**Analysis of heat and air pressure resistance of non-woven fabrics for industrial applications, as well as the effect of ambient temperature**

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**Abstract.** The quality indicators for determining the heat resistance of filter cloth made from local raw materials are established in accordance with GOST standards, scientific research, and methodological principles. The reliability of the obtained results is ensured by the consistency of theoretical and experimental studies, positive results obtained during testing, approval and implementation, and comparative analysis. One of the key parameters characterizing filter cloth materials is the temperature difference between the outer and inner layers. During heat transfer through the filter cloth, heat loss occurs, the magnitude of which depends on the ambient temperature.

**INTRODUCTION**

The dust collection efficiency and service life of filter nonwoven fabrics largely depend on their structure, nonwoven density, thickness, and the composition of the fibers. The density of the filter nonwoven is characterized by the number of fibers per 10 cm. For sleeve filters, fabrics with high density, strength, dust collection coefficient, and pneumatic resistance during the filtration process, as well as low air permeability, are used [1].

The recovery and strength properties of woven filters largely depend on the type of weave. Usually, three types of weaving are used for filter fabrics: plain, twill, and satin.

Needle-punched nonwoven fabrics have relatively high density, high dust collection efficiency, but experience significant resistance during the regeneration process.

**EXPERIMENTAL RESEARCH**

The main feature is the requirements for the flammability of non-woven fabrics. Test methods are specified in the following fire safety standards:

GOST R 50810-95 Classification of decorative non-woven fabric materials based on the flammability test method [2].

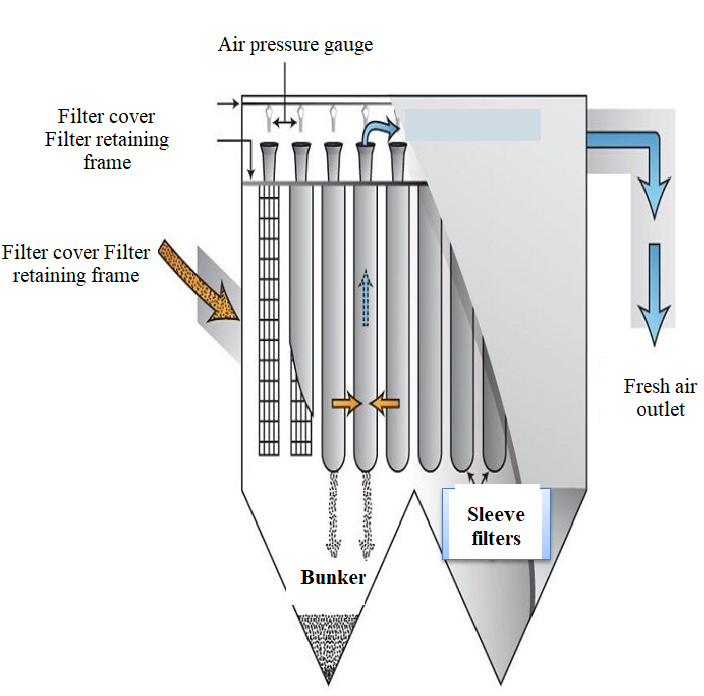
NPB 257-2002. This document regulates test methods for the flammability, burning, fire resistance, and residual burning of non-woven materials such as curtains, drapes, bed linens, and soft furniture upholstery.

Such tests consist of exposing selected tissue samples to a laboratory gas burner flame or the flame of a burning cigarette. The obtained results objectively show how well their fire-resistant coatings have been applied for fire protection [3].

Sleeve filters are among the simplest, yet effective and economical devices for mechanical air filtration. The design of the sleeve filter is a rectangular or cylindrical body (bunker) containing filter bags inside (see Figure 1). The supply air passes through a system of hoses with diameters ranging from 10 to 30 centimeters, which clean the air from the smallest pollutants.

Currently, non-woven materials made of fabric and 100% synthetic fibers are used in the production of filter sleeves:

* Polyester (PYeS).
* • Polyacrylonitrile (PAN).
* • Polyphenyl sulfide (PPS).
* • Meta-aramid (AR).
* • Polymide (P84).
* • Polytetrafluoroethylene (PTFYe).
* • **Glass fiber**.



**FIGURE 1*.*** Application of new filters.

The use of certain filterable materials for the production of sleeves is determined by the following indicators [63]:

* The presence or absence of impurities in the filtered air or gas;
* • The name of the filtered air or gas;
* • The presence or absence of aggressive chemical substances in the filtering material;
* • The size and shape of the particles being filtered;
* • The presence of static electricity;
* • The type of filter used.
* The resistance of the coating decreases with prolonged exposure to heat and high absolute humidity, and the fibers tend to rub against each other [4]. Especially if the sleeves are poorly installed (hanging), and if the gas valves are not synchronously and smoothly shut off to supply clean and contaminated gases, strong friction is observed.

Sleeves are usually hung on flexible springs; strong impacts that cause mechanical effects and bending deformation on the fabric should not be complete. To protect against static electricity and increase resistance to bending deformations, graphite is applied to fibers (in colloidal form); at the same time, the service life of fabrics at high temperatures is significantly extended. Coating filters with a Teflon film (from emulsion) also significantly increases the durability of nonwovens. To increase the air permeability of nonwovens while maintaining strength, yarns for nonwoven fabrics are made from staple fibers [5]. In industry, several types of ready-made glass fabrics differing in air permeability, weight, and strength are produced. Fabrics are used in cement, metallurgy, and other enterprises and are actively used in obtaining fine cement dust, sublimates of non-ferrous and rare metals, and in the production of phosphate fertilizers.

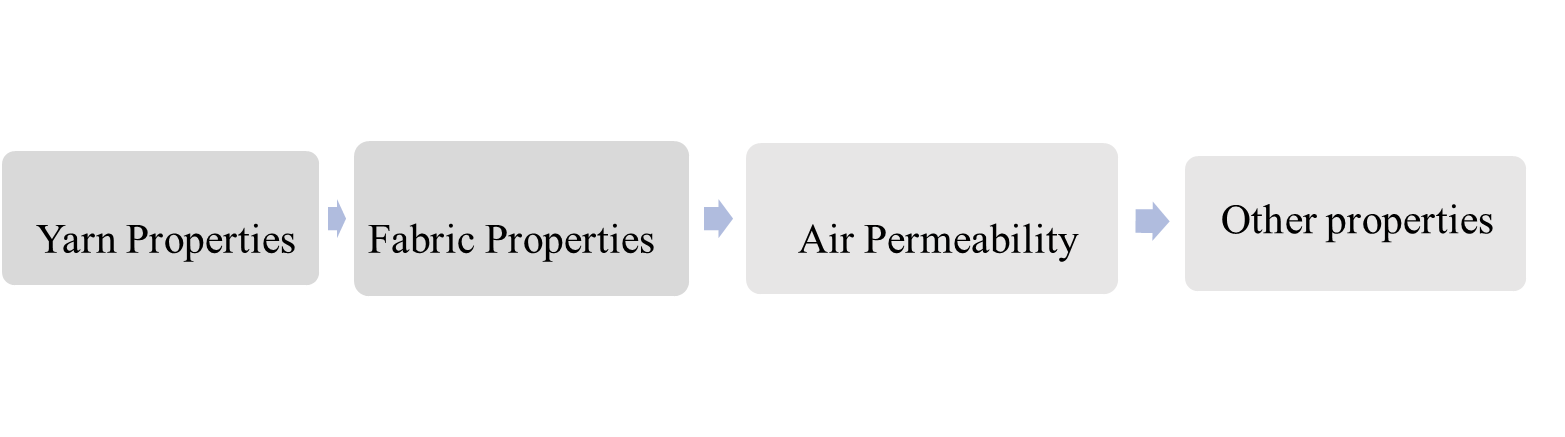
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| D:\ДАРСЛАР\MTICH 2022\Prezintatsiya\2-Mavzu\tkan-vozdushnyh-filt.jpg  а) | б) |

**FIGURE 2.** Heat-resistant nonwoven filters and fabrics. a) filter tissue, b) Industrial filter fabric

The main physical and mechanical properties of filter fabrics made from natural and synthetic fibers used in industry are shown in the first table below[6].

**ESEARCH RESULTS**

The amount of sediment that can be retained without reducing the filtering properties of the fabric depends on the diameter and number of holes, and the diameter of the holes directly affects the air permeability of the filter fabric (Figure 3).



**FIGURE 3.** Factors affecting to filterable fabrics

The strength and filtration properties of a certain nonwoven fabric largely depend on additional processing stages (thermofixation, calendering, antistatic treatment, hydrophobization, increasing friction and bending resistance, and others) [9].

Heat-resistant materials are produced under various brand names: Kevlar, Trevira, Tarpaulin, Oxford, Tomboy, and others. They are divided into the following groups:

One of the pressing issues facing textile enterprises today is the production of technical fabrics. Heat-resistant filter-type technical nonwoven fabrics are imported from abroad. Chemical fibers (glass fiber, carbon fiber, aramid, polyester, polyamide) are used to produce these nonwoven fabrics, and such yarns are not produced in our republic. Nonwoven fabrics made from basalt and wool fibers, which are local raw materials, can replace these in terms of heat resistance and physical-mechanical properties.

Heat-resistant textile materials and products made from these fibers [10] are widely used in various products:

• filter fabrics for high-temperature gases;

• special protective clothing;

• professional safety and rescue equipment;

• special textiles for air, automotive transport, and hazardous buildings;

• friction composites (used in brake pads instead of asbestos).

The change in the parameter value, the change in the function of elongation along the width of the woven fabric , is given in Table 1. Here, Ye=YeN is also determined by the indicator[11].

As can be seen from Table 1, an increase in the amount of wool in the nonwoven fabric structure leads to an increase in the deformation modulus at the moment of tearing. In all samples of the nonwoven fabric and in the indicators of the parameters, it remains approximately the same within the range of experiments [12].

The results presented in Table 1 show that the filter cloth exhibits high stiffness in the widthwise stretching of nonwoven fabrics and undergoes nonlinear shear deformation throughout the entire deformation process.

As can be seen from the above results, the correlations obtained in the experimental diagrams more accurately reflect the deformation stages of the filter fabric.

**TABLE 1.** Values of the deformation modulus at various stages of deformation in the stretching of filter nonwoven fabric along its width and length

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Deformation parameters and their indicators** | **Nonwoven fabric samples** | | | |
| №1 | №2 | №3 |
|  | 490,0 | 220,0 | 340,0 |
|  | 30,0 | 16,0 | 13,0 |
|  | 4,0 | 1,8 | 3,8 |
|  | 180,0 | 320,0 | 370,0 |
|  | 28,0 | 27,5 | 31,0 |

It should be emphasized that the proposed method for identifying and evaluating the shear, shear-plastic, and cohesion stages of deformation is an effective and visual method for studying the state and mechanical properties of the deformation of woven fabrics.

However, experimental methods for determining the mechanical properties of filter nonwoven fabrics require more time and costs. This situation, based on the above results, necessitates the development of a theoretical method for evaluating the mechanical properties of filter nonwoven fabric[13].

The simplest law of deformation of materials is Hooke's law. Hooke's law is the most widely used in all fields of mechanics. For our case, it has the following form

 and  (1)

length of the pipe, mm; the yield strength, mPa (N/mm2); the cross-sectional area of the pipe, mm2; the bursting pressure, N; and the normal pressure, N/mm2.

Hooke's law can be applied when the deformation process of the material is completely reversible, i.e., the process is elastic. Moreover, Hooke's law does not take into account temporary effects, i.e., the viscoelastic properties of the material (creep and relaxation). [4]

Compared to the Kelvin-Foyt and Maxwell models, the Airy model is more modern and has the following form

 (2)

 (3)

here the static viscosity modulus, dynamic viscosity modulus; volumetric parameter of viscosity; volumetric coefficient of viscosity15].

Model (2) is known by the standard linear viscoelastic body name.

Here, the modulus of viscosity and, in a broad sense, are used and they are called the deformation modulus for the entire stretching process.

In this case, it must be determined from the relevant experiments. This requires a large amount of experimental work, so according to [16], at this stage, it is advisable to choose model (3) to describe the deformation process of the nonwoven material.

**CONCLUSIONS**

1. According to the cleaning property, depending on the intensity of the forces applied during filtration and the characteristics of the processed medium, it was determined that filter-appropriate fabrics undergo various degrees of stretching, compression, bending, friction, chemical, and thermal effects.

2. Air filters are one of the simplest, yet effective and economical devices for mechanical air filtration.

3. The main characteristics of the structure of non-woven fabrics designed for filtering liquids and gases are porosity, pore diameter and their size redistribution, and the absolute number of pores.

4. It is recommended to use fabrics made from basalt fiber yarns, which are considered local raw materials in terms of heat resistance and physical-mechanical properties, as sleeve filters.

5. From the experimental diagrams of the stretching of non-woven fabric, the change in the deformation modulus of the non-woven fabric was determined based on the changes in the strain indicators of the fabric's width and length during stretching. It was found that the change in the deformation modulus depending on the value of the strain is mainly nonlinear.

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