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ON AIR PERMEABILITY AND ABSORPTION OF CARBON FIBROUS MATERIALS FOR VENTILATION FILTERS FOR CLEANING UP EMISSIONS

Summary: The development of environmental protection technology is due not only to an increasing in the intensity of man-made pollution, but also in changing in the source of its protection criteria dictated by the revaluation of approaches to the use of fuel and raw materials. The most important environmental issues are the protection of air and water pollution from the excessive variety of industrial wastes.

1. Introduction

The development of environmental protection technology is due not only to an increasing in the intensity of man-made pollution, but also in changing in the source of its protection criteria dictated by the revaluation of approaches to the use of fuel and raw materials. The most important environmental issues are the protection of air and water pollution from the excessive variety of industrial wastes [1,2].

The light and other industries widely use various adhesives and paints as solvents, which use a variety of volatile hydrocarbons (benzene-acetone, ethyl acetate). Typically, these solvents evaporate into the environment, released by the ventilation systems into the atmosphere, polluting the environment. Thus, hundreds of tons of hydrocarbon vapors come in the atmosphere, that is, on the one hand permanently lost material values, on other - atmospheric pollution [3,7]. Thus, the emission of this air into the environment is disadvantageous both economically and from the environmental point of view.

The most effective method of any solvent vapor recovery from poor vapor-air mixtures is adsorption method [4].

Adsorption is the consuming of gases, vapors dissolved solids surface solids (adsorbents). In nature, there are a large number of substances, such as soot, SELIC gel, clay and so on, which have very porous surface which is able to absorb various gases and vapors. Thus, in order to develop is a search for the optimal treatment technology of ventilation emissions from the hydrocarbon vapors [5, 6, 8].

2. Proposed method

Research project aimed at the development of technology and equipment for vapor recovery of hydrocarbons from the exhaust air.

Adsorption-cryogenic cleaning method is proposed. The essence of the method is that contaminated air is cleaned of hydrocarbon vapor by adsorption to a concentration 10 times lower than the TLV. Wherein after regeneration of the adsorbent, air enriched with hydrocarbon vapor to a concentration significantly above the TLV / limitations emerges – this is explosive concentration. Calculations show that at these elevated concentrations can be condensed to 80% of hydrocarbon vapors upon refrigerating air to – 30^0 C. Given that in this case the amount of process air is reduced by more than 10 times, the cost of hydrocarbon vapor recovery abruptly reduced and heavily pay off the return of the solvent for reuse.

The technology is based on this principle of purification of the ventilation emissions of hydrocarbon vapors and experimental model of adsorption-cryogenic plant, which employed a two-step purification of air emissions. At the first step increases the concentration of contaminants. The second step is to made cryogenic purification of the reduced amount of air at elevated concentrations of contaminants.

Adsorption method of cleaning is used on the first step, the adsorption filter is made of carbon fiber cloth twill with good macro - and micro-porosity. Tissue is located in the channel of the duct in several layers to reduce the drag and increase the surface of the tissue.

It is important to examine not only mass-exchange and sorption properties of these materials, but also physical-mechanical. For determining of latter is used the determination method air permeability of the samples of carbon-fiber materials, using the device VPTM-2M (Fig. 1). The essence of the method is to measure the volume of the testing air passing through a given area of the studied material per unit of time at a certain point of discharge. For fabrics, controlled by each piece, spot samples taken across the width of the fabric length 16 cm from any place, but not from the end of it; other materials - length 30 cm or conduct experiments on point samples collected for the indicators characterizing physicomechanical properties. The selected sample point should not be wrinkled.

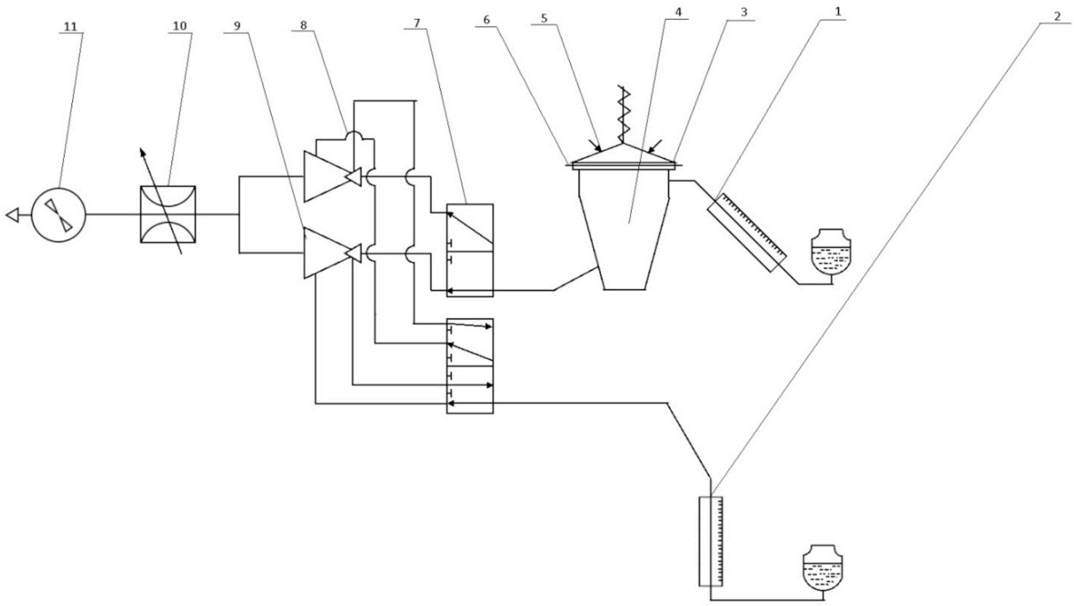

Fig. 1. Schematic diagram of the VPTM-2M device: 1 - charge indicator, 2 - differential pressure gauge, 3 - clamping ring, 4 - vacuum chamber, 5 - interchangeable table, 6 - test piece, 7 - switch venturis, 8, 9 - air flow (venturi), 10 – throttle, 11 - electric motor with a fan.

Device VPTM-2M, which provides a measure of the air permeability in the range of 205 to 10750 dm^3/m^2, the discharge for the sample point 49 Pa (5 mm of water.) and the force of pressing the sample point 147 N is subject to the technical parameters of the filtered tissue change. Allowed to change the parameters in the technical filter cloth.

The device consists of the following units: discharge indicator 1 (49 ± 0,1 Pa); differential pressure gauge 2 with a limit of measurement from 0 to 200 Pa accuracy class; flow of air (venturi) 8 and 9; throttle motor 10 and fan 11; a set of six replaceable tables 5 with openings, (in mm):

- 16,0 ± 0,05 for the area of the hole of the table 2 cm^2
- 25,3 ± 0,05 for the area of the hole of the table 5 cm^2
- 35,7 ± 0,05 for the area of the hole of the table 10 cm^2
- 50,5 ± 0,05 for the area of the hole of the table 20 cm^2
- 78,9 ± 0,05 for the area of the hole of the table 50 cm^2
- 112,9 ± 0,05 for the area of the hole of the table 100 cm^2

and the corresponding clamping rings 3.

Tests were conducted on tissues "Viskum" (TC-2, TCN 4) by carbon fiber material AUVM "Dnepr"; Karbopon; AUT-M; Busofit T-1; TCN5; TCN2. Spot samples of the test material 6 (Figure 1) should be laid on the table faced up, pressed to the table by the deck ring 3 until red warning light comes on. The electric fan 11 is activated automatically when the load on the test spot samples. The opening of the throttle 10 is mounted under the discharge breakdown point equal to 49 Pa, which is determined on a scale indicator discharge 1. On a scale of differential manometer 2 reckon result of the measurement with an accuracy of up to one scale interval. When the load is removed from the spot samples the fan motor 11 is automatically turned off. The purging of material samples on the device perform according to the scheme of Fig. 2.

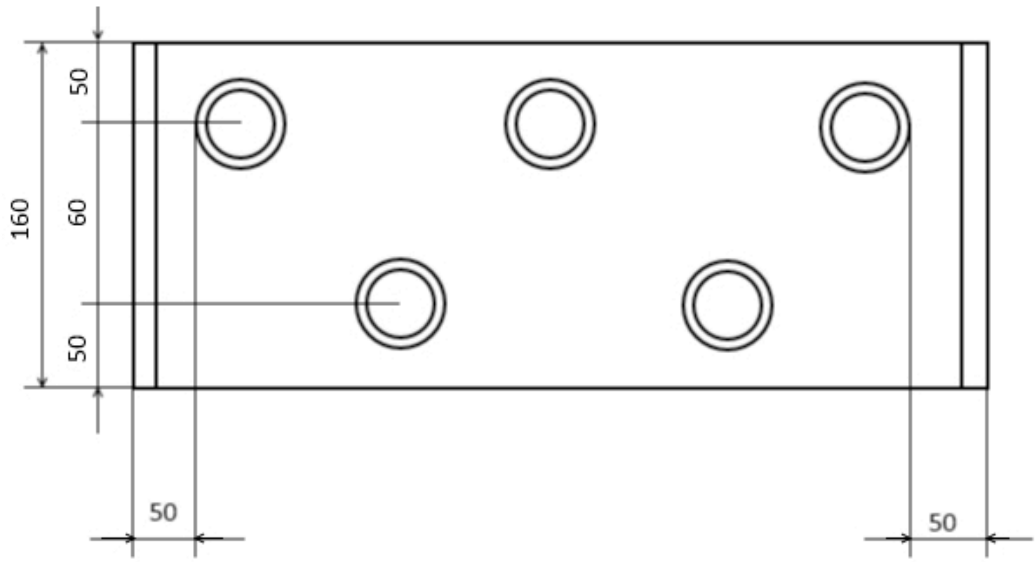

Fig. 2. Scheme of tissue sample purgin

Provide processing of the data received from the device VPTM-2M and fill in the comparative Table. 1.

The air permeability Q_r, (dm^3) of each sample point, a piece or article is given by equation:

$$Q_r = \frac{V_{av} \cdot 10000}{S}$$

where: V_{av} - the average flow rate on this sample point, dm^3/m^2, S - studied area, cm^2.

The average flow rate V_{av} of the sample point, a piece or the article is in the table that is presented to the device, the arithmetic mean of all the measurements of the differential pressure gauge (mm. Sp.st).

Table 1. Characteristic quantities of analysed objects

Plant group	Kind of plant	General characteristics of breathability	V_{av} (for 49 Pa)
I	AUVM "Dnipro" Karbopon	low	50-135
II	AUTM (knitwear) Busofit T-1 A-50%, Act-30%	below average	135-375
III	Double-layer meshes Busofit 5 TCN, TCN 3	average	375-1000
IV	Meshes (1 layer) Viskum TCN1, TCN2	high	> 1500

The result of calculations with an accuracy of up to 0,1 dm^3/m^2 is rounded up to 1.0 dm^3/m^2.

3. Conclusions

Experiments have shown that the lower air permeability under the same conditions, have a plain weave carbon fabric. (Karbopon: Q_r = 55 dm^3). With the increasing of the length of the overlap increases friability of tissue, respectively, increases breathability. Knitted material: Viskum, Busofit, TCN2 have superior breathability compared to other tissues, because coiled structure knitted fabric due to the presence of large open pores. With the increasing of the volume of mass of the carbon material and its thickness, air permeability decreases as decreasing the number of through pores and their dimensions, especially in dense-structure materials (Karbopon, AUVM). The air permeability of researched carbon materials ranges from 50 to 1750 dm^3.

During the researching is established that such carbon fibrous materials such as AUTM "Dnepr" Karbopon with relatively low air permeability have high sorption properties and can be used as air filters.

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O przepuszczalności i absorpcji włóknistych materiałów węglowych stosowanych w filtrach wentylacyjnych do zmniejszenia ich emisyjności