DEVELOPMENT OF A DEVICE WITH INCREASED CONSUMPTION FOR FIRE EXTINGUISHING

Stas Serhiy [1], Buzun Oleksandr [2]
[1] *Cherkasy Institute of Fire Safety named after Chornobyl Heroes (ChIFS), Ukraine*
[2] *State Emergency Service of Ukraine*

Abstract
Here we have the results of device design, which is able to provide increased consumption of extinguishing fluid: water or foam. Was created an experimental sample of a firefighting hose, which allows to supply water to the fire. Consumption (flow rate) is up to 40 l/s, jet generation range – 50-60 m.

Keywords: water jet, firefighting, firefighting hose, spraying liquid.

INTRODUCTION

The effectiveness of fire extinguishing directly depends on the applied fire-fighting technical means and features of their use in certain emergency situation. A special place among fires is occupied by those that can lead to human losses and cause significant financial damage. Nuclear power plants are objects that are subject to special regulation and need to ensure fire safety at the highest possible level. As we can see all stages of electricity generation at nuclear power plants are high-energy, the requirements for fire-fighting equipment designed to prevent fires, and in case of its occurrence to minimize the spread of fire and ensure effective firefighting this is its reliability, efficiency of application, the ability to generate the required amount of extinguishing agents to the fire.

Since fire extinguishing of buildings where there are devices with high electrical voltage is associated with many difficulties and risks, special attention should be paid to the results of studies of various fire extinguishing agents under the same reproducible conditions. From this point of view, there are interesting results of Rappsilber T. et al. (2019), where researched efficacies of water, water with a foaming agent, nozzle-aspirated foam and compressed air foam [1]. Their use is possible when the fire extinguishing facility is disconnected from electricity. The results show that compressed air foam suppressed fire most effectively under the test conditions.

The range of generation of a "classic" water fire extinguishing jet depends on ensuring the stability of its surface in the zone of exit from the branch pipe. He Jie et al. (2019) proposed an experimental method for visualizing the stability of the jet surface to obtain patterns of the generated surface waves on the jet in the zone of jet departure from the branch pipe [2]. Based on the analysis of the surface, the relationship between the wave characteristic of the water jet and the Weber number was determined. It was found that the average wavelength of a water jet formed by a fire nozzle (monitor) decreases with an increase in the Weber number, in this case, the amplitude of the waves increases continuously with distance from the outlet of the pipe. In other words, the higher Weber number, the higher speed of surface waves on the water jet.

The accuracy of determining the spray zone of a fire extinguishing jet has a significant effect on the efficiency of fire extinguishing. M. Zhang. et al.(2020) used a quadratic resistance model based on the analysis of the mechanical model of the hydraulic control volume, taking into account the change in the cross-sectional area, caused by the destruction of a stream of water along its length [3]. The water jet was simulated by examining several key operating parameters, such as the

positioning angle of the branch pipe (jet throw angle) and the initial speed of jet.

A model based on the provisions of the theory of fracture taking into account air resistance, proposed by W. Shang et al.(2019, 2020) allows to predicting the trajectory of fire extinguishing water jets [4, 5]. It was assumed that the trajectory of the jet created by the branch pipe mainly depends on its own gravity and air resistance, both the amount of air resistance changes depending on the cross-sectional area of the jet. A comparative analysis of theoretical modeling data and experimental data was carried out, the error was about 10%, which can be considered a completely satisfactory result.

EXPOSITION

Compensators have a special place in the technological chain of electricity generation at nuclear power plants and its subsequent generation into the network.. In the case of a communication compensator fire, the entire power unit must be disconnected from the mains. In such cases the automatic fire extinguishing system should work, and on cooling of the technological equipment operative calculations with the corresponding fire-prevention equipment should be involved.. The most dangerous factors in cases of fire extinguishing the relevant objects include high voltage (up to 700 kV) and the presence of a large amount of transformer oil (up to 100 tons).

Firefighting of compensators of nuclear power plants, which take place from time to time, are especially resonant in the media against the background of the greatest man-made catastrophe of mankind - the Chernobyl accident. This way on the 15th of January in 2015 at 22 hours 04 minutes to the communication point 27 of the state fire and rescue unit for the protection of a separate unit "South-Ukrainian NPP" of the Main Department of the State Emergency Service of Ukraine in Mykolayiv region was received a message about the activation of the alarm on the compensator of the communication system 330/150 kV 1 AT. It was found that in the system of the compensator was a transformer oil of the GK type in the amount of 70 t. At the scene of the fire, the staff of the electrical shop was working to de-energize and ground the compensator (330/150 kV). In total, 16 units of equipment and 125 personnel were sent to the scene of the fire from the Main Department of the State Emergency Service of Ukraine in Mykolaiv region, a military unit № 3044 was involved to surround the perimeter of the facility, an ambulance and chemical and radiological laboratory. Although the fire was eventually contained and extinguished, extinguishing of fire was complicated by the absence of a sufficiently powerful device to form and supply a spray jet of water from a safe distance. Therefore, it wasn't possible either to organize combined extinguishing with water and powder, or to carry out extinguishing with sprayed water after depletion of special resource extinguishing agents. In fact, according to the results of the analysis of the emergency situation, it was established that it is necessary to involve more powerful means of generating water jets with the required characteristics to the centers of such fires.

There is a need to develop a device for forming and supplying to the fire center of sprayed water of appropriate dispersion for extinguishing fires of combustible liquids, both independently and in a combined way. The device must meet the safety conditions when you will extinguish high-voltage electrical installations, ensure the work of personnel and firefighting equipment in conditions of intense thermal radiation and in conditions of radiation danger.

The pipe with NRT-5 turbine nozzles was chosen as a prototype of a new branch pipe (during extinguishing of live electrical installations) (Fig. 1).

Fig. 1. *Type of NRT-5 nozzle on the branch pipe RS-70 (main characteristics of the nozzle: working pressure - 0.4-0, MPa, water flow - 5 l / s, water jet supply range - 20 m, nozzle outlet diameter 7.5 mm)*

The basis for the new branch pipe was a combined stationary gun pipe SPLK-C60 (Fig. 2), in which the system of switching the flow of liquid from the water pipe to the foam holes was dismantled, as well as the water pipe itself was dismantled. In the six holes for the foaming agent were replaced by spray inserts, on inserts (nozzles) for the formation of compact jets with a diameter of 19 mm (later replaced by 15 mm). Instead of a water pipe the cover with the turbine spray which were made separately from stainless steel was established. The spray itself rotates on a brass sleeve, which is lubricated with a fire extinguishing agent through special channels, also there is a possibility of maintenance (cleaning) of the channels. The author of the technical solution O. V. Buzun proposed to install a new branch pipe on the tower of the armored personnel carrier BTR-60 PB (Fig. 3).

Fig. 2. *Type of the combined stationary gun pipe of SPLK-C60 (working pressure - 0, 8 MPas, the maximum range of a continuous water stream - 70 m)*

Due to the implementation of the above technical solutions, the flow rate of the pipe was up to 40 l / s and the length of the obtained jet reached 55 m. The advantage of the design was the ability to operate this device from conventional fire trucks and pumps. It is important! When you use a foaming solution with a flow rate of 1.8 l / s formed a stable foam of low multiplicity.

Fig. 3. *View of the developed branch pipe installed on the armored personnel carrier BTR-60 PB (State Service of Emergencies of Ukraine in Nikolaev region, protection guard of the South-Ukrainian nuclear power plant)*

CONCLUSION

At this stage of research, we can only talk about preliminary results. It was possible to design and create a prototype of a new branch pipe, which improves the characteristics of water fire extinguishing jets. It became possible to supply a fire extinguishing jet with the characteristics required in this particular case on the existing firefighting equipment. At the present time, experiments are continuing, which should help to get an answer to the question: "is it possible to use the obtained types of jets to extinguish equipment under electric voltage?".

REFERENCE

[1] Rappsilber, Tim & Below, Philipp & Krüger, S. (2019). Wood Crib Fire Tests to Evaluate the Influence of Extinguishing Media and Jet Type on Extinguishing Performance at Close Range. Fire Safety Journal. https://doi.org/10.1016/j.firesaf.2019.04.014.

[2] He Jie et al. Investigation on Surface Wave Characteristic of Water Jet / Mathematical Problems in Engineering // Volume 2019, Article ID 4047956, 10 pages. https://doi.org/10.1155/2019/4047956.

[3] M. Zhang, X. Liu, X. Wang, Y. Wang, and W. Liang, "Fire Water Monitor Trajectories Based on Turbulence Breakup Model," Journal of Testing and Evaluation 48. Published ahead of print, 01 November 2020, https://doi.org/10.1520/JTE20180428.

[4] W. Shang, X. Liu, M. Zhang, Y. Qu, and Y. Wang "Firewater Monitor Trajectories Based on Jet Expansion and Dynamic Breakup Model." Journal of Testing and Evaluation. Web. 20 Apr 2020. https://doi.org/10.1520/JTE20190748.

[5] X. Liu, J. Wang, B. Li, and W. Li, "Experimental study on jet fow characteristics of fre water monitor,"The Journal of Engineering, vol. 2019, no. 13, pp. 150–154, 2019.

[6] Stas S. V. Rozrobka prystroiu z pidvyshchenoiu vytratoiu dlia formuvannia ta podachi v oseredok pozhezhi rozpylenoi vody / S. V. Stas, S. M. Bychenko, O. V. Buzun. // Mizhnarodna naukovo-tekhnichna konferentsiia "Hidroaeromekhanika v inzhenernii praktytsi", m. Kyiv. – 2020. – S. 297–300. http://pgm.kpi.ua/downloads/conf_file/Thesis_2020.pdf#page=56.

[7] Stas S. V., Yeroshevich M. M. and Melnyk M. V. "Applying different types of water jets as a component of firefighter safety work." Problemy ta perspektyvy rozvytku systemy bezpeky zhyttiediialnosti: Zb. nauk. prats KhV Mizhnar. nauk.-prakt. konf. molodykh vchenykh, kursantiv ta studentiv. – Lviv: LDU BZhD, pp. 114–115, 2020. https://ldubgd.edu.ua/sites/default/files/8_konferezii/konferenciya_2020_studentsko-kursantska-stisnuto.pdf#page=114.