Determination of flammability and explosion parameters of aerosols of flammable liquids based on a new test method

Abstract

The topic of aerosol explosion risk has been previously addressed, yet precise guidelines and preventive measures remain lacking. Implementing such measures requires a detailed understanding of the flammability and explosiveness of aerosols. Currently, the most effective way to expand knowledge in this area is through experimental research. Aerosols of flammable liquids are present in many industrial processes and can also appear accidentally in various technologies. When assessing explosion risks, liquid aerosols occupy an intermediate position between gases, liquid vapors, and dusts.

To comply with the ATEX directive [2014/34/EU] in explosion-hazard areas, it is essential to understand the flammability and explosive properties of aerosols. Unlike dusts and gases, aerosols lack specific guidelines, standardized testing equipment, and established testing methods beyond a simple binary classification (flammable/non-flammable).

This doctoral dissertation presents a novel method for determining the flammability and explosiveness parameters of flammable liquid aerosols, based on a newly designed and constructed test stand. The developed research methodology enables the determination of key flammability and explosiveness parameters, including minimum ignition energy (MIE), maximum explosion pressure (pmax), maximum rate of pressure rise (dp/dt)max, and lower explosion limit (LEL).

The designed test station and innovative research method significantly differ from those used by other researchers. The uniqueness of this approach lies in introducing a controlled, shorter aerosol injection time without an additional carrier gas medium, which is typically used in other methods. This methodology allows for testing across a broad concentration range with a defined injection time and a specific particle size distribution range (based on the Sauter mean diameter), in accordance with the aerosol definition in standard [EN 60079-10].

Applying this newly developed method represents an innovative scientific and research solution for assessing aerosol explosion risks in workplaces and industrial installations. This allows for the selection of appropriate explosion prevention measures for aerosols and protective systems. Furthermore, it indicates the possibility of implementing suitable technological solutions and meeting legal requirements.