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On the ignition hazards of combustible liquid: the case of S-lactic acid water solution

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Abstract:

The current ongoing innovation in the field of energy production has promoted the development and utilization of alternative combustible liquids in a wide range of processes and under different operative conditions. Once flammable liquids are of concern, the simultaneous exceedance of the flash point and the presence of an external source of ignition, such as electrostatic sparks or hot spots, lead to a flame-related scenario. Besides, a flame can be expected if the vapours are in contact with a hot surface also in the absence of an electrostatic source. Based on these considerations, safety parameters are typically collected and adopted for the classification of the safety of liquids. Nevertheless, anomalous behaviour can be observed if the liquid is subject to pyrolysis or thermal degradation due to the heating, even below the flash point. Indeed, the integrity of the initial chemical structure is not guaranteed anymore, with obvious implications on the composition of the produced vapours. For these reasons, this work is dedicated to the specific case of the hazard of combustible liquids due to the insurgence of secondary reactions (e.g., thermal degradation and soot formation) because of thermal radiation produced by heating resistance providing constant heat flux to the sample within the range 7 kW/m2 and 50 kW/m2. To this aim, an aqueous solution having 90 %w lactic acid was analysed experimentally by employing a cone calorimeter. More specifically, the time evolution of the mass of a liquid sample initially placed in an open box of 10 cm x 10 cm x 1 cm was monitored together with the composition of the exhaust gas and the heat release rate. The temperature of the liquid during the pool fire of lactic acid was also measured during the test. Therefore, the ignitability and the flame intensity were assessed. Results were compared with experimental data from the literature and theoretical data. The use of flash point temperature (regardless of the approach adopted for its evaluation) has been found to lead to non-conservative results on the safe side. Based on the collected data, the use of a cone calorimeter is recommended to evaluate the ignitability of liquid substances exposed to heating and electrical sources.

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