INVESTIGATION OF THE CALORIFIC VALUE OF BIOFUEL COMPOSITES

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The study of the thermophysical properties of biofuels makes it possible to optimize their application in various technologies to produce thermal and electrical energy. This helps to improve the efficiency of combustion processes, reduce emissions of polutions into the environment and ensure the stability of power equipment. That is why research on the thermophysical properties of biofuels, considering the need to develop environmentally friendly and efficient energy sources for the sustainable development of society, is undoubtedly relevant.

In this paper, two biofuel composites based on phloem birch (Betula pendula) are considered: with the addition of brown coal from Pavlovskoe deposit (Primorsky Krai) and pine needles (*Pinus sylvestris)*. During the experiments calorimetric studies were carried out to determine the lowest heat of combustion of the obtained pellets and thermogravimetric analysis to identify the main stages of thermal decomposition. The lower heat of combustion allows to calculate the necessary amounts of fuel used to obtain the amount of heat that is usually consumed by objects. Thermogravimetric analysis is based on continuous recording of the dependence of the sample mass change on time and temperature.

The following results were obtained during the study:

- *Thermogravimetric analysis:*

The decomposition processes of the main components of pellets (phloem, coal and pine needles) in atmospheric conditions are generally divided into three stages: 1) release of free water and a small number of volatile gases, 2) release of the main part of volatile gases and combustion of bound carbon, 3) at the last stage of the carbon residue burning out.

At the end of the moisture removal process, the mass of hulls decreased by ~5%, charcoal by 13%, and pine by 7%. After complete combustion, the ash of birch phloem was ~2%, brown coal - ~5%, and pine - 1%.

- *Calorimetry*:

In the process of analyzing calorimetric data, it was revealed that in the range of mass distribution of components with coal content from 0 to 1, the change in the lowest heat of combustion obeys a linear law ($y = 3763.8x + 18352$). The caloric value of brown coal is on average ~17.6% higher than that of birch phloem, the lowest heat of combustion of pellet from brown coal is about 22.4 MJ/kg.

Also, the lowest heat of combustion of biofuel composites containing pine needles with a ratio to phloem from 0 to 1 was analyzed. The caloric value of pine needles is higher than that of birch phloem by about 6%, while their calorific value is on average 19.6 MJ/kg.

As studies have shown, the obtained pellets have a slightly lower the calorific value than the fuels used in boiler houses and enterprises, but the ash content of even pure components is much lower than that of coals, the residue of which after complete combustion can vary from 7 to 45% of the fuel mass.

As a result of a calorimetric study, a linear dependence of the value of the heat of combustion on the concentration of brown coal particles as a component of pellets obtained from bast was established. The obtained dependence will allow to carry out mathematical modelling of combustion processes and optimize the combustion process of biofuel composites by selection of the manufacturing process suitable for the set objectives and equipment. Studies of composites and pine needles in a mixture with birch phloem have shown that pellets have a relatively high heat of combustion (~19MJ/kg) and small indicators of the mass of ash residue. Thus, such pellets are promising for use in domestic boilers with automatic fuel supply.

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