

PROTECTIVE FACTORS OF TEXTILE MATERIALS FOR SPECIAL DESIGNATION CLOTHES

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Summary. The work is focused on standard methods, means and equipment now used for studying protective factors of textile materials in the process of development and serial production of special designation clothes when carrying out works with such corrosive media as mineral acids with various concentration, alkali and salt solutions on their base.

Key words. Chemical resistance, corrosive media, permeability, evaluation, method, sample.

INTRODUCTION

Protective properties of the textile materials designated for clothes production should be defined depending on their functional purpose, corresponding normative documents (standards, means) or should meet the customer's requirements. Thus if one has in mind special clothes for protecting the workers from the effect of such corrosive media as mineral acids, alkali and salt solutions on their base then protective properties of the textile materials, mainly woven, used for its production should be studied with control of chemical durability (chemical resistance) of the samples and reagent permeability through their thickness.

RESEARCH OBJECT

Subject of research is protective properties of the textile materials of special designation clothes when carrying out works with corrosive media.

When studying chemical resistance of woven materials according to the requirements of GOST 16166-80 [GOST 16166-80] material samples are treated during one hour in contact bath consisting of 50%, 80% or 93% solutions of sulfuric acid i.e. with the concentration from which it is necessary to develop acid-protective costume. Liquor ratio should be 1:40.

After this material samples are washed with water up to neutral reaction, dried and researched for changes in breaking loads using dynamometer device, e.g. PT-250 M. If values of the stated characteristics have reduced but not more than by 15% from the initial ones then the textile material is considered to be chemically resistive to effect of acid of the given concentration.

Similar means of chemical resistance study of the textile materials are recommended by GOST 11209-85 [GOST 11209-85] and OST 17-345-85 [OST 17-345-85] but one have to take into account that besides sulfuric acid hydrochloric, nitric, hydrofluoric acid of different concentrations are used or produced in various industries as well as solutions of salts of acid character on their basis then it is evident that mentioned normative documents connected with the study of chemical resistance of textile materials for the special clothes do not meet requirements of the enterprises and this complicates development process of new competitive materials and their grounded selection out of existing range.

RESULTS OF EXPERIMENTAL RESEARCH

Analysis of the available literary sources testifies that the European normative documents or documents of other states in relation to the study of chemical resistance of the textile materials in the process of the effect from the mentioned corrosive media including potassium and sodium hydroxides as well solutions of salts on their base are also lacking.

As it was mentioned above the second but not less important factor when studying protective properties of the textile materials used for production of special clothes for protection from effect of corrosive media it is necessary to account their permeability in relation to gas, liquid or gas-liquid phase that can be in the form of volume, drop or aerosol.

According to classical interpretation of the permeability and its physical essence it is the property of the material to let reagents pass through its thickness if there are gradients of pressure, concentration and temperature. Mechanism of permeability is multi factor function and diffusion and phase theories are used to characterize and define them.

In the first case namely diffusion permeability is linked with the absence of micropores and cracks by material thickness and presence of gradients of pressure, temperature and concentration of doping agent and diffusion process are described by Fick's equation. According to known dependences diffusion permeability is evaluated by diffusion factor that in practice is defined by graphic means according to Deiness-Barerra's method.

As to relative permeability it is grounded by material structure defectiveness by thickness i.e. presence of micro-, micropores and cracks and thus its mechanism is considered as drain of corrosive medium from openings of the sample under research.

It is necessary to note that evaluation criteria when defining diffusion factor (diffusion permeability) is m^2/sec , of the relative permeability - $\text{dm}^3/\text{m}^2\cdot\text{sec}$. It leads to complexity during experiments. Thus when one takes into consideration that textile materials used for protective special clothes production must protect from effect of

corrosive media during defined period stated in normative document then it is logical that the criterion for their evaluation should be time needed for dopant drop or its traces to pass through sample thickness. As to the volume of the corrosive medium its permeability through such porous system as woven textile material has not been studied.

Conditions for carrying out research of permeability of special materials for protective clothes are described in the standards [GOST 16166-80, GOST 11209-85, OST 17-345-85].

The main point of the evaluation method of sample permeability with sulfuric acid solutions of 50%, 80% and 93% concentration is in that round shaped material is located on the special support with face surface up on which drops of one of the indicated corrosive media are put in five points. Control of the permeability should be for 20 minutes. If in 20 minutes none of the drops permeates to the sample back side then the material is thought to be suitable for production of the special clothes for protection from the given concentration [GOST 16166-80].

As to other mineral acids, alkali and salt solutions on their basis there is no information in the mentioned standard.

According to the conditions foreseen by the standard [GOST 11209-85] study of the textile materials permeability is carried out in relation to the effect of 20% sulfuric acid.

The essence of the method lies in the fact that dashed drops of the corrosive liquid should not permeate through the material thickness but already after 6 hours. Similar to the first case there is no information about possibility to carry out research of permeability in relation to other corrosive media. It is necessary to mention that analyzed normative acts have general imperfection namely – control of the moment of permeability of the drop of corrosive liquid or its trace is not carried out that would be important from the point of view of protection from effect and visual monitoring after elapse of the given time is low informative and doesn't provide the opportunity for improvement of the existing range of textile materials or new developments. Also it is necessary to note as the disadvantage of impossibility to carry our experiments with sulfuric, nitric and other light acids and solutions of salts on their basis as the used equipment doesn't provide for the technical opportunity to carry out mentioned works.

If one analyses conditions for carrying out research indicated in the normative document [OST 17-345-85] permeability of sulfuric and hydrochloric acid is studied with their help. Control of the drop or its traces permeability is carried out with the device that is especially important for sulfuric acid. As to research of hydrochloric (so to say light acid) permeability, the use of the mentioned equipment is not expedient due to oxidation of sensitive element with its vapors that leads to incorrect results.

To study textile materials permeability against effect of 100% alkali GOST 12.4.135-84 [GOST 12.4.135-84] is applied. Its main point is in control of time during which solution of potassium or natrium hydroxide permeates through sample thickness of woven and non-woven materials under effect of hydrostatic pressure of 687 ± 7 Pa. If to remember that mentioned materials have porous structure than it is practically impossible to ground expedience for study of their permeability under pressure.

Method for defining material resistance against liquid penetration (EN 368:1992, IDT) is described in DSTU EN 368:2002 [DSTU EN 368:2002]. The main point of the method is that liquid chemical substance with the volume of 10 cm^3 is supplied on the

surface of the special material under researched in the form of continuous flow or drops with injection needle during 4 or 10 secs. Before this the same size filter paper preliminary weighted on the scale together with transparent film is placed under sample back side. Thus made package is put into trough with 45° slope when the test is made, measuring glass is located in its bottom edge.

In 60 secs after the start of the experiment the filter paper and transparent film is weighted again and the number of milliliters of corrosive liquid that flew within this time by trough is measured with measuring glass.

Ratio of the mass of the liquid chemical substance settled on the filter paper and film to the mass of chemical substance effected the sample and this is for the volume of 10 cm^3 , is an evaluation criterion of its permeability or as defined in the standard – permeability factor.

Ratio of the mass of liquid chemical substance collected in measuring glass to output mass (10 cm^3) is non-permeability factor.

Disadvantage of this method is that independently on the nature of the liquid substance, concentration and as a consequence mass, its quantity applied on the material sample is equal i.e. 10 cm^3 , that determines researches under different conditions as reagent pressure per area unit will depend on the mentioned physical and chemical factors. Besides filter paper in case of determining permeability factor in relation to mineral acids will be damaged (process of hydrolysis) changing its initial mass depending on reagent concentration that will lead to inaccuracy during weighing. If the chemical substance is volatile, e.g. hydrochloric or nitric acids, then experiment is practically impossible as their gas phase, whose diffusion process precedes liquid phase, will not be fixed with recommended gravimetric method.

Besides this there is another method for determination of material permeability in corrosive media (GOST 12.4.218-2002, ITD) described in DSTU GOST 12.4.218:2004 [DSTU GOST 12.4.218:2004].

According to the conditions the round shaped sample material is fixed with wash and pressure nut in the glass with face side up and filter paper is put under its back side and placed on the cassette of ring electrodes connected to teraohmmeter and teraohmmeter in its turn is connected to potentiometer of KCP-4 type.

If material permeability is defined in relation to corrosive liquid in the form of drops (not less than three drops in different places on the sample area) or volume then this should be foreseen in the normative document for the material. When corrosive liquid or its vapors permeate through sample thickness they contact with filter paper and thanks to this the values of its relative surface electric resistance in comparison to output value changes and this is fixed with refraction point of potentiometric curve on the potentiometer tape.

If to analyze this method then one of the disadvantages is insufficient accuracy of defining the moment of penetration of the corrosive liquid and if one takes into account its vapors than it will be almost impossible to make research because of lack of sensitivity.

The reason for that is the cassette of ring electrodes designated for measuring the total sample surface and it should be tight pressed to it with the force of 150kPa in case of research of the material with polymeric surface or with the force of 280 kPa when artificial knitted fur is under study but there are no such conditions in this method.

Moreover for filter paper to perform its role of indicator of the penetration moment it should be immediately moistened by dopant permeated through material thickness. This condition is necessary for teraohmmeter to fix change of the value of the surface electric resistance of the filter paper compared to its initial data on the tape of KCP-4. Above mentioned disadvantages are also shown in local penetration and when studying diffusion processes of volatile corrosive media.

SUMMARY

Thus carried out analysis of the methods testifies for the presence of the immediate problem concerning the research of the protective properties of the textile materials used in production of special clothes.

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ЗАЩИТНЫЕ ПОКАЗАТЕЛИ ТЕКСТИЛЬНЫХ МАТЕРИАЛОВ ОДЕЖДЫ СПЕЦИАЛЬНОГО НАЗНАЧЕНИЯ

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Аннотация. В работе рассмотрены стандартные методики, способы и оборудование, используемое в настоящее время для изучения защитных показателей текстильных материалов в процессе разработки и серийного выпуска одежды специального назначения при проведении работ в агрессивных средах, таких как кислоты разных консистенций, щелочей и растворов на их основе.

Ключевые слова: агрессивная среда, проницаемость, текстильные материалы, оценка, метод, проба.