

Recycling of wastes from the production of aviation equipment based on Polymer Composite Materials in order to regenerate carbon fibers and obtain activated carbons

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Abstract

Polymer composite materials (PCM) with the expected total output in Russia in 2020 in the amount of 118 thousand tons per year are actively used in almost all industries. Taking this into account, the volume of PCM to be recycled, according to various estimates, can reach 1–3 % of the annual production. For a wide range of such wastes, which have high values of thermal and chemical resistance to external environmental influences, mechanical strength and the cost of carbon fillers included in them (for chopped carbon fiber, 3–5.5 thousand rubles / kg), the problem of disposal is both economic and environmental.

All methods of recycling waste carbon fiber reinforced plastics, organoplastics and fiberglass, focused on the release of reinforcing filler (fiber), are united by the need to destroy the matrix (binder), accompanied by the production of various processed products. When comparing the possible methods, it was shown that for maximum preservation of the properties of each filler, its own disposal method is preferable: for carbon fiber reinforced plastics, for example, it is pyrolysis and solvolysis, for fiberglass plastics - pyrolysis. It is noted that in the pyrolysis of organoplastic waste, when heated, the filler usually collapses together with the binder, in some cases it is possible to focus on the production of rather expensive and effective carbon adsorbents such as activated (active) carbons. These adsorbents can be used in numerous industrial industries for the refining of gaseous and liquid media and streams, in various related industries, as well as in solving a wide range of environmental protection problems.

The **degree of elaboration** of the research topic: A significant number of scientific and technical publications and sources of patent information indicate the possibility and efficiency of processing organoplastic waste to obtain carbon adsorbents. Nevertheless, the problem of utilization of the PCM production waste generated at Russian aviation enterprises for this purpose has been developed very modestly, which necessitates a deeper study.

The **present research work main goal** was a technological substantiation of the recycling of waste products of aviation equipment based on PCM, focused on the regeneration of carbon fibers and the production of activated carbons.

Scientific novelty:

In this research work for the first time using samples of PCM waste provided by VIAM:

1. The fundamentals of the technology of granular activated carbons based on PCM waste by the method of chemical activation with KOH have been developed;
2. Set character and the regularities of the influence on the yield and technical characteristics of the target product of the conditions of impregnation of raw materials with a KOH solution and using the method of mathematical planning of the experiment - the intensity of heating of the raw materials, the final temperature and the duration of isothermal holding at it of the obtained activated carbon;
3. Using the method of low-temperature nitrogen adsorption, the regularities of transformation of the porous structure of target products during the transition from their powder form to granular were revealed;
4. Using Raman spectroscopy on the surface of the obtained activated carbon, the presence of oxygen-containing groups was revealed, potentially indicating the ability of this

material to extract heavy metal ions;

5. Determined the kinetic and equilibrium characteristics of the adsorbents obtained in the processes of recovery of vapors of volatile solvents (for example, the extraction of n-butanol from mixtures of its vapors with air), compared with those of activated carbon grade AR-A; the patterns and peculiarities of the absorption of organic impurities by them from multicomponent wastewater were revealed (by the example of wastewater treatment from the territory of the coke-chemical production of JSC "Moskoks");

6. Substantiated the possibility of thermal processing of PCM production wastes with the production of secondary carbon fibers, providing an increase in the strength of the obtained granular activated carbons when they are introduced in an amount of 1% by weight. as a reinforcing material in raw materials for their production.

The practical significance of this research work

1. Substantiated the fundamental possibility of using wastes from the production of PCM products of aviation equipment as raw materials for obtaining high quality activated carbons by the method of chemical activation;

2. It was shown that the obtained powder, granular and reinforced activated carbons do not differ in their absorption capacity;

3. The unique ability of the obtained activated carbons for deep extraction of benzene and toluene from their aqueous solutions of low concentration was discovered;

4. The hardware-technological scheme of the developed technology was proposed and its approximate feasibility study was carried out, indicating the feasibility of its practical implementation;

5. By means of comparative studies, the prospects for the effective use of the obtained activated carbons in solving the problems of cleaning and neutralizing gaseous and liquid media from contaminants have been revealed.