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Analysis of influence of tilt angle on the distribution of water droplets diameters in a spray generated by the Turbo Master 52 nozzle

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Abstract

This paper presents studies on the influence of the nozzle tilt angle on the distribution of water droplets diameters in a spray generated by the Turbo Master 52 nozzle. Analysis was limited to the most representative points located on the defined ellipses, constituting sprinkling surface of streams for the set angle of the nozzle, spray angle and flow rate. Among the others the following is discussed in the paper: study subject, study method, research stand and the course of studies. The studies were conducted for three different nozzle tilt angles of 20º, 30º and 40º, three different flow rates 200 dm^3/min, 300 dm^3/min and 400 dm^3/min, and two different spray angles 30º and 60º. The studies also included investigation of solid jet type for the same three nozzle angles and three flow rates. However, it is not covered in this article. The obtained results are presented in a tabular and graphical form. Based on the analysis of results the conclusion are formulated, important not only for the theoretical considerations but also in practice, especially in the context of water stream operation by the firefighters during rescue and fire-fighting actions.

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Keywords: spray; water nozzle; water stream; water droplet diameter; flow rate; sprinkling area; firefighting jets; spectrum drops.

1. Introduction

Water is one of the most commonly used extinguishing agent. It is mostly due to among others its physical and thermal parameters, as well as almost unlimited availability and reduced operational costs. Thus, unsurprisingly it is

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used for almost all types of fire. However, not always its extinguishing effectiveness is satisfactory. It depends on many factors, the most important one is method of providing it to the fire. Therefore, since many years numerous research institutes and even firefighters taking part in the firefighting actions on a daily basis, have conducted multiple studies on the effective use of water. Their main objective was optimization of water stream parameters with regards to firefighting actions. Over the years it has been proven among others that spray enables better use of water and its extinguishing properties. In the half of the 20th century Rasbash published works on extinguishing of hydrocarbon spills with water spray, where he analysed dependencies between droplets size, speed of mist, and extinguishing efficiency [26,27]. His experiments resulted not only in many valuable conclusions, but most of all revolutionized firefighting of that time. Little later, at the end of 70's of the 20th century, the studies of the US navy created the foundation for the present firefighting water installations in the buildings [2]. Thanks to them the importance of prevention has also increased – protection of buildings against the fire. Tangible benefits resulting from the use of fixed firefighting equipment in the buildings have been noticed. Naturally it gave an impetus for the development of the technical firefighting protection systems. Nowadays, studies on sprays are conducted by the American firefighter – instructor Paul Grimwood, who analyses mainly internal fires [7,8]. In his articles he discussed the use of sprays and related issue of droplets diameter optimization, characterized by the high efficiency of cooling of the ceiling zone by the effective heat removal and significant decrease of the after fire losses created by flooding of the part of the objects do not covered by the fire zone. Grimwood as a practitioner, based on many years of experience, focused mostly on practical aspects of the use of water streams in his studies, such as e.g. techniques of handling of firefighting jets. However, in his publications he specified also among others theoretical and practical ability of water cooling. Additionally, based on the available literature he presented an overview of recognized optimum droplets diameters in the context of ability to cool down fire environment. They are in the range of 200 μm to 500 μm depending on the type and phase of fire. All above mentioned studies confirm that firefighting has been dominated by the sprays. However, the problem is that the knowledge on sprays is still too little. Although there are some publications available, especially American and Scandinavian, on the water streams applied in firefighting, but none of them covers the full topic [20,21,29]. However, there are still missing works on sprays generated by the nozzles in the real conditions, and it should be stressed that it is especially important in a practical aspect, as the firefighting efficiency reflects duration of the fire. The theory on the spray and practical information on efficient fire-fighting among others can be found in [3,14,16,22,23,24]. Many studies on parameters of the spray generated by the different type of nozzles were carried out in The Main School of Fire Service in the last decades [4,5,12,15,17,28].

2. Study subject

A subject of the studies was Turbo Master 52 water nozzle manufactured by AWG Fittings GmbH, shown in Fig. 1 [6,25].

Fig. 1. Water nozzle Turbo Master 52 view [11].

Spray and jet type produced by the nozzle were analysed with regards to the droplets diameter distribution in the real conditions. The studied nozzle had a step flow rate controller in a range of 100-200-300-400 dm^3/min and flexible control of spray angle maximum to 160°. Control of flow rate was performed by the rotating ring, while control of