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Determining the elongation of T-type pressure fire hoses

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The phenomenon of changing the geometric parameters of pressure fire hoses is manifested when they transport extinguishing liquids. Although the extension of pressure fire hoses does not have a significant impact on the fire extinguishing process, the energy costs associated with such changes should be taken into account. In fact, part of the power of the fire pump is spent not on transporting liquids and forming extinguishing jets but on the «optional» lengthening of pressure fire hoses. Latex pressure fire hoses with diameters of 51 mm and 77 mm and fire pressure hoses with doublesided polymer coating of 51 mm (all of type T) were randomly selected for the experiments. The temperature was 263 K and 298 K, the fluid flow rate was constant, the pressure values at the inlet of the Protek 366 fire barrel had fixed values. No significant changes in the diameters (expansion or narrowing) of pressure fire hoses were recorded during water transportation. An elongation of 79 cm with a hose length of 1960 cm (73 cm with a hose length of 1790 cm) was recorded when transporting water in the case of using hoses with a diameter of 77 mm, a pressure at their inlet of 0.8 MPa, a temperature of 263 K, and a water flow rate of 0 l/s. The force that provided such a stretch was 2.04 kN. When extinguishing liquid was supplied by pressure fire hoses with a diameter of 77 mm in the temperature range of 263–298 K, the elongation decreased slightly with decreasing temperature. A slight unevenness of stretching of pressure fire hoses along the length was found when stretching increased closer to their middle. The results indicate the dependence of the amount of stretching on the materials from which pressure fire hoses are made, as well as their diameter. The values of dynamic forces that cause stretching of pressure fire hoses established in the study can be used in practice when taking into account the forced energy losses for fluid transportation

Keywords: *fire hose; hose line; water transportation; geometric dimensions; fire hose extension*

Introduction.

In order to transport water and working solutions of foaming agents, fire hoses of various lengths, diameters, and types can be used at a fire site. Fire trucks are equipped with pressure fire hoses (PFH) of type T. In accordance with the norms of the civil protection operational and rescue service, the frequency of testing pressure fire hoses should be at least once a year. Such requirements are due to the conditions, modes, and features of the use of these types of fire protection equipment. PFHs are used as the main means for transporting extinguishing liquids to the site of most fires. The requirements for their reliability and operability are decisive since the result of fire extinguishing directly depends on their level. For manning fire trucks, PFHs of type T are used. They are usually made of synthetic materials and may have a rubber or polymer coating inside and outside. The main characteristics of PFH are geometric dimensions, operating pressure of the transported liquid, water resistance, and strength. The life cycle of PFH depends both on these characteristics and on the modes, frequency, and features of their operation.

Determination of the amount of stretching of pressure fire hoses when using fire barrels. The hoses transported water to a fire barrel at an ambient temperature of 298 K. The fire barrels Protek 366 [1,2] and RS-70 were used. At this stage of research, the initial length of the PFH was 1790 cm. A gradual increase in the inlet pressure from 0.2 to 1.0 MPa in increments of 0.2 MPa was ensured by the operation of the fire pump PN-60-R-R with a capacity of up to 60 lps and a maximum pressure of 1.0 MPa. At different values of fluid flow using a fire barrel, as at the previous stage (at zero flow), no significant changes in the diameters of the PFH were recorded. The results of experiments for three types of PFH are shown in Fig. 4. The maximum elongation was recorded when

generating a flow of extinguishing liquid using a latex hose with a diameter of 77 mm at a pressure at its inlet of 1.0 MPa and a flow rate of 1.9 lps. The change in length was 620 mm (Fig. 1).

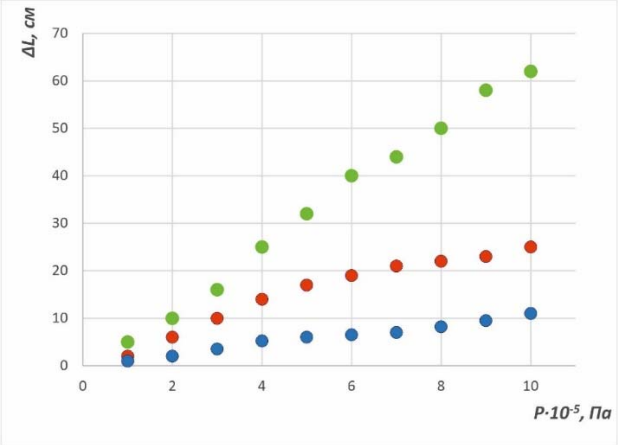

Fig. 1. Plot of changes in the lengths of the investigated pressure fire hoses when using the PROTEK 366 fire barrel: lower plot – double-sided polymeric, 51 mm; middle – latex, 51 mm; upper – latex, 77 mm

Determination of the force that provides tension of the pressure hose during water transportation. It was decided to conduct a full-scale experiment using the entire PFH, rather than its fragment. To determine the force that provides stretching of the hoses during the transportation of water, a test installation was designed (Fig. 2). With the help of the installation, the amount of force required to ensure the deformation that in previous experiments caused the tension of the PFH during the transportation of water was determined. The experimental data shown in Fig. 3 indicate an increase in the magnitude of elongation with an increase in the applied force.

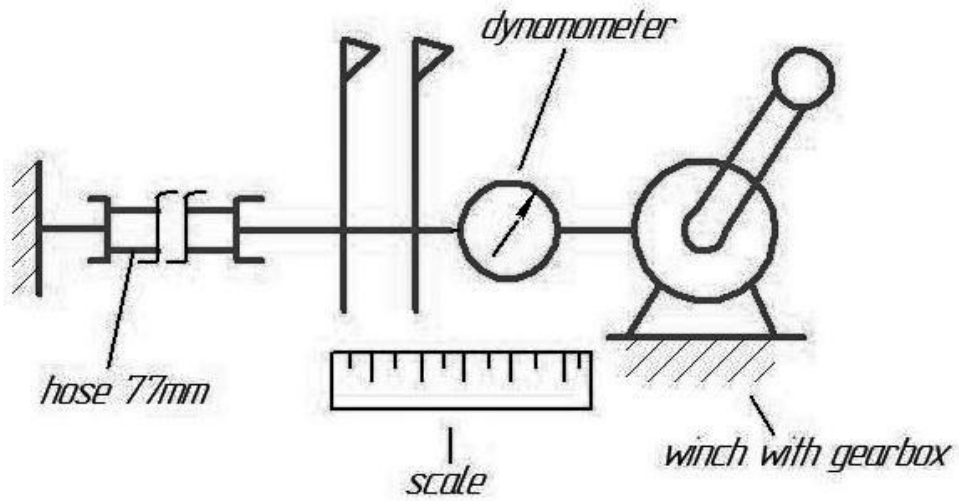

Fig. 2. Conducting a full-scale experiment using latex pressure fire hoses with a length of 1960 cm and diameter D = 77 mm: a – schematic; b – fragment of the experiment

Thus, the elongation by 79 cm of the investigated latex PFH with a diameter of 77 mm corresponded to a pressure at its inlet of 0.8 MPa [3]. The force providing such stretching was 2.04 kN, and according to [4] – 2.28 kN. The elongation by 62 cm of the investigated latex PFH with a

diameter of 77 mm corresponded to the pressure at its inlet of 1.0 MPa and flow rate of 1.9 l/s [5]. The force providing such stretching was 1.41 kN, and according to [4] – 1.69 kN. Due to the peculiarities of the experiments and randomly selected fire hoses that were in operation, such discrepancies in our results can be considered acceptable.

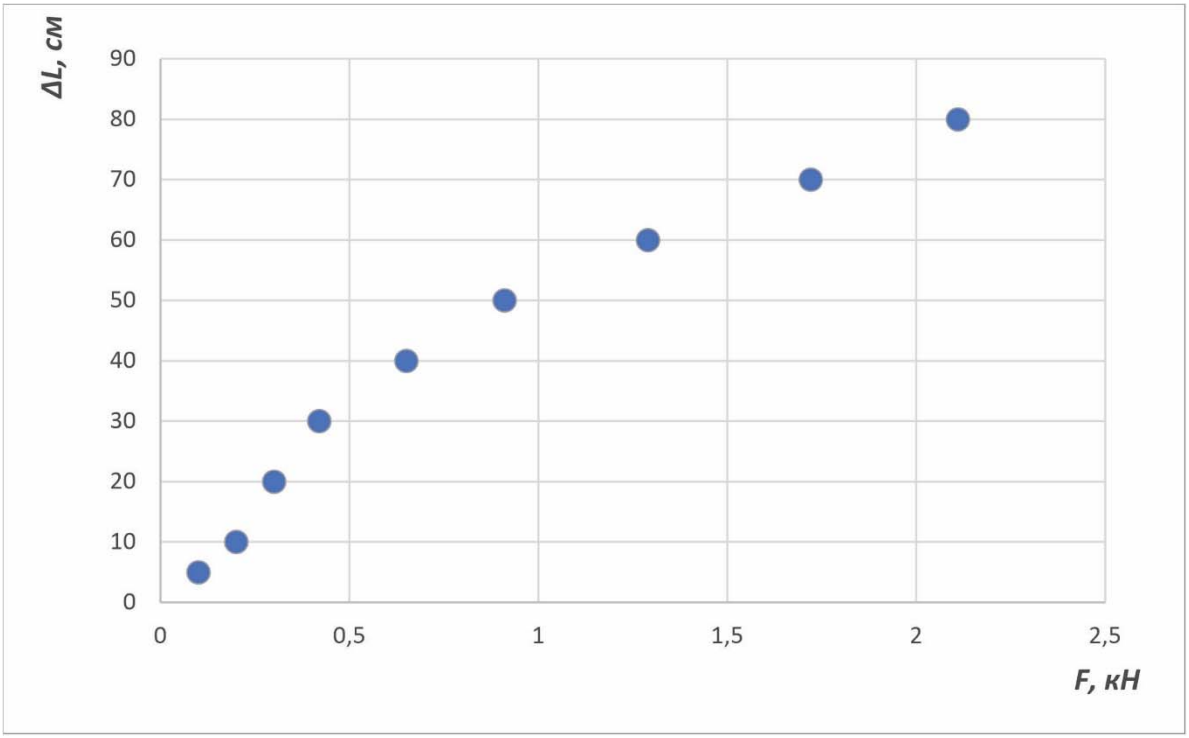

Fig. 3. Dependence of the elongation Dl of latex pressure fire hoses with diameter D = 77 mm on tensile force F

Discussion of results of determining the elongation of pressure fire hoses.

As expected, as a result of the experiments, the dependence of the elongation of PFH on the value of the inlet pressure at which water is transported to the jet molding device was established. It was found that the elongation of different types of PFHs under the same initial conditions can vary significantly. The phenomenon of stretching PFH can be explained by the physical and technical features of their structure, the influence of conditions and modes of their operation. Thus, the dependences of change in the lengths of the investigated PFHs when using the PROTEK 366 fire barrel were significantly different for PFHs with different material bases. It is possible to allow the application of known laws of fluid motion through pipelines with solid walls with increasing pressures of transported liquids. However, this should take into account such manifestations of flexible pipelines-hoses as a sharp overlap of the fire barrel, the connection of new hoses through branching. It is important to take into account the lengthening of the hose line by adding new hoses, transitions of hose diameters, pulsation effects of fluid movement due to the operation of fire pumps [5], etc. In general, a certain value of PFH elongation (up to 4.3 %) can be taken as a basis for further research related to the transportation of extinguishing liquids by flexible pipelines that change their original geometric dimensions, such as length. At the same time, as a result of the experiments, a significant level of dependence of the obtained results of PFH elongation on the state Fig. 7. Elongation Dl of latex pressure fire hoses with diameter D = 77 mm along length L = 1790 cm in the case of using a plug at the end of the hose (water consumption, 0 lps; pressure, 0.8 MPa) c a b Fig. 9.

Determining the tension of pressure fire hoses at an ambient temperature of 263 K: a – entrance section of the hose; b – fixed end of the hose before the experiment; c – lengthening of the hose under the action of water pressure Engineering technological systems: Reference for Chief Designer at an industrial enterprise 19 of their wear was established. For six latex PFHs of the same type with a diameter of 77 mm and a length of 1960 cm, the variation in the elongation value was about 12 % (73, 77, 79, 81, 82, 83 cm). For six latex PFHs with a diameter of 51 mm, the variation in the elongation value was about 9 %. Doublesided polymeric PFHs with a diameter of 51 mm were almost not extended.

Conclusions.

1. The results of investigating the properties of pressure fire hoses of type «T» with internal diameter D = 77 mm and a length of up to L = 1960 cm at longitudinal deformations were confirmed by conducting a full-scale field experiment. using not a fragment but the entire pressure fire hose. The maximum value of the tensile force was 2.04 kN, and the relative elongation did not exceed 0.032. However, unlike previous studies, the uneven stretching of the pressure fire hose was revealed when the stretching increased closer to its middle [2].

2. It has been established that an important factor influencing the ability to extend the pressure fire hoses is the state of their wear, primarily the number of cycles and operating conditions. Thus, for six latex pressure fire hoses of the same type with a diameter of D = 77 mm and a length of L = 1960 cm, the variation in the elongation value was about 12 % (73, 77, 79, 81, 82, 83 cm), for six latex pressure fire hoses with a diameter of D = 51 mm, the variation of the elongation value was about 9 % [2].

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