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EXPERIMENTAL STUDY OF THE GEOMETRIC CHARACTERISTICS OF WATERING ZONES FORMED BY A HANDLINE NOZZLE PROTEK-366

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ABSTRACT

The formation of the watering zone of the core of fire with a fire-extinguishing substance is primarily ensured by the design features of the handline nozzles, as well as the pressure and flow rate of the liquid. The conducted researches made it possible to reveal the dependence of the watering zone shape on the characteristics of the hydraulic system for generating fire extinguishing flows while using the typical handline nozzle Protek-366. During the exercises we studied differences in the shape of the watering zone during water supply and while using a wetting dilution of a foaming agent.

1. INTRODUCTION

Researches related to the generation of water jets for surface watering has been conducted for more than a hundred years. The fields of implementation of such jets are primarily agriculture and fire extinguishing. The main tasks of research are the development of means for generating water flows, determining the intensity and range of liquid supply as well, as their dispersion. A separate direction of research is the determination of the area and intensity of watering zone at each point where the sprayed jets are supplied. The question of the application of irrigation water by sprinkling related the work of J. E. Christiansen [1]. However, firstly the author considers some technical material essential to an economical design of sprinkler systems—material of interest primarily to engineers, irrigation contractors, and others engaged in manufacturing and installing sprinkler equipment. That's why it can be argued that a significant number of ideas proposed by J. E. Christiansen were correct for his time. But, the development of technologies significantly adjusts the approaches of creation and use of watering zone means. Appear more powerful pumps, more efficient means of spraying, more accurate ways of supplying sprayed liquids at a specific time and to specific points of watering zones.

It is also important to understand in which way a fire extinguishing jet is formed, how it is sprayed, and how liquid droplets move in the stream. For several decades, modeling methods are most often used to describe such processes. For example, William T. Reeves method for modeling fuzzy objects such as fire, clouds, and water [2]. Particle systems model an object as a cloud of primitive particles that define its volume. Over a period of time, particles are generated into the system, move and change form within the system, and die from the system. The resulting model is able to represent motion, changes of form, and dynamics that are not possible with classical surface-based representations. The particles can easily be motion blurred, and therefore do not exhibit temporal aliasing or strobing.

The need for reliable measurement of droplet velocities and droplet size has increased with the more widespread use of water mist systems. Husted B.P. researched two optical measuring techniques - Particle Image Velocimetry and Phase Doppler Anemometry. Measurements have been performed on two high-pressure nozzles, a hollow cone nozzle and a full cone nozzle. Both methods performed well close to the nozzle and further away from the nozzle. In the intermediate region the results obtained with Particle Image Velocimetry are biased against the larger droplets. The two methods complement each other, Particle Image Velocimetry giving the instantaneous velocity field and Phase Doppler Anemometry giving both the droplet velocity and droplet size at a point. Similar studies demonstrate options for measuring drops speed and size. Absolutely it should be taken into account such features like pressure at the outlet of the nozzle, the diameter of the nozzle, the flow rate and the speed of the liquid, for the generation of water fire extinguishing jets.

Fire water monitor is an important part of a watering system. Characteristics of the generated jet of fire water monitor, were researched by X. Liu [4]. The water jet system was used to launch the water jet experiment under six pressures. A high-speed camera was used to obtain the water jet images. The feature extraction of water jet was obtained based on the image processing technology, and it was used to study the jet diffusion angle and bundling of the fire water monitor under different pressures. The results of this study showed that the jet pressure is an important

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parameter, which has a great influence on the cluster and surface characteristics of the jet. The fire water monitor had a limited range of pressure. When the pressure was constant, the jet distance determines the size of the air acting on water column, so the cluster and surface characteristics of the water column had changed obviously with the jet distance.) However, all of the above points to the process of jet formation and the processes inside the jet [5]. For our research, it was important to determine the main characteristics of the horizontal spraying zone.

2. EXPOSITION

For water supplying and aqueous foaming agents for extinguishing fires, were used jet-forming devices - handline nozzles. There are manual and carriage handline nozzles. Due to the specifics of firefighting tactics, manual handline nozzles are the most commonly used. Until recently, in Ukraine were used manual handline nozzles of structures developed in the 60s and 80s of the last century, and they were outdated both technically and morally. So happened that the handline nozzle Protek 366 became widely used in Ukraine (SPRK) (Fig.1), which replaced the handline nozzles of the RS-50 (RSK-50) and RS-70 (RSK-70) type. Unlike them, Protek 366 handline nozzle has a wide range of nozzle flow adjustment (Fig.2) and the ability to adjusting the spray angle of the jet from compact to sprayed.

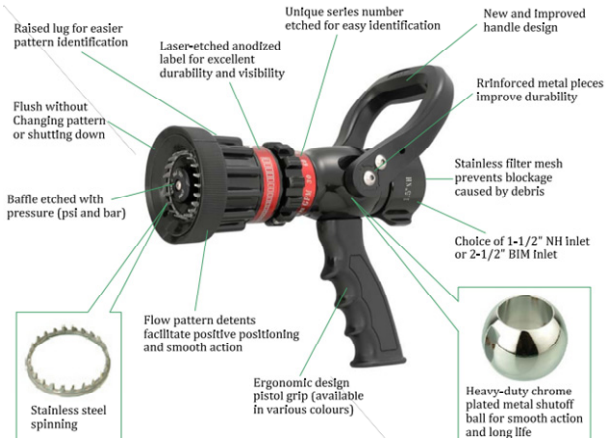


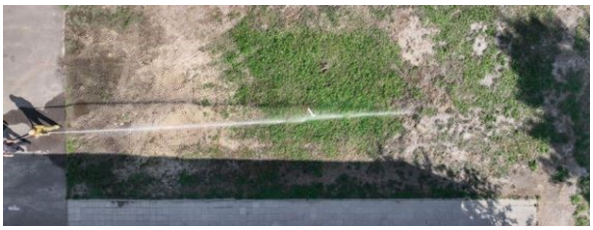
Fig. 1. Handline nozzle PROTEK-366 [6]

The disadvantage of the Protek-366 handline nozzle can be considered the high value of the nominal pressure of the handline nozzle, which is 70 m of water art. This value significantly limits the possibilities of water supplying and its agents by fire-rescue units in terms of the length and height of the laying of hose lines.

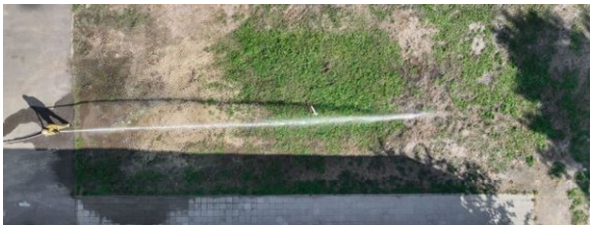
Style	Nozzle Pressure		Flow Settings		Actual Flow		Straight Stream Reach Effective		Straight Stream Reach Overall	
	PSI	BAR	GPM	LPM	GPM	LPM	Feet	Meters	Feet	Meters
366	75	5	30	115	26	98	67	20	90	27
			60	230	52	197	85	26	110	34
			90	360	82	310	99	30	130	39
			125	475	108	409	106	32	140	42
	100	7	30	115	30	115	78	24	95	29
			60	230	60	230	94	28	115	35
			90	360	90	360	109	33	135	41
			125	475	125	475	122	37	150	45
	125	8.5	30	115	34	129	81	25	100	30
			60	230	67	254	99	30	120	36
			90	360	107	401	115	35	135	41
			125	475	140	530	133	40	145	44

Fig. 2. Table of the PROTEK-366 main characteristics [6]

However, the PROTEK-366 handline nozzle has become widely used in the State Emergency Service of Ukraine and is used in almost every fire-rescue unit. Therefore, it is relevant to determine the geometric parameters of the spray torch at different water consumptions with the formation of the nozzle watering map. The technical documentation provided by the manufacturer does not provide information on these cutting angles.



a



b

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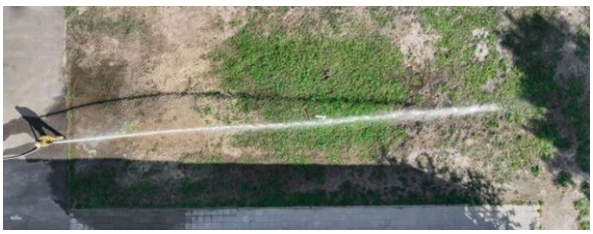
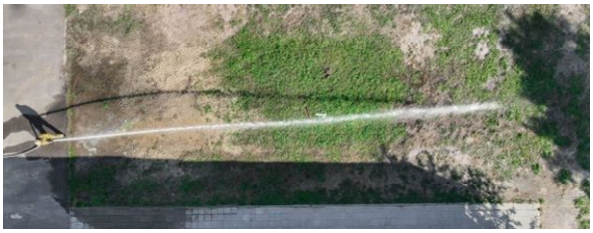


d

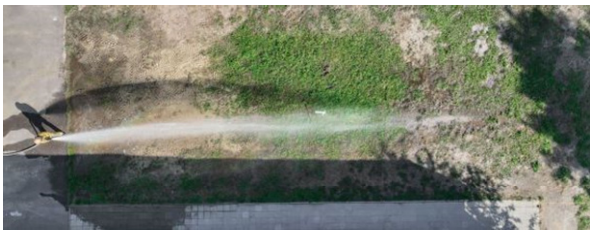
Fig. 3. Change the length of the jet at constant pressure (6 bar) and different flow rates (a -115 lpm, b – 230 lpm, c -360 lpm, d - 470 lpm)

This study was conducted in order for the practical using this nozzle and to be able to quickly choose the correct mode of operation mode for it.

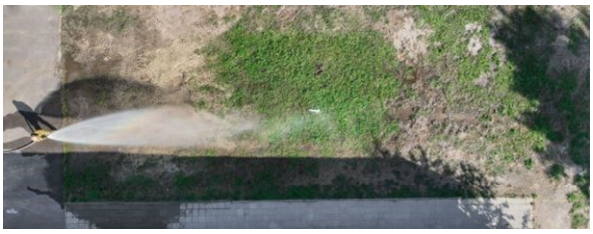
Thus, the size and shape of the watering zones determined, which corresponded to different operation modes of the PROTEK-366 nozzle. Experiments were conducted for four levels of consumption of fire extinguishing agents: 115-230-360-470 l/min; for two modes of jet forming: direct (solid) and sprayed; for different values of pressure on the fire nozzle: 4-5-6-7-8 bar.



a



b



c

d

Fig. 4. Change of the shape of jet at constant liquid pressure (6 bar), constant liquid flow rate (470 lpm) for different spray angles of the jet (a - min, b – 15°, c -30°, d - max)

For a visual demonstration of the obtained results were selected the cases of using the PROTEK-366 handline nozzle at a pressure of 6 bar with different flows and a solid jets. (Fig. 3). The change of the jet shape at the same values of pressure and flow rates, but for different spray angles, is demonstrated in Fig. 4.

3. CONCLUSION

The obtained results make it possible to additionally inform firefighters who use the PROTEK-366 handline nozzle in practice about the main characteristics of fire extinguishing jets. It was determined not only the effective and overall range of fire extinguishing liquid, but also the width of the watering zone for different modes of use of the handline nozzle PROTEK-366.

This study is the first stage of a larger full-scale study, where it is planned to use not only water as a fire extinguishing agent, but also aqueous solutions of foaming agents. Therefore, the sizes and shapes of the effective zones (watering zones) during the use of the handline nozzle PROTEK-366 in different modes and with different fire extinguishing agents should be determined in the future.

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