RESEARCH ON THE INTENSITY OF FIRE SPRAY NOZZLES WITH A CONCENTRATED JET

Svilena Arabadzhieva
Academy of the Ministry of Interior, Sofia, Bulgaria
ssarab@mail.bg

Gabriela Gigova
Directorate Fire Safety and Civil Protection – Sofia City, Bulgaria
gigova.gabriela@abv.bg

ИЗСЛЕДВАНЕ ИНТЕНЗИВНОСТТА НА ОРОСЯВАНЕ НА СТРУЙНИЦИ ПРИ СБИТА СТРУЯ

Abstract

The jet range and the spray intensity of manual fire nozzles type B, C and D, brand AWG, with a compact jet have been studied. The methodology, experimental setup and results of the experimental studies have been presented. A comparison of the obtained results of the studied parameters at different pressures has been made.

Keywords: *Fire Nozzle; Compact Jet; Jet Range; Spray Intensity.*

INTRODUCTION

One of the most important prerequisites for successful firefighting is ensuring the necessary amount of extinguishing agent at the right moment.

Various types of extinguishing agents are used for firefighting. One of them is water. Various types of equipment are used to deliver it to the source of the fire. Two of the most commonly used are fire hoses and nozzles.

A fire hose is a flexible pipe designed to transport fire extinguishing agents [1]. The main type of hoses used by firefighters working for the General Directorate "Fire Safety and Civil Protection" - Ministry of Interior (GDFSCP-MI) is flat hoses.

Depending on the internal diameter of the cross-section, hoses are divided into [2]:

- Type A hoses (with an internal diameter greater than 75 mm);
- Type B hoses (with an internal diameter between 52 and 75 mm);
- Type C hoses (with an internal diameter between 36 and 52 mm);
- Type D hoses (with an internal diameter between 25 and 36 mm).

A nozzle is a device that is placed at the end of a hose line. It is used to shape, direct and regulate the jet of extinguishing agent, in particular water.

There are various criteria for classifying fire nozzles for water, the most important of which are:

Depending on the size of the couplings:

- nozzles with a coupling diameter of 75 mm (type B);
- nozzles with a connector diameter of 52 mm (type C);
- nozzles with a connector diameter of 25 mm (type D).

Depending on the type of jet they deliver:

- for dense (concentrated jet) – forming a dense water jet;
- for a dispersed water jet
- combined nozzles.

The main type of nozzles used by the employees of the General Directorate for Fire Safety and Civil Protection - Ministry of Interior (GDFSCP-MI) are combined nozzles.

A review of the literature [3], [4], [5], [6], [7] revealed that there are not many studies on the working characteristics of hand-held fire nozzles, and those that do exist are largely limited in terms of their specificity and results.

As a result of the literature review, it was found that there is a lack of up-to-date data on the nozzles that are the subject of this study, namely the AWG-52 mm, AWG-75 mm and AWG-25 mm hand-held fire nozzles, which are among the most widely used in the GDFSCP-MI.

EXPERIMENTAL SETUP AND METHODOLOGY

Study of the range of nozzles

To determine the range of the jet from the nozzle, a test bench is used in accordance with the requirements of [2].

The range of the jet is measured by fixing the nozzle on the stand at a height of 1 (± 0.01) m and at an angle of (30 ± 0.5)° to the ground. A control manometer is mounted in front of the nozzle. The maximum range of the jet is measured – the distance at which the furthest drops fall (dmax) and the effective range (deff), which is the maximum range reduced by 10% (deff = 0.9 dmax).

The maximum permissible wind speed during the tests is 2 m/s (3 on the Beaufort scale).

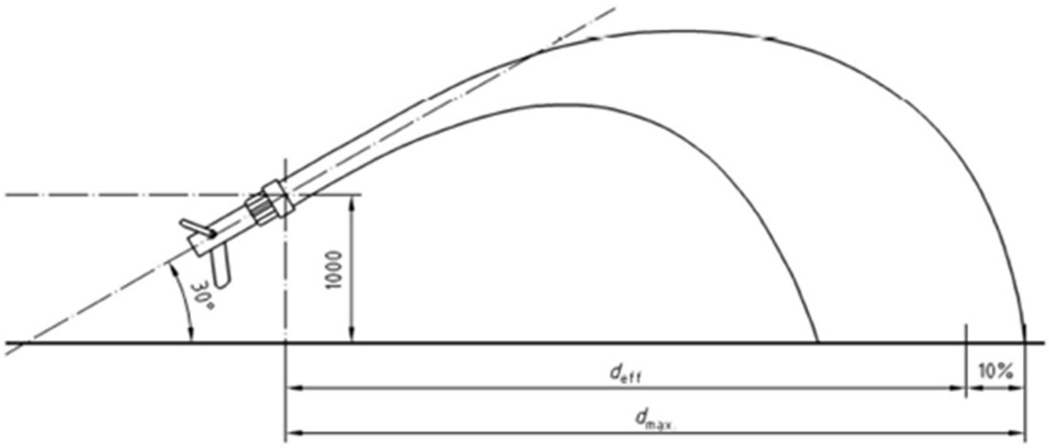

Figure 1 – Stand for determining the jet range from a nozzle

A limitation of the study is that the range of the jets from the different types of nozzles is measured at the same flow rate - 130 l/min. This flow rate was chosen because it is available for all three types of nozzles. The supply pressure is 0.5 MPa.

Study of the irrigation intensity of jets from nozzles

Forty metal measuring volumes, each measuring 0.5 x 0.5 x 0.2 m, are placed in front of the stand for determining the range of the jet. This results in a measuring line measuring 1.0 x 10.0 x 0.2 m. The measuring volumes are placed in the part of the jet where it begins to spread to its end (where there is irrigation). Water is supplied at a pressure of 0.5 MPa for 60 s. After the end of each experiment, the amount of water that has fallen into the metal boxes is measured using laboratory cylinders. The amount of water is measured for each square metre, i.e. for four measuring volumes.

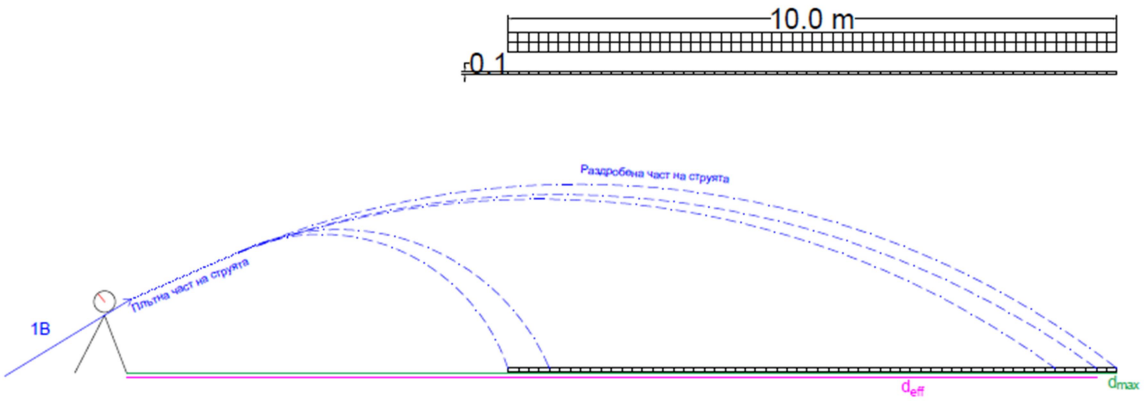

Figure 2 – Stand for determining the intensity of fire spray

MAIN RESULTS

Twenty experiments were performed with each type of nozzles. When a value is measured repeatedly, its most probable value (xavg.) is the arithmetic mean of all measurements and measured values. The arithmetic mean value of the measured quantity is also an approximate value, therefore, to characterise the accuracy of the measurement, the standard deviation of the mean result (σ) is introduced, which is accepted as the absolute error of the measured quantity when there are an infinite number of measurements.

The absolute (according to formula 1) and relative error (according to formula 2) of each type of measurement made is determined.

$$\sigma = \Delta x = \sqrt{\frac{\sum_{i=1}^{n}(x_{avg} - x_i)^2}{n(n-1)}} \quad (1)$$

$$\varepsilon = \pm \frac{\Delta x}{x_{avg}} \quad (2)$$

Jet range

The average values obtained from the measurements of the jet range and effective jet range are presented in Table 2.

Table 1 - Jet range and effective jet range

Nozzle connector diameter	[mm]	75	52	25
Jet range	[m]	24.5	21	20.5
Effective jet range	[m]	22.1	18.9	18.5
Relative measurement error	[%]	0.76	1.25	0.93

Intensity of jet irrigation

Twenty experiments were conducted to determine the jet intensity with each type of nozzle at a flow rate of 130 l/min and a pressure of 0.5 MPa.

The relative error of the measurements in the experiments with nozzles type B, C and D is 1.68%, 1.73% and 2.09%, respectively. The errors are below 3%, which makes the results reliable.

The average results of the experiments conducted to study the irrigation intensity of jets from nozzles types B, C and D are presented graphically in Figures 3, 4 and 5, respectively. The figures show a limit value of 0.100 l/s.m(^{2}) – the minimum intensity required for water supply when extinguishing solid combustible materials [8].

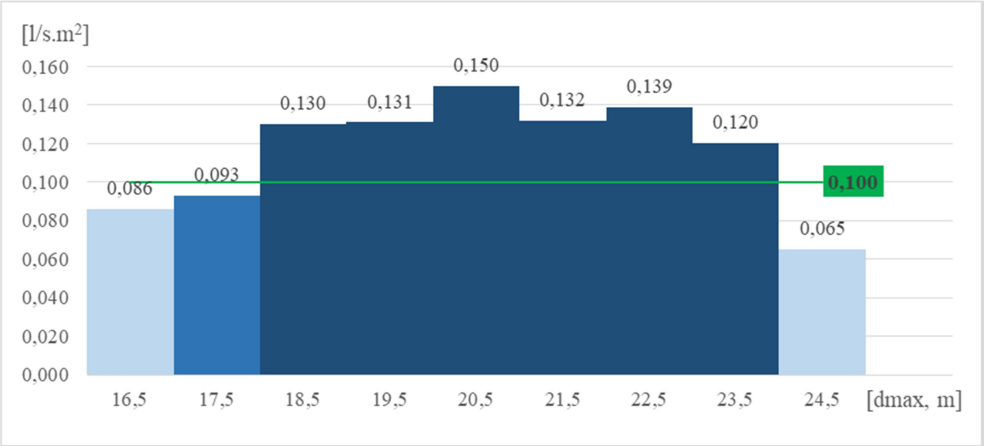

Figure 3 – Sprinkler intensity for type B sprinklers

Figure 3 shows that the maximum intensity is observed in the zone between 18.0 and 24.0 m, where the jet begins to fragment. This zone coincides with the effective area of water supply when extinguishing solid materials.

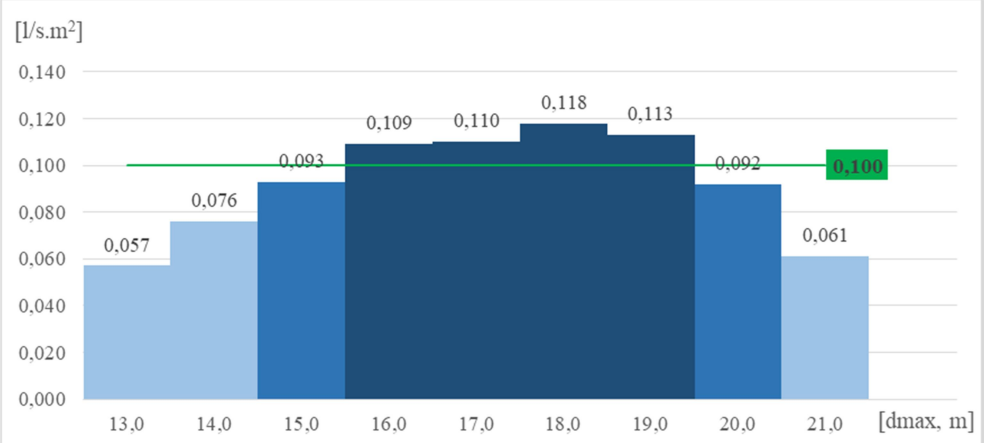

Figure 4 – Sprinkler intensity for type C nozzle

Type C nozzles have a shorter effective zone (15.5–19.5 m) compared to type B nozzles. The limit value of 0.100 l/s·m² is reached at the end of the fragmented part of the jet.
Figure 5 – Irrigation intensity from a type D nozzle

The zone in which the minimum required intensity (0.100 l/s·m²) is achieved is between 16.0 and 19.0 m. Due to the smallest diameter of the connector, this type of nozzle provides a smaller range but a finer and more uniform water curtain, suitable for close delivery.

For all types of nozzles, the minimum required water supply intensity along the length of the jet is achieved even beyond the standard effective range specified in [2], [9].

CONCLUSION

1. The experimental study conducted on hand-held fire nozzles type B, C and D (model AWG) with a compact water jet showed that under identical conditions of pressure (0.5 MPa) and flow rate (130 l/min), there are significant differences in range and irrigation intensity depending on the diameter of the connector.
2. The greatest effective range was recorded for type B nozzles – 22.1 m, while for type C and D nozzles the values were 18.9 m and 18.5 m, respectively.
3. The minimum required water supply intensity (0.100 l/s.m²) for extinguishing solid combustible materials is achieved in the fragmented part of the jet for all types of nozzles, but outside the regulatory effective range.
4. The relative measurement errors are below 3%, which confirms the reliability and repeatability of the results.
5. The results can be used to optimise the choice of nozzle according to the type of combustible material in a fire, as well as to improve the methods for evaluating firefighting equipment and in firefighting tactics training.

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