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The Volume contains works of young researchers - participants of the XVI International Forum-Contest of Students and Young Researchers “Topical Issues of Rational Use of Natural Resources”, which was held at St. Petersburg Mining University on June 17-19, 2020. The Volume can be of great interest for a wide range of researchers, scientists, university lecturers, specialists and managers of industrial enterprises and organisations as well as for businesspeople involved in exploration, prospecting, development and processing of minerals.

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3) Most of the suitable regions are located south of the Huai River in southern China (with the exception of Heilongjiang province) and most of the unsuitable regions are located north of the Huai River. The low-WSF regions are concentrated in the central provinces of China and the high-WSF regions are concentrated in the North China Plain and Xinjiang province.

Two conclusions are summarized based on our analyses:

First, the total water use for shale gas development in China by fully considering both direct and indirect water use in all exploitation stages of shale gas is assessed. The results show that the total water consumption is about 42100-108700 m^3/well (average value:79000 m^3/well). Of them, the direct water consumption is about 9700-37600 m^3/well (average value:24500 m^3/well), while the indirect water consumption is about 32400-71100 m^3/well (average value:48100 m^3/well). By considering the total gas production from the well, the water intensity is calculated, i.e., producing every 10^6 m3 of shale gas needs 320-824 m^3 (average value:598 m^3) of water.

Second, WSF of shale gas development in China is assessed by using AWARE method. The results show that the average water pressure for shale gas development in China is relatively high, with a water scarcity footprint of 16556 m^3 world. eq/$10^6 m^3$ gas. The advances in hydraulic fracturing technology will lead to more water use and higher WSF. Furthermore, 13 of 31 provinces have even higher WSF than the national average, which means these provinces may be not suitable for extracting shale gas resources. Other 18 provinces have lower WSF compared to the national average. However, to avoid the significant influences on local water use from other sectors, the exploitation of shale gas in these 18 provinces should also consider the speed and scale of extraction, as well as the amount of local shale gas resources.

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REDUCTION OF AIRBORNE PARTICULATE MATTERS EMISSIONS REDUCTION ASSOCIATED WITH PETROLEUM COKE PRODUCTION

Today, the delayed coking process is one of the most rapidly developing and promising processes for crude oil deep conversion, since commissioning of a delayed coking unit at a refinery leads to an increase in the main indicator - oil conversion ratio up to 95%. To ensure safe conduct of the process, it is necessary to strictly comply with the requirements of industrial and fire safety, labor protection, in addition, the working conditions of the workers of the plant are changing, as there is an additional harmful production factor - dust, due to the release of coke dust into the air of the working area, which has the ability to smouldering, spontaneous combustion and self-ignition. Exceedence of the maximum allowable concentrations for petroleum coke dust in the air of the working area of production facilities (MAC in the working area is 5 mg/m^3) can lead to development of occupational lung diseases [1-4].

Compounding of thickening additive with solvent was carried out, the selection was made and the optimal ratio of initial raw components was determined to obtain a dust suppression-antifreeze agent with a complex of required properties. Dust suppression and anti-freeze agent was obtained in a cylindrical mixer with a mechanical mixing device with adjustable heating of the entire outer surface, a thickening additive in the amount of 3 ... 5% wt. was heated in a cylindrical metal mixer to (85 ± 5)°C, 95 ... 97% wt. of solvent was added and the mixture was stirred for 10 minutes at (85 ± 5)°C to obtain a homogeneous mass, then the resulting mixture was subjected to isothermal aging for 60 min at (85 ± 5)°C. As thickening additives for dust-suppression and antifreeze preventive agents the following was used: - fuel oil from the AVT-6 Crude Distillation Unit of Naftan OJSC with density at 20°C according to GOST 3900 equal to 939 g/cm^3, open cup flash point according to GOST 4333 equal to 173°C; - tar from the VT-1 Unit of Naftan OJSC with density at 20°C according to GOST 3900 equal to 1002 g/cm^3, open cup flash point according to GOST 4333 equal to 275°C. Secondary process kerosene-gasoil fractions were used as solvents in dust suppression-antifreeze preventive agents – kerosene-gasoil fraction of the visbreaking process from the Visbreaking-Thermal Cracking Unit of Naftan OJSC with boiling point of 195-245°C.

The obtained dust-suppression anti-freezing agents were studied by standard methods to determine the pour point (GOST 20287-74), closed cup flash point (GOST 6356), assumed viscosity at 50^{o}C (GOST 6258), density 20°C (GOST 3900), mass content of mechanical impurities and water (GOST 6370 and GOST 2477, respectively). The obtained dust-suppression antifreeze agents are a thin dark brown oily liquid based on a solvent and a thickening additive of petroleum origin, and with a small thickening additive content they have good low-temperature properties, which allows their use in severe climatic conditions. In this case, 3 ... 5% wt. is the optimal concentration of a thickening additive (tar or fuel oil) to achieve the maximum depressant effect in kerosene-gasoil fractions.

Air pollution with coke dust was evaluated by the mass method. It was found that dust suppression and anti-freeze agents based on diesel fractions of secondary oil refining processes with the addition of 5% wt. fuel oil from AVT-6 Unit (sample 1) reduces dust content of air by 7.4 times, and 3% wt. tar (sample 2) from VT-1 Unit – by 3.5 times. The simulation of the dust loss process of petroleum coke was carried out to prevent blowing out during transportation by open method. The wind speed in the laboratory wind tunnel was determined using a mechanical cup anemometer. A dry and treated weighted sample of petroleum coke dust was placed in a wind tunnel for 30 minutes at the wind speed of 30 km/h. The weighed sample without treatment with a preventive agent showed that dust removal is 58%, while dust removal for weighed samples treated with a sample is 1 - 12%, thus, losses during the blowing process are reduced by 4.8 times.

The developed dust suppression-antifreeze agents do not show corrosiveness with respect to metal surfaces, do not contain mechanical impurities and water, have sufficiently high flash points that meet fire safety requirements, are characterized by low pour points, allowing them to be used at ambient temperatures below minus 30 ° C; have good wettability, adhesive ability and rheological properties; low consumption of about 1.5% wt. per the mass of the transported cargo. The proposed dust-suppression and anti-freeze agents from local raw materials can be recommended for use to combat dust formation and to prevent freezing and adhesion of rocks and bulk carbon-containing cargoes to metal surfaces and cavities of automobile and railway vehicles. The use of kerosene-gasoil fractions of secondary processes in optimal proportions with residual oil products (tar or fuel oil) will increase the raw material base for the production of preventive agents, as well as expand the scope of use of petroleum by- and co-products.

Industrial implementation of the proposed agents for preventing freezing, adhesion as well as for dust suppression of bulk carbon-containing materials will decrease the cost of their transportation and unloading and reduce the impact of the dust factor on personnel.

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UTILIZATION OF IRON TAILINGS TO PREPARE HIGH-SURFACE AREA MESOPOROUS SILICA MATERIALS

Iron tailings, one of the major mine solid wastes, are mainly produced in the iron and steel industry. Abundant of non-recycled iron tailings are mainly disposed in iron tailings dam, which is a waste of land resource and also a potential threat to the environment. Iron tailings are fine, stable and complex materials, which are mainly composed of silica and iron oxide [1]. Residual silicon in iron tailings can be used to prepare mesoporous silica materials applied to energy storage, environmental protection and other fields. The conventional synthesis methods for mesoporous silica materials is the hydrothermal method using tetramethyl orthosilicate, tetraethyl orthosilicate or sodium silicate as the silicon source, which has several problems, such as time and energy inefficiency, high raw material costs, and potential environmental consequences [2]. Recently, synthesis tactics with simple technological conditions, high efficiency and energy conservation have been developed [3]. Meanwhile, in order to explore a green strategy for synthesizing mesoporous material, researchers have attempted to use natural silicate minerals or industrial solid wastes to replace the potentially toxic organic silicon [4]. The obtained mesoporous silica materials have demonstrated excellent properties. It is revealed the potential of using natural silicate minerals or industrial solid wastes in wide-scope synthesis of mesoporous silica materials.

High-surface area mesoporous silica materials were synthesized using iron tailings through an innovative non-hydrothermal route at room temperature. The high content of silica in iron tailings serves as a source of raw material for the synthesis of mesoporous silica materials applied in energy storage, environmental protection and other fields. A new idea is provided for a more efficient use of iron tailings and the preparation for environmental materials.

A pretreatment process involving acid leaching and hydrothermal alkaline reaction was vital to the successful utilization of iron tailings. Chemical pretreatments (acid leaching) was used to remove iron oxides, increasing the silica content in iron tailings, and extracted silicon sources by the hydrothermal alkaline reaction, followed by the application of non-hydrothermal