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Carbonized Residues Electrical Resistance as a Result of the Supramolecular Structure Organization

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Abstract. The carbonized materials structure levels from molecular to macrostructure is analyzed. A study was conducted to find correlations between the granular carbonized materials electrical resistance and other substance physicochemical properties. It is proven theoretically and experimentally that determining the electrical resistance for a granular material, rather than a finely ground sample, is a more informative indicator for reflecting the microstructural features of the material, its reactivity, strength, and clarifying the carbonization conditions. A method is developed for determining the granular materials electrical resistance in the rotating drum interelectrode space, with determination of the indicator value in the cold and hot state for the substance under investigation. An indicator of the granular matter electrical resistance based on the heating time to 670 °C at a drum power supply constant voltage is introduced. Calculated dependencies is obtained for predicting, based on experiment results, some quality indicators for such a carbonized material as metallurgical coke: structural strength, apparent density, reactivity, gasification degree, and electrical resistivity. Better correlations is achieved with these indicators than with the standard electrical resistance on the "micropress" device, which indicates a better reflection of the carbonized materials substance supramolecular structure.

1 Introduction

Carbonized residues are formed during the pyrolysis of organic origin 2nd kind solid combustible materials. They are obtained either specifically for technological needs (blast furnace and pitch coke, charcoal, etc.), or they are a by-product of controlled and uncontrolled combustion (fires). The starting material transformation degree into the final carbon structure (amorphous or crystalline) depends on its initial structure and thermal stability, exposure time and holding temperature. The more anisotropic structures are formed, the larger their size, the denser the contact between the "grains" of the structure – the lower electrical resistivity. Then this parameter becomes an indicator of the depth and direction of structural transformations in the material. It can indicate both the coke readiness for the metallurgical process and be the thermal conditions indicator in which the material was exposed. At the same time, electrical resistance also depends on the impurities presence in the material, for example, sulfur, the which content, in turn, affects the certain technological process efficiency [1]. Nevertheless, this carbonized substance properties indicator is used as an additional one and its potential has not been fully revealed. More often in practice, indicators of reactivity and structural strength are used. Therefore, this study task is to identify the relationships between the carbonized materials electrical conductivity with their properties and directly with the features of the substance micro and macrostructure.

2 Literature Review

Carbonized materials are widely used in the national economy as household fuel, as a reducing agent in ferrous and non-ferrous metallurgy, in technologies for obtaining aluminum, boron, and pure

5 Conclusion

It is proven that the lumpy carbonized material electrical resistance is the simplest and most universal indicator of the matter structure organization. A measuring method the carbonized materials electrical resistance in a granular state in a rotating drum for cold and hot testing is developed and investigated. The determining results comparison of the metallurgical coke electrical resistance with its technical analysis indicators showed a greater correlation than when measuring the electrical resistivity for a sample in a powder state. Higher correlations (0.92–0.94) were obtained with following analysis components: apparent density, electrical resistivity according to the standard method, and structural strength. This indicates the testing possibility their supramolecular structure by means of the electrical resistance of carbonized materials in the granular state. The time indicator for heating the sample to 670 °C at a constant drum power supply voltage of 40 V allows displaying the electrical resistance indicator with similar accuracy. Calculation dependencies is developed to predict the metallurgical coke following quality indicators based on experiment results: structural strength, apparent density, reactivity, gasification degree, and electrical resistivity.

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