N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 3, Number 423 (2017), 236 – 240

UDC 677.024

A. E. Aripbayeva[1], Zh. U. Mirkhalikov[1], Sh. Shapalov[1], A. Sh. Suigenbaeva[1], Kh. K. Kuspangalieva[2], K. K. Yerniyazova[2], M. Zh. Makhambetov[2], A. M. Uteshkalieva[2], A. K. Sakparova[2], G. Takibaeva[1]

[1]M. Auezov South Kazakhstan State University, Shymkent, Kazakhstan,
[2]Kh. Dosmuhamedov Atyrau State University, Kazakhstan.
E-mail: akerke-1982@mail.ru

WAYS FOR IMPROVEMENT OF STRENGTH CHARACTERISTICS OF A FIRE PRESSURE HOSE

Abstract. A fire hose is a pipeline for transportation of fire extinguishing agents, equipped by special joints. One of the key qualities of a fire hose is flexibility. Therefore fire hoses are made from a special fabric, consisting of natural or synthetic fibers. Pressure hoses with reinforcing frame from synthetic fibers have some design options such as rubberized fire pressure hoses, latex fire pressure hoses, with differential coating, meant for pressure in 3,0MPa. On the exterior, for protection from negative factors and damages, the hose may be equipped by a rubber coating. The fire pressure hoses are one of the main types of fire-extinguishing equipment and successful and fast fire extinguishing to a large extent depends on their accuracy. Our paper shows results of investigations on possibility to improve strength indexes of the fire pressure hoses by means of double rubberizing of the hoses made from synthetic fibers. We developed a special formulation of the rubber compound, allowing work out strength characteristics of the fire pressure hoses. The fabric hose rubberizing will also allow to protect the fire pressure hose from harmful environmental load and extend service life of the product.

Key words: fire hose, pressure hose, reinforcing frame, natural and synthetic fibers, rubber layer, hydraulic pressure.

Introduction. A fire hose is a pipeline for transportation of fire extinguishing agents, equipped by special joints. One of the key qualities of a fire hose is flexibility. Therefore fire hoses are made from a special fabric, consisting of natural or synthetic fibers. Pressure hoses from natural fibers have limited application [1]. Dry clean linen hoses are comparatively light, and their rolls are compact. When supplying water through such hoses, the exterior surface of the case fabric is wetted owing to water percolation through the case walls (percolation). That rises thermal resistance of the linen hoses in conditions of fires. However, high tendency of the linen hoses to sour processes, heavy hydraulic losses, as well as complex exploitation in conditions of low temperatures limit area of their application on mobile fire-extinguishing means [2, 3]. Pressure hoses with reinforcing frame from synthetic fibers have some design options such as rubberized fire pressure hoses, latex fire pressure hoses, with differential coating, meant for pressure in 3,0MPa [4]. On the exterior, for protection from negative factors and damages, the hose may be equipped by a rubber coating [5]. The fire pressure hoses are one of the main types of fire-extinguishing equipment and successful and fast fire extinguishing to a large extent depends on their accuracy.

The primary bearing element of the fire pressure hoses is the reinforcing frame, represented by woven pressure shell. The woven reinforcing frame fully takes forces, conditioned by availability of liquid pressure inside the fire hose.

Experimental part. Analysis of woven reinforcing frames' structure of the used fire hoses showed that they are single-texture cross-woven fabrics in most cases. At that core threads, which interweave with weft threads, laid in a circle of the fire pressure hoses, are arranged along the length of the fire pressure hoses. Therefore, calculation of the fire pressure hoses strength generally comes to calculation of strength of their woven reinforcing frame. The main strength index of the fire pressure hoses at the action of internal hydraulic pressure of its liquid for fire extinguishing is disruptive pressure, at which the fire hose breaks. The disruptive pressure values for all kinds of the fire pressure hoses are regulated by appropriate the State of Standards.

Our paper shows results of investigations on possibility to improve strength indexes of the fire pressure hoses by means of double rubberizing of the hoses made from synthetic fibers. As stated above the natural fibers, particularly lint, have a number of engineering deficiencies, therefore we used the pressure hoses with the reinforcing frame from synthetic fibers. Furthermore, the fabric frame from the synthetic fibers has good adhesion to the rubber compound. We developed a special formulation of the rubber compound, allowing to work out strength characteristics of the fire pressure hoses. The rubber compound formulation has been developed on the basis of SKI-3 rubber with good elasticity and giving high flexibility to the pressure hoses. The formulation also includes sulfur, polysulfur, the curing agents and together with zinc white and stearic acid compose the cure system. The cure system in the curing process gives high strength and elasticity to the rubber. Such components as sulfonamide M, acetone anil R, diaphene FP and Phthalic anhydride are anti-ageing agents and protect the rubber and fabric frame against destructive effect of sun rays, atmospheric oxygen, ozone and heat. ZVI wax migrating to the surface of product when storing, also protects from environmental hazards. Such ingredients as octophor NN and hydrocarbon resins are plasticizing agents, which improve processing properties of the rubber compound and allow to enter the rubber compound between fibers and even inside the fibers, hence improving the bonding strength between fabric of the frame and rubber, as well as between fibers of the pressure hose. PN-6Sh oil is a plasticizer which increases plasticity of the compound and assists to the equilibrium distribution of the components in the rubber improving quality of the rubber coating. Zeolite is a mineral extender which increases fire-resisting property and thermal endurance of the rubber coating. Technical carbon P 245 extender improves rubber strength [6, 7].

Result and its discussion. The rubber compound formulation is shown in Table 1.

Table 1 – The rubber compound formulation for rubberizing of the fabric hoses' frames

Item	Mass fraction per 100 mass fractions of the rubber
SKI-3	100
Sulfur	1,6-0
Polysulfur	0-1,3
Sulfonamide M	1,4
Phthalic anhydride	0,3
Zinc white	2,5
Stearic acid	2,0
Acetone anil R	1,2
Octophor NN	2,0
Hydrocarbon resins	4,0
ZVI wax	1,0
PN-6Sh oil	4,0
Diaphene FP	1,5
Technical carbon P 245	30,0
Zeolite	20,0

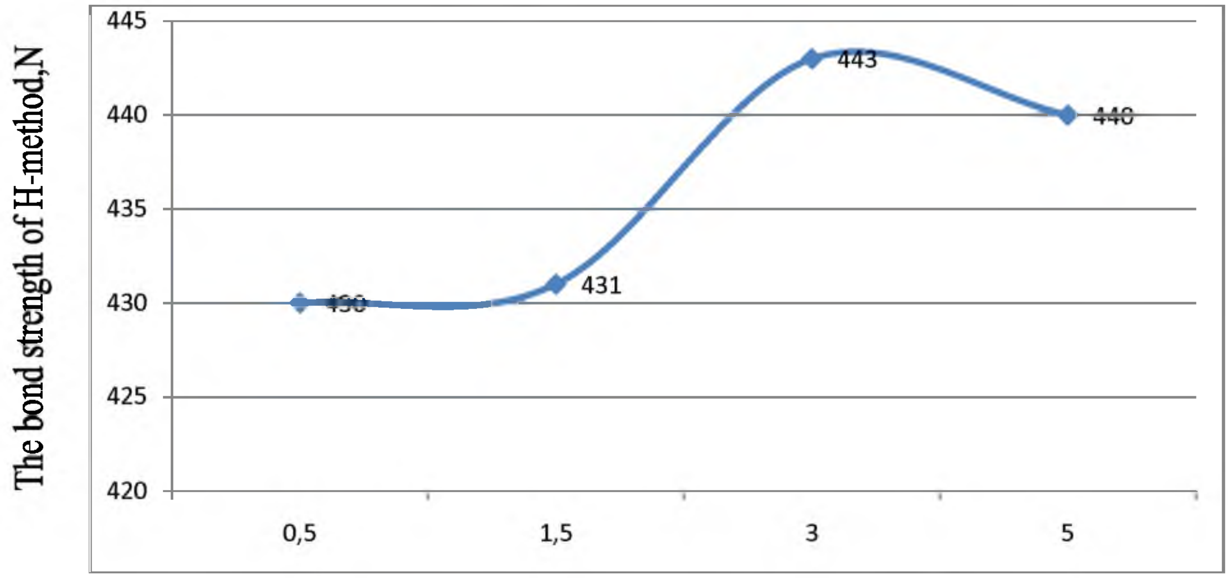
The rubber compound mixing was carried out in two stages. The temperature conditions met technical regulations. The vulcanizing of the samples was carried out at a temperature of 155°C during 15 minutes. The ageing test was carried out in autoclave at a temperature of 393°K in flocculent environment, at a pressure of 0,2MPa during 40 hours, and in similar conditions at constant irrigation by 5% NaCl water during 8 hours. Results of physical and mechanical tests of the developed rubber compound are shown in Table 2.

Table 2 – Physical and mechanical properties of the rubbers for rubberizing of the fire pressure hoses

Item	Indexes
Modulus at 300%, MPa	10,1
Nominal shearing strength, MPa	21,1
Elongation at break, %	525
Tear resistance, kN/m	63
Resistance to repeated tension at elongation 200%, thousand cycles	6,1
Bonding strength by N-method, N	443

It is seen from the data of Table 2 that the developed rubber compound has high strength properties that will allow to increase strength of the fire pressure hoses at the action of internal hydraulic pressure of its liquid. The fabric hose rubberizing will also allow to protect the fire pressure hose from harmful environmental load and extend service life of the product.

Further, we carried out experiments for determination of optimal thickness of rubber coating layer at the rubberizing of the fire pressure hose [8-10].



Thickness of the rubber layer at the fire pressure hose coating

Influence of the rubber layer coating thickness at the rubberizing
of the hose on the bonding strength of the fire pressure hose fibers

As it is seen from Figure by the results of experimental data, considerable increase in the strength properties and bonding strength between the rubber and fabric hose at the coating thickness of 3 mm is observed.

The following technical characteristics, Table 3, were defined after the tests of the rubberized hose.

Table 3 – Technical characteristics of the fire pressure hoses

№	Technical characteristics	Thickness of the rubber layer, mm		
		1,5	3	5
1	Diameter nominal (DN)* of suction and delivery-suction hose	100	100	100
2	Minimal bend radius, mm	400	600	500
3	Working pressure of delivery-suction hoses, MPa (kg/cm^2)	About 1,0 (10,0)		
4	Vacuum gauge pressure, MPa (kg/cm^2)	Approximately 0,08 (0,8)		
5	Working environment for suction and delivery-suction hoses of “B” class	Technical water, water (weak) solutions of inorganic acids and alkali by concentration to 20%		

Conclusion. When using the rubber compound for the rubberizing of the hoses, encapsulation of each fiber by the rubber compound occurs. That results in increase of bonds between the fibers and improvement of strength of the fire pressure hoses at the action of internal hydraulic pressure.

The external rubber layers protect the hose from negative factors and damages. Such rubber layer gives the hose necessary flexibility and keeps the strength. The tests showed that such pressure hose meets the requirements of GOST 51049–97 “Fire engineering. Fire pressure hoses. General technical requirements. Test methods” and fire code 152–2000 “Fire engineering. Fire pressure hoses. Technical fire safety regulations. Test methods”.

Finance. *Source of funding research – M. Auezov South Kazakhstan State University.*

REFERENCES

[1] Stepanov S.G. The development of the theory of the formation and structure of the tissue on the basis of nonlinear mechanics of flexible filaments. Dissertation of Doctor of Technical Sciences. Ivanovo. IGTA. 2007. 443 p. (in Rus.).

[2] Motorin D.V., Stepanov O.S., Bratolyubova E.V. Izv. Vyssh. Uchebn. Zaved. Tech. Tex. Prom. 2010. N 8. P. 103-109 (in Rus.).

[3] Motorin L.V. A simplified mathematical model for strength calculation of pressure fire hoses in hydraulic impact / L.V Motorin, A. Stepanov, E. Bratolyubova // Math. universities. The technology of the textile industry. 2011. N 1. P. 126-133.

[4] Aripbaeva A.E. Method of calculation and rational design of reinforcement carcases of pressure fire hoses with synthetic filaments [Text] / A.E. Aripbaeva, ZH.U. Myrhalykov, O.I Koifman, Y.M Bazarov S.G Stepanov // Math. Universities. Chemicals & Chem. tehnologiya. 2016. T. 59. Vol. 10. P. 83-87.

[5] Aripbaeva A.E Methods of rational design of woven reinforcing skeletons pressure fire hoses / A.E. Aripbaeva Myrhalykov Zh.U. Stepanov S.G .// Coll. materials XIX International Scientific and Technical Forum "Physics of fibrous materials: structure, properties, high technologies and materials» (SMARTEX - 2016). P. 235-237.

[6] Koshelev F.F., Kornev A.E., Bukanov A.M. General chemical technology of rubber. M.: Chemistry, 1999. 527 p.

[7] Chemical encyclopedia: in 5 vol. / Editorial Board.: N. S. Zefirov (ed.). M.: Soviet encyclopedia, 1995. Vol. 4. P. 319. 639 p.

[8] Tarasov-Agalakov N.A. Practical hydraulics in fire business. M., 1959. 134 p. (in Rus.).

[9] Deaconov E.G., Nikolaev I.K. Journal of Computational Mathematics and Mathematical Physics. 1973. N 4. Vol. 13. P. 938-951 (in Rus.).

[10] Bukhin B.L. Application of the theory of mesh membranes to the calculation of pneumatic tires. The mechanics of pneumatic tires. Sbor. tr. NII Shinnoy Prom. M., 1974. P. 59-74 (in Rus.).

А. Е. Арипбаева[1], Ж. У. Мырхалыков[1], Ш. Шапалов[1], А. Ж. Суйгенбаева[1], Х. К. Куспангалиева[2], К. К. Ерниязова[2], М. Ж. Махамбетов[2], А. М. Утешкалиева[2], А. К. Сакпарова[2], Г. А. Такибаева[1]

[1]Южно-Казахстанский государственный университет им. М. Ауезова, Шымкент, Казахстан,
[2]Атырауский государственный университет им. Х. Досмухамедова, Казахстан

ПУТИ ПОВЫШЕНИЯ ПРОЧНОСТНЫХ ХАРАКТЕРИСТИК ПОЖАРНОГО НАПОРНОГО РУКАВА

Аннотация. Пожарный рукав это трубопровод для транспортирования огнетушащих средств, оснащенный специальными соединениями. Одно из основных качеств пожарного рукава – гибкость. Поэтому пожарные рукава изготовляются из специальной ткани, состоящих из натуральных или синтетических волокон. Напорные рукава с армирующим каркасом из синтетических волокон имеют несколько вариантов конструктивного исполнения: прорезиненные напорные пожарные рукава, латексированные напорные пожарные рукава, с двусторонним покрытием, рассчитанные на давление 3,0 МПа. Снаружи для защиты от негативных факторов и повреждений рукав может быть оснащен резиновым покрытием. В работе показаны результаты исследований по возможности увеличения прочностных показателей пожарных напорных рукавов посредством двойного обрезинивания рукавов, изготовленных из синтетических волокон. При использовании резиновой смеси для обрезинивания рукавов происходит обволакивание резиновой смесью каждого волокна, что приводит к повышению связей между волокнами, тем самым повышая прочность ПНР при действии внутреннего гидравлического давления. Слой резины, находясь снаружи, защищает рукав от негативных факторов и повреждений. Такой слой резины придает рукаву нужную гибкость и сохраняет прочность. Проведенные испытания показали, что данный напорный рукав соответствует требованиям.

Ключевые слова: пожарный рукав, напорный рукав, армирующий каркас, натуральные и синтетические волокна, резиновый слой, гидравлическое давление.

А. Е. Арипбаева[1], Ж. У. Мырхалыков[1], Ш. Шапалов[1], А. Ж. Суйгенбаева[1], Х. К. Куспангалиева[2], К. К. Ерниязова[2], М. Ж. Махамбетов[2], А. М. Утешкалиева[2], А. К. Сакпарова[2], Г. А. Такибаева[1]

[1]М. Әуезов атындагы Оңтүстік Қазақстан мемлекеттік университеті, Шымкент, Қазақстан
[2]Х. Досмұхамедов атындағы Атырау мемлекеттік университеті, Қазақстан

АРЫНДЫ ӨРТ ТҮТІКТІН БЕРІКТІК СИПАТТАМАЛАРЫН АРТТЫРУ ЖОЛДАРЫ

Аннотация. Өрт сөндіру түтігі бұл – өрт сөндіргіш құралдарды тасымалдау үшін арнайы қоспаларымен жабдықталган құбыр. Өрт сөндіру түтігінің негізгі бір қасиеті – икемділік. Сондықтан өрт сөндіру түтігі табиги немесе синтетикалық талшықтардан тұратын арнайы матадан жасалады. Қысымды түтік синтетикалық талшықтардан тұратын армирлерген қаңқасы бар бірнеше конструктивті орындаудан тұрады: резеңкеленген арынды өрт сөндіру түтігі, латекстелген арынды өрт сөндіру түтігі, екі жақты жабыны бар, және 3,0 МПа қысымга есептелген. Жагымсыз факторлардан және зақымданудан қоргау үшін түтік сыртынан резеңке жабыны жабдықталган болуы мүмкін. Осы жұмыста өрт сөндіру түтіктерінің қысымга беріктік көрсеткіштерін ұлгайту мақсатында синтетикалық талшықтардан жасалган түтікті қос резеңкелендіру нәтижелері бойынша зерттеулер дайындалган. Резеңке қоспасын пайдалану кезінде түтікті резеңкелендіру үшін, әрбір талшықты резеңке қоспасымен талшықтандыру жүреді, бұл талшықтар арасындағы байланыстарды арттыруга әкеледі, осылайша ішкі гидравликалық қысым әрекеті кезінде ПНР беріктігін арттырады. Резеңке қабаты сыртында тұрып түтікті теріс факторлардан және зақымданудан қоргайды. Осындай резеңке қабаты түтікке қажетті икемділік береді және беріктігін сақтайды. Жүргізілген сынақтар көрсеткендей, бұл қысым түтігі талаптарга сәйкес келеді.

Түйін сөздер: өрт сөндіру түтігі, қысым түтігі, армирлерген қаңқасы, табиги және синтетикалық талшықтар, резеңке қабаты, гидравликалық қысым.