FIRE AND EXPLOSION HAZARD OF ACCIDENTAL HYDROGEN RELEASES IN ROOMS AND IN AN OPEN SPACE

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Abstract: An analysis was conducted on the research evaluating fire and explosion hazards associated with accidental releases of compressed and liquid hydrogen into both open spaces and enclosures. Scenarios with and without gas ignition were considered. It was established that for gaseous hydrogen releases, the length of the zone where the gas concentration exceeds the lower flammability limit can reach tens of meters; for liquid hydrogen, this distance can exceed 100 m. Research indicates that the combustion of quiescent hydrogen–air mixtures in open spaces, when initiated by a weak ignition source, proceeds in a deflagration regime for mixture volumes of up to 10,000 m^3. In such cases, the flame velocity increases as the volume of the hydrogen–air mixture grows. The critical size of the gas cloud required for deflagration-to-detonation transition was estimated to be 70 m. In the event of a hydrogen release into a closed space, either a jet fire or a hydrogen–air explosion may occur depending on the ignition delay. It was found that a layer with a uniform hydrogen concentration initially forms near the ceiling. A uniform distribution across the entire volume of the room is achieved only after several hours. The ignition of these hydrogen–air mixtures generates hazardous explosion loads. Such loads can be produced by the activation of thermally activated pressure relief devices, with the severity depending on the valve diameter and the airtightness of the room. The aforementioned characteristics of accidental hydrogen releases must be taken into account when developing fire safety regulations and designing hydrogen energy infrastructure.

Keywords: hydrogen; accidental release; ignition; explosion hazardous zone; scenarios of accidents

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