

Theoretical Aspects of the Application of Compressed Air Foam Generated from a Sodium Polyacrylate-Based Fire Extinguishing Agent for High-Rise Firefighting

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Abstract. This article investigates the features of the generation and application of compressed air foam, obtained from an aqueous sodium polyacrylate-based fire extinguishing agent, for firefighting operations, particularly concerning the delivery of extinguishing agents to elevated heights. The relevance of this study is driven by the need to improve the efficiency of firefighting in high-rise buildings. The paper examines an experimental setup for producing compressed air foam, which ensures the formation of a foam stream using compressed air and an aqueous solution of a gelling agent. Experimental studies of the physical characteristics of the generated foam were conducted; specifically, its density, expansion ratio, stability, and formation parameters were determined depending on the concentration of the polymer component. It was established that introducing sodium polyacrylate into the fire extinguishing agent increases the solution's viscosity, promotes the formation of a more stable foam structure, and enhances its water retention capacity. Based on the obtained experimental data, the parameters for the vertical delivery of the generated compressed air foam were calculated. It is demonstrated that using the developed setup in combination with the modified aqueous fire extinguishing agent allows for the formation of stable compressed air foam with improved performance characteristics, thereby expanding its application capabilities for high-rise firefighting purposes.

1 Introduction

Today's security challenges cause a significant increase in the number of man-made and war-related fires resulting from missile and artillery strikes, the use of unmanned aerial vehicles, and attacks on critical infrastructure facilities, fuel and lubricant storage facilities, industrial enterprises, and natural ecosystems. Thus, a significant portion of the fire seats is located in high-hazard zones at elevated heights or in territories with restricted access for fire and rescue service units. This necessitates the search for new technological solutions aimed at increasing personnel safety and firefighting efficiency.

An urgent problem arises regarding the resolution of two main tasks: improving firefighting efficiency and ensuring personnel safety. Given the high level of danger, extinguishing such fires requires high promptness and the application of means capable of more effectively combating the combustion of hazardous substances and materials. Traditional firefighting methods often prove insufficiently effective or require excessive volumes of fire extinguishing agents (hereinafter referred to as FEA), which determines the acute scientific and practical relevance of implementing innovative technologies, particularly the use of compressed air foam with enhanced characteristics.

Compressed air foam is a promising firefighting medium formed by mixing an aqueous solution of a foam concentrate with compressed air. Thanks to this technology, a foam structure with a controlled expansion ratio and increased stability is formed [1]. Studies show that compressed air