Obtaining filter material from natural fiber composition and areas of its use

Y. Ergashev1,2*, E. Egamberdiev1, S. Turabdzhyanov1, G. Akmalova2, R. Isanova1, R. Rashidov1, and O. Sobitov1

1Tashkent State Technical University named after Islam Karimov, 100095 Tashkent, Uzbekistan
2Tashkent chemical technological institute, 100011 Tashkent, Uzbekistan

Abstract. For all types of paper and paper products, we must take into account mechanical strength, the use of paper sheet and its processing or non-processing. Taking into account the above points, knowing its relevance and the requirements for the obtained product, we devoted our experiments to the study of the influence of the composition of the composition on the obtaining of filtering materials and its quality. The demand for paper and paper products is increasing today. Further increase of types of paper and production of competitive, import-substituting export products are considered urgent issues. The main components of paper composite materials are reinforcing fiber fillers, binders and reinforcing additives. Filtration materials were obtained from the composition of fibers containing cellulose and the processes of its extraction were analyzed. The results of the study of the effect of the composite composition and the method of obtaining the filter material on its filtering properties and main indicators are presented.

1 Introduction

The demand for paper and paper products is increasing today. Further increase of types of paper and production of competitive, import-substituting export products are considered urgent issues [1, 2]. The main components of paper composite materials are reinforcing fiber fillers, binders and reinforcing additives. Depending on the purpose of using paper composite materials, the components added to it are selected and the necessary requirements are set. In order to achieve the specified target properties, in all cases it is required to organize a multi-component system and select the appropriate technology [3-5]. It is promising to create materials that meet the purpose of cleaning gases from small aerosol particles and work in high temperature and aggressive environments. In this case, if the solution to the technological problem is successful and it is possible to obtain a material with a constant level of strength properties, mineral fibers provide the necessary operational properties [6-8].

As a result, several effective tools for air purification from submicron aerosols are fiber filters, which are widely used in the industrial purification of gases from radioactive, toxic...
and bacterial aerosols, as personal protective equipment for respiratory organs, as well as in technological gases and in the analysis of aerosols in the atmosphere [9, 10]. We are looking at the possibilities of creating materials such as paper for this purpose. They must work for a long time at high temperatures, show high stability to chemical (acid and alkali) effects [11].

The filtering surface is necessary not only for the filter material to have a sufficient retention capacity according to the dispersed phase ratio according to its function, small hydraulic resistance during filtration, mechanical strength and stability in an aggressive environment, a long service life due to stability, minimal contact with sediments due to adhesion, but also to retain it during organization [5-6, 10-13]. It is necessary to provide adequate protection for the complete absorption of sediment, stability against pore clogging and easy cleaning (permeability regeneration), convenience and quick replacement in the sense of easy connection to the filter supports, and cheapness [14].

Creating or producing a filter material that can meet all the above requirements is a very difficult task. The created filter is limited to satisfying one or two requirements for the material according to its purpose and function [12-14]. For all types of paper and paper products, we must take into account mechanical strength, the use of paper sheet and its processing or non-processing. Taking into account the above points, knowing its relevance and the requirements for the obtained product, we devoted our experiments to the study of the influence of the composition of the copposition on the obtaining of filtering materials and its quality. We decided to take the initial experiment only on the basis of plant cellulose, and the results did not come out as we expected [4-5, 7]. Experiments were conducted using one- and two-layer forming methods of filter paper. Based on the obtained results, it can be concluded that the filter paper made by the two-layer forming method based on plant fibers has almost no advantages compared to the filter paper made by the single-layer forming method [1-6]. Based on our theoretical knowledge that the factors affecting them depend on the nature of mineral fibers and the amount added to the composition, we carried out our next experiments. In our experiments, we decided to use basalt fiber, which is considered an inorganic fiber.

2 Material and Methods

In this research, heliánthus tuberósus cellulose, basalt fiber, cotton wool cellulose and fillers were taken as research objects. Heliánthus tuberósus cellulose and cotton wool cellulose, as well as basalt fibers were used to ensure mechanical strength at the fiber level in the preparation of filter materials [1-3, 9]. Basalt fibers have a negative electrokinetic potential in water. This indicator has a maximum position in pH7 in terms of the absolute value of its magnitude [2]. Therefore, the dispersion of basalt fibers is carried out in a neutral environment and is considered one of the advantages[4]. The obtained results are shown graphically in Figures 1-5, with the exception of the coefficient of permeability.

3 Results and Discussion

According to the results, for composites made from a mixture of cotton wool cellulose and Heliánthus tuberósus cellulose, double-layer formation (formalin) leads to poor results, compared to single-layer; compared to the two-layer formation of filter materials made of Heliánthus tuberósus cellulose and basalt fibers gave good results (Fig. 1-5).
1 – $\sigma_p$, kPa; 2 – $P$, mm water column. 

**Fig. 1.** Effect of compositions on the quality of double-layer filtering material.

1 – $\sigma_p$, kPa; 2 – $P$, mm water column. 

**Fig. 2.** Effect of fiber composition on the quality of the filter material.

1 – $\sigma_p$, kPa; 2 – $P$, mm water column. 

**Fig. 3.** Effect of fiber composition on the quality of the filter material.
The stability of the 2-layer material containing cotton fluff is weaker compared to the one-layer one, in which Heliánthus tuberósus cellulose has a greater difference in compositions with $d_v = 0.25 \mu m$ (compared to Heliánthus tuberósus cellulose compositions with a size of $d_v = 0.75 \mu m$). In two-layer and one-layer formation, these two indicators are almost the same.

Only filter materials composed of Heliánthus tuberósus cellulose with $d_v = 0.25$ and $0.75 \mu m$ are less sensitive to changes in the shaping method. The resistance to air flow and the coefficient of permeability of single-layer and double-layer samples differ little from each other, and the existing differences are almost insignificant. A relatively clear dependence on the method of formation is determined in the analysis of stability. In the samples containing less than 25% Heliánthus tuberósus cellulose with $d_v = 0.75 \mu m$, the stability in two-layer formation is relatively low, this stability does not depend on the method of forming the paper quality sheet. The bilayer formation stability is relatively stronger when the sample contains 75% Heliánthus tuberósus cellulose with $d_v = 0.75 \mu m$. 

**Fig. 4.** Effect of fiber composition on the quality of the filter material.

**Fig. 5.** Effect of fiber composition on the quality of the filter material.
It can be said that the relationship between stability in one- and two-layer formation and Heliánthus tuberósus cellulose compositions with \( d_v = 0.7 \) μm is the same: stability increases with an increase in the percentage of these fibers, but in two-layer formation, the increase in stability takes place intensively.

Filter materials formed by the double-layer method containing s have more advantages. Double-layer filter materials consisting of basalt and Heliánthus tuberosus cellulose with a diameter of 0.25 μm have higher stability (compared to single-layer) in all studied ratios. But due to the decrease in the percentage of basalt fibers in the compositions, the stability decreases.

The same pattern is observed in compositions consisting of a mixture of basalt and Heliánthus tuberosus cellulose with a diameter of 0.75 μm. The stability of the double-layer filter material, which consists of a mixture of cotton wool and basalt fibers, is 1.5-2.0 times higher than that of a single layer. But in this case, the decrease in the percentage of basalt fibers leads to an increase in stability.

In other compositions containing basalt fiber, there is no clear relationship between the aerodynamic resistance of the filter material and the method of its formation. In general, the aerodynamic resistance in two-layer samples is relatively high, but this difference is not so great - 10 mm H\(_2\)O equal to out.

The advantages of the transmission coefficient of the filter material prepared by the two-layer forming method, consisting of a mixture of basalt and Heliánthus tuberosus cellulose with sample \( d_v = 0.25 \) μm, are of some importance. In two-layer materials of the given composition, the conductivity coefficient is 3 times less (compared to one-layer). In both cases (3:1 and 1:1 ratio of basalt and topinambur cellulose), the permeability coefficient does not exceed the coefficient required for light air cleaning materials.

In other compositions containing basalt fibers, two-layered samples also have a small coefficient of permeability. But their difference is relatively low - no more than 65 times, and the specified minimum value - 0.0113% is a very large value for filter materials for light cleaning of gas air environment [5].

In double-layer molding, two samples (casting) are joined together with their outer layers, and in this case, a layer saturated with defective parts is formed between the material, which is not observed in single-layer molding.

Heliánthus tuberosus pulp does not contain strong fibers. Therefore, in the composition of pure Heliánthus tuberosus cellulose, a certain degree of structural change is not observed, and double-layered materials differ little from single-layered materials in terms of quality indicators.

Basalt fibers contain less strong fibers than cotton wool cellulose. But there are small amounts of foreign substances (or impurities) associated with normal fibers of different shapes and sizes. When preparing the mass, these substances do not separate from the fibers and pass into the cast. Therefore, in the double-layer formation of materials containing basalt fiber, there are situations similar to the production of double-layer paper based on plant fiber: almost rare defective parts of one layer are covered by normal parts of the next part. The structure of double-layer materials is uniform, and the quality indicators are higher than those of single-layer materials.

Changes in the quality indicators of two- and one-layer filter materials with different compositions depend on the chemical and physical-chemical properties of mineral fibers. For example, the amount and ability of functional groups whose complexes are susceptible to exposure, the magnitude and sign of the coordination electrokinetic potential on the surface with aluminum polyhydroxide, the relative surface area of fibers, etc. But these factors are not very important in the current situation.
4 Conclusions

In conclusion, it can be said that in a number of cases, the transition of the material from one-layer to two-layer formation makes it possible to expand the range of properties of filter materials based on mineral fibers. First of all, the two-layer method of forming is recommended for materials containing basalt fibers.

But with this method, it would not be possible to obtain a filter material suitable for light gas-air cleaning. It is recommended to use filter materials with basalt fiber in individual cleaning filters for cleaning and sterilizing process air.

References