

Results Of Research On Fire-Technical Indications Determination Of Fire Resistant Textile Materials

N. V. Medentsev¹ and M.R.Doschanov²

¹First deputy chief of the research institute of fire safety and emergencies of the MES

²Head of the Academy department of the MES of the Republic of Uzbekistan



Abstract – In this article it is described the composition properties of the new synthesis on the basis of collagen based textile materials, the fire-technical classifications of the new recommended fireproof clothes and the results of the experimental tests.

Keywords – Fire, Burning, Smoke, Textile Materials, Collagen, Composite Compounds, Fireproof Clothes.

I. INTRODUCTION

The textile industry in Uzbekistan is developing day by day. Modern enterprises are being built on the basis of the special attention of the head of our state and the adopted state programs. Nevertheless, the production of high-demand special clothing and flammable fabrics for services designed to perform specific tasks remains a pressing issue. The demand for fabrics for special protective clothing in the world market is growing year by year. In 2010, this figure increased by 15%, while in 2012 the figure was 22%. Currently, the demand for flammable fabrics in the world market is 5,000 tons per year. In this new technology era, new biotechnology, nanotechnology, artificial intelligence, new technologies have been discovered in every field, as well as in the textile industry[1].

As a result of our research, other foreign research works in this area have been studied in detail. Scientific research aimed at the development of techniques and technologies for the production of flammable fabrics in the textile and light industry, the expansion of the range of such fabrics, comprehensive research to improve quality indicators, the world's leading research centers and higher education institutions, held at the All-Russian Academy of Fire Service, St. Petersburg State Fire University, IPNK NAS of Belarus (Белоруссия), Kazan National Research Technological University (Russia), Goman P.N. (Republic of Belarus), Oerlikon Barmag (Germany), National Institute of Materials and Chemical Research (Japan), Beijing Institute of Technology (China), Polymer Research Institute (USA), National Institute of Technology (India), Institute of Applied Chemistry of the Chinese Academy of Sciences, Chanchun (China), National Institute of Pharmaceutical Education and Research (India), Institute of Green Chemical Engineering (China), Zhongkai University of Agriculture and Engineering Guangzhou (China), University of Melbourne (Australia), Indian Institute of Technology (India) [2].

II. METHOD AND MATERIAL

One of the main components of the composition for the flame retardant treatment of textile materials has been identified by scientists Francis Creek, Linus Pauling, Alexander Rich, Ada Jonat, Helen Berman, Wallace D.G., Holmes D.F., Graham H.K on the composition and application of collagen. Tang K., Wang F., Iia P., Liu J., Wang K, Berkhaut X.Y., Garcia Del Rio X.R. developed methods of degreasing and drying animal skins, Poluboyarov V.A., Voloskovaya E.V., Yankovoya V.V., Guryanova

T.I. proposed a method of mechanochemical separation of collagen. Research on the production of welded copolymers of synthetic polymer monomers with cellulose has been carried out by Wang Li Li, Hong Kyung Hwan, Yan Lifeng, Ishihara Kazuhiko, Cheng Qian, Eromosele I.C., Eromosele C.O., Teramoto Y., Thakur V.K. and other researchers.

Research on the synthesis and determination of properties of welded copolymers of natural polymers in Uzbekistan is carried out in the scientific schools of M.Askarov, A.Magrupov, S.Sh.Rashidova and scientists of the Chemical technology institute, National university of Uzbekistan, Tashkent institute of textile and light industry.

The creation of highly effective compositions for fire protection of textile materials, scientific solutions to theoretical and practical problems in the production of flammable textile materials, the development of modern methods of testing materials are a number of scientists: Baratov A.N., Konstantinova N.I., Molchadskiy I.S., Zubkova N.S., Perepelkin K.E., Kozinda Z.Yu., Gorbacheva I.N., Bolodyan G.I., Brenda J., Traek, John V., Vorater Monty, Konkin A.A., Edward D. Well, Elizabeth Ranuchchi and others in their studies.

A number of researches were carried out by A.T. Djalilov, I.I. Ismailov, A.S. Maksumova, E.Abdurahmanov, M.Kh.Usmanov and other researchers on synthesis, determination of properties, application in textile materials of inorganic and organic antipyretics containing nitrogen, phosphorus, halogen, boron, silicon in Uzbekistan [3].

III. CONCLUSIONS AND DISCUSSIONS

Obtaining flammable, waterproof fabrics based on 3-D technology and protective clothing with self-cleaning properties of the obtained fabrics are entering the world markets. All offered flammable textile fabrics must meet the requirements for non-flammable and non-flammable substances, such as fire time, flammability value, moderate flammability, toxicity and flammability, regardless of the field in which they are used [4].

During our research, we conducted experiments on the basis of samples of some materials imported from foreign countries. As an example, here are examples of materials produced by the Russian company "Favorit-textile", which are recommended as high temperature, humidity, fire-resistant and waterproof fabric.



In accordance with ISO 9001:2008, ISO 14001:2004 OHSAS-18001: 2007 requirements, materials sample entering the country caught fire during the experimental process and continued to burn even after the end of the fire. Tests on the "Determination of smoke formation coefficient" and "Determining the rate of flame spread" devices showed that the sample was completely burned to ashes and that the flame spread at a high rate.



Samples of refractory fabrics from Tashkent markets

In recent years, a number of materials and fabrics made of various chemical, natural synthetic fibers have been produced to create flammable materials: polyamide (polyaramid), polyester, polyacrylonitrile, etc.

However, test results of imported and domestic materials and fabrics show that they typically protect against heat flux at a density not exceeding 5 kW/m^2 , with a exposure time of approximately 4 minutes.

However, the standard combat clothing of firefighters does not provide protection for the face and neck area, which in turn reduces the possibility of its effective use under the influence of strong heat. The heat effect can withstand a heat flux of no more than 0.56 kW/m^2 from long-term exposure to humans, and a heat flux of up to 1.12 kW/m^2 from short-term exposure[5].

In our country, firefighting uniforms are mainly imported from the Russian Federation and the Republic of Belarus. The average cost of firefighting uniforms for one firefighter is 223 (300) US dollars or 2.3 million soums.

Over the past period, it has become clear in firefighting practice that today, firefighters' combat clothing designed for firefighters has some shortcomings such as discomfort in its human body, water permeability, and relative heat transfer.

From this point of view, now, firefighters are comfortable in all respects, do not cause discomfort to the human body, waterproof, heat-retaining, beautiful appearance and, of course, equipped with new and modern tools for working in fire conditions, using innovative technologies, most importantly local raw materials using firefighters to create combat clothing.

To this end we, we are conducting research in creating flammable textile materials that can be used not only in the field of fire safety, but in all areas and the study of such materials and the analysis of their physicochemical properties and, if necessary, the development of methods of application of flammable textile materials treated with a new composition and to recommend it to relevant fields.



Re-tested samples

It is known that textile materials recommended as flammable fabrics change their properties over time. The main reason for this is that the flame retardants do not fully penetrate into the fabric, as well as the methods of increasing the fire resistance of the recommended flame retardants to textile materials have not been fully studied.

For the creation and use of flammable fabrics in Russia for the first time in 1995 SS R 50810-95 «Fire safety of textile materials. Decorative fabrics. Flammability test method and classification »has been developed and flammable fabrics must meet this standard[6].

In accordance with current SS requirements, samples must be retested after a long period of time and the performance must be compared in order for the fabric to have fire resistance or flammability properties. We also retested the samples taken after 2 years and concluded that the above parameters did not change and the fabric did not lose its properties.

Samples were cut to size 125x12x0.1 mm on request. The experiment was previously performed according to the A-method given by SS. In this case, when all samples (in the horizontal position) were tested for 30 seconds, the part of the sample that was in contact with the flame burned, and the fabric stopped igniting after the burner was removed.

According to the SS requirement, if the sample ceases to ignite when exposed to flame by means of a torch using an A-method, this experiment should be carried out according to the B-method.

Therefore, the fabrics were inspected according to the B-method (in the vertical position). The flame is applied to the bottom of the sample for 10 seconds. If the sample still does not burn, the sample will ignite again

It is affected for 10 seconds. If the sample burns, then its burning time and incubation time are measured.

In the later study stages, the exposure process to the fabric by changing the amount of components in the mixture was studied. When the specific properties of the components used to form the composition were studied, it was found that the coefficient of smoke formation was higher in acrylic emulsion. Based on the results, in the later stages of the experiment, a composition was prepared by increasing the amount of collagen and reducing the amount of acrylic emulsion.

Table 1 Fire protection composition of textile materials

Name of components	Content component share options, %				
	1	2	3	4	5
Acrylic emulsion	2	4	6	8	10
Boric acid	2,5	3	5	4	6
Collogen solution	16	18	22	30	32

Potassium persulfate	0,02	0,02	0,025	0,025	0,03
Water	89,48	74,98	68,975	64,975	58,97

IV. CONCLUSIONS AND RECOMMENDATIONS

In order to increase the flammability properties of the recommended fabric, as well as to reduce the smoke emission coefficient from the recommended fabric when exposed to flame, the results were obtained by completely immersing the recommended composition on the fabric surface (Table 2). The results showed that the sample began to ignite in 13 seconds and that the flammable fabric properties increased as the amount of collagen increased. After testing, the sample did not turn to ash, but it was observed that the fabric was crumbling due to the hand brittleness. This condition was thought to be due to the high amount of collagen. Based on the result, it is considered necessary to use a certain amount of replacement component of the acrylic emulsion in the process of bonding the fabric with the mixture.

The effects of several chemical components were studied and polyacrylamide was selected. Polyacrylamide is a non-toxic product, but when in contact, it can cause eye damage.

Table 2: Investigation of fire resistance properties of textile materials

Sample serial number	The exposure time of the flame to the sample, sec	Free burning time of the sample, sec	Burning time to the end of the sample, sec	Condensation time, sec	conclusion
1.	20	3	-	-	burned
2.	20	3	-	-	burned
3.	20	2	-	-	burned
4.	20	1	-	-	did not burn
5.	20	-	-	-	did not burn

The action scope of polyacrylamide on the textile fabric, which acts as a non-combustible barrier between air and material during combustion, was studied. To do this, the polyacrylic-amide in the composition was prepared in different concentrations and its effect on the flammability properties of the fabric was studied.

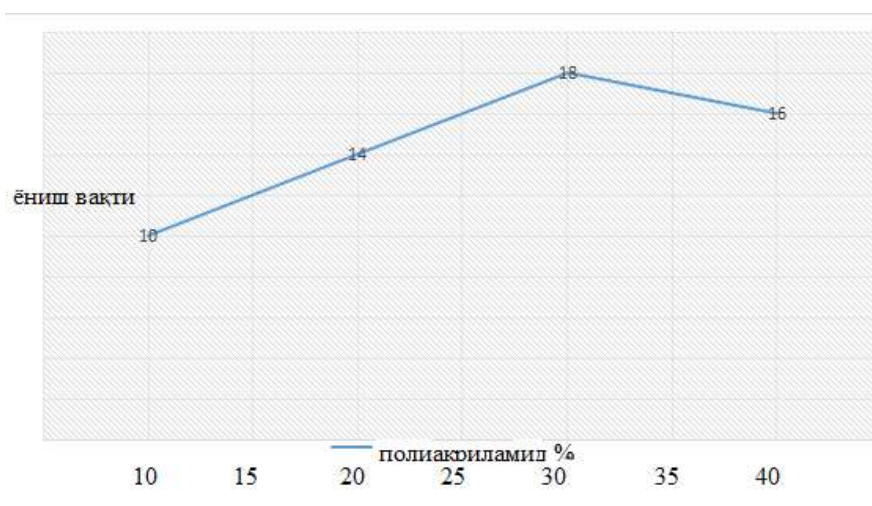


Figure. Binding effect of polyacrylamide prepared in different concentrations in collagen solution on the fabric flammability

The following composition of the composition with the polyacrylamide addition was determined.

Table 3 : Fire protection composition of textile materials

Name of components	Content component share options, %				
	1	2	3	4	5
Acrylic emulsion	2	4	6	8	10
Boratic acid	2,5	3	5	4	6
Collogen solution	20	25	30	35	40
Polyacrylamide	10	20	25	30	40
Potassium persulfate	0,02	0,02	0,025	0,025	0,03
Water	65,48	58,98	46,98	29,97	21,97

The sample bottom treated with the selected composition was exposed to flame for 10 s. As the sample did not burn, the sample was once again exposed to the flame for 10 s.

The following results were obtained during the inspection of the samples.

Table 4. Investigation of fire resistance properties of textile materials

№	Sample size, mm	Sample mass, m, g		Mass loss, %	Flame exposure time, s	Burning time, s	Note
		before	after				
1	2,8 x 10	2,35	2,1	11	10	-	smokes
2	2,8 x 10	2,4	2,2	8	10	-	did not burn
3	2,8 x 10	2,6	2,5	4	10	-	did not burn
4	2,8 x 10	2,75	2,6	5	10	-	did not burn
5	2,8 x 10	2,9	2,7	7	10	-	did not burn

When the sample was exposed to the flame, the sample began to ignite in 25 seconds. After testing, the sample did not turn to ash. No abrasion was observed even when the fabric was captured. Based on the results, the smoke formation coefficient of the sample was determined (Table 5) and the results were obtained.

On the basis of SS 12.1.044-89 "Combustion and explosion hazard of substances and materials" and Urban planning norms and rules 2.01.02-04 "Fire safety of buildings and structures" the coefficient of smoke formation of textile materials was determined the indicators and corresponds to the group of collagen-impregnated fabric T1 (had little grip) (has a low holding capacity when the value is less than 50). Based on the value, fire safety meets the requirements [7].

Table 5. Recommended smoke formation coefficient of flammable fabrics

Test result	Sample №	Sample mass, m, g		Lighting, conductivity %		Continuity, min	Smoke formation coefficient Dm , m ² /kg
		Before the test	After the test				
Condensation	1	0,8	0,3	59,0	55,7	15	46,0
	2	0,82	0,31	58,9	55,7	15	44,6

	3	0,81	0,3	59,0	55,5	15	45,9
Average		≈ 0,8	≈ 0,3	≈ 59,0	≈ 55,7	15	≈ 45,8

It should be noted that in 2016, the intellectual property agency applied for a patent for this project and a patent for utility model FAP 2019 0103 was obtained by the agency's decision on 18 January 2021.

Taking into account the urgency of improving and expanding the range of high temperature resistant protective clothing, it is only natural that it in turn imposes several requirements on flame retardants. For example: fire resistance (the treated tissue material is able to extinguish the grass freely and retain its structure after partial combustion), the selected flame retardant is definitely cheaper, long service life of woven material treated with flame retardant (at least 5-7 years or more), The fabric treated with flame retardant has a good appearance (the fabric should have no restrictions on the material color and the product quality), the material treated with flame retardant must have a high tolerance to the cleaning agents during cleaning and the ability to easily clean from household contaminants.

REFERENCES

- [1] Presidential Decree of the Republic of Uzbekistan on December 14, 2017 PD№-5285 "On measures to accelerate the development of the textile and clothing industry."
- [2] O.M.Yuldasheva., S.Kh. Karimov.,A.S.Rafiqov. Physical and chemical properties of the imparted copolymers of collagen and polyacrylic acid. // J. European Science Review. -2018. №7-8. –P.270-274.
- [3] O.M.Yuldasheva., Rafikov A.S. Ensuring the safety of ginneries // J. Bulletin of the Polytechnic University of Turin in Tashkent. -Tashkent. -2018. -№4. -p.38-41.
- [4] Yuldasheva O.M. Development of technology for improving refractory tarpaulin fabrics // J. Bulletin of the Polytechnic University of Turin, Tashkent. -Tashkent. -2018. -№4. -p.41-43.
- [5] Fire safety standards 157-97. Combat clothing for firefighters. General technical requirements. Test methods.
- [6] SS N 50810-95. Fire hazard of textile materials. Decorative fabrics. Flammability test method and classification.
- [7] SS 12.1.044-89. " Fire and explosion hazard of substances and materials. Nomenclature of indicators and methods of their determination".