the necessary plasticity of the composition: coal+binder. If plasticity is insufficient, an uneven distribution of the coal powder in the binder and a disruption of the pelletizing process through the die is possible. The coke residue content in the binder is normalized at about 15 mass percent. Low coke residue content (less than 10%) may result in insufficient carbon bridge formation during heat treatment, which will not provide the required pellet strength in the final coal. On the other hand, the high coke residue content (more than 15-17%) can lead to coagulation of the pores of the sorbent and, as a consequence, to a decrease in its adsorption activity [12-15].

The aim of the study is to establish the composition of binders for the creation of granulated coal adsorbents on the basis of the results of the study of viscous characteristics and coke residue of the binder system.

Objective and methods. Commercial coal tar (KB) (Chemistry and Technology, LLP, Kazakhstan) and residual oil products of «Fergana Refinery» LLC asphalten and construction bitumen were chosen as the binder for coal pellets production.

In this paper, dynamic and conditional viscosity of investigated binders were investigated. The HSN-3 rotary viscometer was used to measure dynamic viscosity. The principle of the instrument is to measure the force required to rotate one element of the measuring geometry relative to another. In order to assess the variation of dynamic viscosity over time under constant conditions, measurements were made within three hours.

The quantitative determination of the BC is carried out in accordance with the requirements of GOST 22989-78 when choosing a binder for the production of activated carbon.

Results and discussion. The quality and viscosity characteristics of the binders used in the studies are given in table. 1 and 2.

Table 1.

Physical and chemical indicators of binders

Sample	Density, sm^3/g	Humidity, %	Ash content, %
Coal tar	1,15	3,6	0,10
Asphalten	1,08	1,4	0,12
Bitumen	1,11	0,9	0,56

Table 2.

Viscosity properties of resins

Sample	Kinematic viscosity, sPz		
	50 ºC	65 ºC	80 ºC
Coal tar	159,2	68,8	33,3
Asphalten	448,3	189	58,6
Bitumen	211,2	86,5	39,3

A high content of coke residue can cause negative consequences. A high concentration of coke can lead to the formation of undesirable slag inclusions and make it difficult to achieve the optimal granule shape [17–20]. Higher amounts of coke can contribute to increased dust generation and losses during pellet handling and transport. Therefore, it is necessary to balance the content of coke residue in the binder in accordance with the quality requirements and the goals of activated carbon production. The data obtained are given in table. 3.

Table 3.

Quantity KO, %

Coal tar	Asphalten	Bitumen
21,5	18,6	13,1

According to GOST 22989-78, coal tar has the highest carbon residue value at a lower viscosity at 50ºC. This means that when using this resin in a composition with coal, it is possible to achieve the lowest energy costs for the formation of a homogeneous mixture and granulation with increased mechanical strength of coal granules. Since the amount of carbon residue, composition uniformity and viscosity affect the strength of the coal pellets, based on scientific findings, it can be argued that the use of coal tar with a high carbon residue content at optimal viscosity contributes to the production of pellets with increased mechanical strength. However, when the content of the coke residue of the binder material is more than 20%, a decrease in the adsorption activity of the finished granules is observed. This is explained by the fact that an increased amount of coke residue can lead to clogging of the pore structure of coal.

Changes in the viscosity of mixtures during the preparation of granules may be due to temperature control. Therefore, it is important to investigate the effect of temperature on this process. For binders such as asphaltene and bitumen, which are characterized by high viscosity, it is difficult to achieve a homogeneous composition of coal and binder to form granules. Therefore, these binders require the use of solvents to reduce their viscosity. As a result of the use of such binders, two-component mixtures were obtained, in which auxiliary substances were used, such as heavy gas oil ((TG) KO=5.41%) and diesel fuel ((DF) KO=2.15%) (Table 4).). Samples were mixed at a temperature of 80ºC to obtain a homogeneous mixture on a UTAS-0195 laboratory mixer.

Table 4.

Variation of viscosity and coke residue values depending on the composition of the binder mixture

Compound, №	Component content, %					Dynamic viscosity, Pa*s		KO, %
	KS	AF*	BT**	TG	DT	40ºC	80ºC	
1	80	-	-	20	-	43,32	6,86	18,3
2	80	-	-	-	20	34,21	5,51	17,6
3	-	70	-	30	-	18,24	2,43	14,6
4	-	70	-	-	30	15,51	1,96	13,7
5	-	-	70	30	-	31,31	3,12	10,7
6	-	-	70	-	30	28,75	2,18	9,8

**- asphaltene;*
***- bitumen.*

The table lists the most promising binder compositions in which it is possible to obtain optimal values of viscosity and CO.

The composition 1 has an asphaltene (AF) content of 20% and the COP component and 80%. The dynamic viscosity at 40 ºC is 49.32 Pa*s and the coke residue (BC) content is 18.3%, while the composition 2 differs as a result of 20% DT instead of AF. The dynamic viscosity of the mixture at 40 ºC is 43.21 Pa*s and the coke residue content is 17.6%.

Composition 3 contains 70% AF and

30% heavy gas oil (TG). The dynamic viscosity of this composition at 40 ºC is 18.24 Pa*s, and the coke residue content is 14.6%, and the composition 4, which is distinguished by the auxiliary substance DT, is characterized by dynamic viscosity values at 40 º C of 15,51 Pa*s, and the coke residue content is 13.7%.

Formulations 5 and 6 consist of 70% bitumen (BT) and 30% sweat TG and DT, respectively. More viscous is the composition 5, and its coke residue is 10.7% versus 9.8 for the composition 6.

Compositions No. 1 and No. 2 are the most viscous systems with a dynamic viscosity at 40ºC of 49.32 Pas and 43.21 Pa*s, respectively. This indicates their higher plasticity and formability for the process of preparing granules of coal-tar compositions.

The content of coke residue in compositions No. 1 and No. 2 is 18.3 and 17.6%, respectively. However, it should be noted that these values exceed the recommended range of 9% to 15%. A higher content of coke residue can lead to clogging of the pores of the carbon adsorbent, which can potentially reduce its adsorption activity. Thus, it is important to consider this factor when choosing formulations for further research.

Compositions No. 3 and No. 4, containing heavy gas oil (TG) and diesel fuel (DF) as auxiliary substances, have a lower dynamic viscosity and coke residue content. This may indicate the potential of using these compositions to reduce viscosity and prevent clogging of the carbon adsorbent pores.

Compositions No. 5 and No. 6, consisting of bitumen (BT) and TG or DF, also have a lower viscosity and coke content. They may be of interest for further research in order to optimize the process of preparing granules and obtaining carbon adsorbents with desired characteristics.

In general, in order to select the most promising compositions for further study of their adsorption and strength characteristics, it is necessary to take into account both the viscosity and the content of the coke residue in order to achieve optimal results in the process of preparing coal adsorbent granules. Therefore, compositions Nos. 3, 4, and 5 were chosen for further studies, which are characterized by the most appropriate values of coke residue and dynamic viscosity.

The study also analyzed the change in the viscosity of these compositions during their storage at elevated temperatures. Observations have shown that with time the viscosity of these mixtures (Fig. 1) practically does not change, even at elevated temperatures. The increase in viscosity during storage at constant temperature and shear stress is no more than 10-13% of the initial value. These results confirm the promise of using these mixtures to create a coal + binder composition.

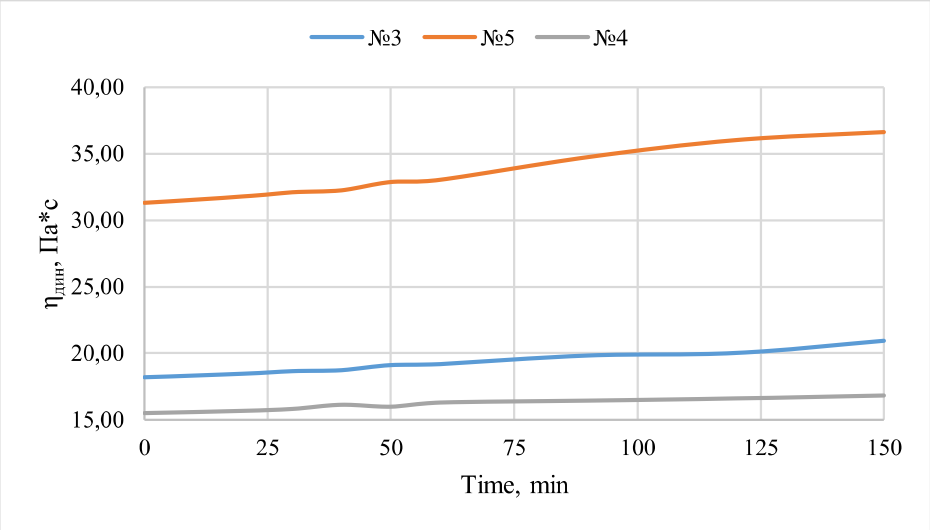

Fig. 1. Change in the viscosity of the mixture of binders from the duration of storage

Data analysis shows that all three formulations show some changes in viscosity during storage. It is important to note that changes in viscosity depend on the composition of the binder and its interaction with other components.

It can be assumed that the viscosity changes are associated with the composition of the binders. Comparing compositions Nos. 3, 4 and 5, it can be seen that asphaltenes are the basis for compositions Nos. 3 and 4, while bitumen is the basis for composition No. 5. Bitumen and asphaltenes have different chemical structures and properties, so their interaction with other components may be different.

In the case of composition №5, which contains bitumen, there is a more significant increase in viscosity over time. This may be due to physico-chemical processes, such as polymerization or oxidation of bitumen, which can lead to an increase in viscosity.

Formulations №3 and №4 containing asphaltenes do not show such a significant change in viscosity over time. Asphaltenes generally have a more stable structure and are less prone to viscosity changes than bitumen.

Conclusion. From the analysis of the data obtained, it follows that the key characteristics of the binder material for the formation of coal-tar granules are the viscosity and the content of the coke residue. Optimum viscosity values provide the plasticity of the mixture necessary for granulation. The content of the coke residue in the range of 9-15% ensures the formation of carbon bridges and does not reduce the adsorption activity.

High viscosity binders such as asphaltene and bitumen require the use of solvents to reduce the viscosity. The use of auxiliary substances, such as heavy gas oil and diesel fuel, makes it possible to obtain compositions with low viscosity and carbon residue content.

The study also showed that the viscosity of the created (No. 3, 4 and 5) compositions practically does not change during storage at elevated temperatures. The increase in viscosity is less than 10-13% of the original value. This indicates the prospects of using these mixtures for the formation of coal-tar granules. Thus, the selected binder compositions have the potential to create carbon granules with desired characteristics, and further research will be directed to the analysis of their adsorption and strength properties.

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ANALYSIS OF OIL DUST RELEASED DURING PROCESSING OF METAL SURFACES UNDER LABORATORY CONDITIONS

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Abstract:
Objective. In this article, in the process of metal surface treatment, in order to cover the metal surface, in laboratory conditions, the process of processing metal heated to a high temperature using motor oils is studied.
Methods. A laboratory device was used to study this process. Oil-containing gases obtained in laboratory conditions have been studied.
Results. The results obtained were compared with the allowable concentration of gases. Absorption cleaning is recommended to retain gases in excess of the permitted rate. The results obtained with the proposed new device were analyzed.
Keywords: metal, oil dust, absorption, metallurgy, gas concentration, concentration, absorber, mass transfer coefficient.

Introduction. The activation of technological processes in ferrous and non-ferrous metallurgy, chemistry, mechanical engineering and other industries in practice serves to increase production volumes, improve quality and reduce costs [1]. These processes mainly use compressed gases, especially air, oil products [2,3,4]. The purification of oil-containing gases emitted into the atmosphere as a result of oiling the metal surface by the absorption method is considered effective. Separation mass transfer processes are widely used in industry and are carried out mainly in column-type apparatuses. Gas mixtures

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