NOVEL ADSORPTION-FILTERING MATERIALS ON THE BASE OF ACTIVE CARBON-POLYMER COMPOSITES

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Introduction

An actual target is to develop composite adsorption materials (CAM) of the "Active carbon [active component] - Polymer [matrix]" type and to optimise their properties. The following different routes for the preparation of optimised CAM will be pursued: a) formation of block CAM (hard structure); b) formation of elastic CAM based on the polymer foams; c) formation of immobilized CAM (sorption-active components are immobilised on a polymeric filter material by the extrusion process).

As an active component it can be used powder, granulated and fibrous activated carbons and their modifications. As polymer carrier materials we examine commercial polypropylene, its mixtures with polyamide and viscose as well as the various types of polyurethane's. By appropriate modification the carrier-filter materials can also have additional functional ability, for example, bactericide, fungicide properties, etc..

Recently it was done some successful attempts to synthesize the CAM of various types and to study their structural and exploring parameters [1]. These researches were developing in the field of working out appropriate technologies and preparation of new perspective adsorption-filtering materials in the frame of international cooperation.[1]

Experimental

It has been obtained three types of composite adsorption materials (CAM) - block and elastic type, and also immobilized particles of adsorbent on the non-cloth filtering material.

As an initial carbon adsorbent has been used fruit-stones active carbon KAU, the reception technology of which is developed in the Institute for Sorption and Problems of Endoecology, NAS of Ukraine (National Standard TU U 88.290.015-94). The fractions of used carbon were 0.5-1 mm (grains) and less than 0.1 mm (powder) in diameter. The

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main adsorption characteristics of the material: volume of adsorption pores on benzene (W_s) 0.6 cm^3/g; specific surface area on argon (S_{sp}) 1100 m^2/g.

As polymeric components for reception of composites of block type polymers of industrial production (polyvinyl alcohol, polyvinyl chloride and several linear polyurethanes) were used. To prepare CAM of elastic type it was used foamed polyurethane. Immobilized composites were received on an industrial non-cloth filtering material from polypropylene ultrathin fibers.

Method of reception of block CAM. Active carbon KAU was preliminary processed by solvent (carbon tetrachloride, ethylbuthylacetate, methylene chloride, etc.), dried at room temperature. After this carbon was mixed with solutions of polymers of different concentration (5-30 % mass.), placed in special "sieve" forming and dried under loading (0.1-1 kg/cm^2) at temperature 50-60 ^oC and the lowered pressure (2 mm Hg). The obtained ratio – carbon / polymer in block CAM was 85-99.8 : 0.2-15 (% mass.) [2].

Method of reception of elastic CAM. Active carbon KAU was preliminary processed by solvent, dried at room temperature and mixed with the components necessary for processing foamed polyurethane. After this formation and drying of a material was carried out. The obtained ratio – carbon / polymer in elastic CAM was 25-55 : 45-75 (% mass.) [3].

Method of reception of immobilized CAM. The powder of high disperse active carbon KAU or its suspension in polymer (PVA, PU) was entered through dosing out device into system of aerodynamic formation of ultrathin fibers from the melted polypropylene at simultaneous drawing components on a moving reception surface, where there was their coupling. The obtained ratio – carbon / polymer in immobilized CAM was 15-85 : 85-15 (% mass.) [4, 5].

Parameters of porous structure of initial carbon and obtained CAM have been investigated on parameters of volume of adsorption pores on benzene (W_s), of a specific surface area on thermal desorption of argon (S_{sp}). Distribution of volumes of macro- and mesopores on equivalent radii was determined with a mercury porosimeter (Model M 9200, “Cultronics”).

Researches of kinetic and diffusion characteristics of carbon KAU and CAM on its base were carried out in static conditions and a dynamic mode on a substance - marker (methylene blue) from corresponding water solutions. On the significances of time to a floor of adsorption factors of effective and true diffusion were designed and their comparative analysis was done.

Operational properties of CAM were estimated by a level of a dust content (dust creation) for active carbon and composites, and on dynamic characteristics (time of protective action on benzene in accordance with GOST 12.4.158-75, resistance to a constant flow of air in accordance with GOST 10188-74, factors of penetration of microgrinding powder M-5 and an oil fog in accordance with GOST 12.4.156-75).

Results and Discussion

By original technologies three principally different CAM on a base of fruit stones carbon KAU and polymers of various structure were synthesized and investigated, namely: block (KAU-PVA, KAU-PVC, KAU-PU), elastic foamy (KAU-FPU) and immobilized (KAU-NFM) ones.

By methods adsorption - weight analysis and mercury porosimetry it was investigated change in porous structure of CAM and it was established that action of polymers results, basically, to blocking system of transport pores of carbon (macro- and partially mesopores). Intervals of insignificant influence of polymers on adsorption parameters of active carbon in CAM were determined:

- In block composites the content of polymer up to 10% linearly reduced W_s and S_{sp}, and reduction of parameters proportionally to increase of contents of polymer in CAM;
- In elastic composites the content of polymer within 50-70% reduced parameters W_s and S_{sp} of carbon in a composite near 3-5%;
- Composites of immobilized type were characterized by almost full absence of influence of polymer on adsorption characteristics of carbon in a composite (reduction W_s and S_{sp} at any ratio carbon/polymer within the limits of 2-5 %).

It was investigated the kinetics of adsorption of modeling substance - methylene blue from water solutions on CAM of block and elastic types and were determined the diffusion characteristics of these materials as well as it was found a prolonged character of adsorption actions of composites; in comparison with initial carbon a corresponding decrease in factors of diffusion were on the average on 8-12%.

By standard methods it was carried out the estimation of operational characteristics of obtained CAM, and it was shown that these materials differed a high level of absorbing ability on VOC at much best physical mechanics parameters, than at an initial carbon adsorbent, namely - an increased durability, a low level of dust emission (in elastic - completely was absent) and insignificant resistance to a gas flow.

On basis of CAM of immobilized type it was developed and offered the simplest adsorption-filtering respirator for protection of breath of the person simultaneously from VOC vapors, toxic or poisonous gases, dust particles and aerosols of various structure, including radioactive (see Table). Such respirator can be considered as the cheap mini-gas mask of short-term action designed for mass use in extreme situations (failure, fires, acts of terrorism, etc.). The further improvement of characteristics of adsorption-filtering materials such as «active carbon - polymer» is possible and by updating carbon adsorbent (giving ion exchange, complexing, catalytic, antibacterial and other properties), and by updating a polymeric part (improvement aero- and hydrodynamic characteristics, giving complexing, bactericidal or fungicidal properties, etc.).

Table. Data of tests for respirators.

Parameter	Commercial respirator on a base of NFM	Experimental respirator on a base of KAU-NFM
Coefficient of penetration of microgrinding powder, % D = 0.28-0.34 mkm D = 2 mkm	 1.4 0.8	 1.4 0.8
Resistance to air flow at V = 30 L/min, mm H_2O	< 2	< 2
Protective action on benzene at 50 mg/m^3 (10 LC), h	8±1	absence
Protective action on radioactive ^{131}I, %	85±5	< 5

References

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