Propagation of Hydrogen-Air-Vapor Flame in presence of water droplets

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Water Spray Systems, are widely used to decrease the containment building pressure and to avoid a fission products leak, in case of Severe Accident in Nuclear Power Plant. In case of severe accident context, hydrogen may be produced and released inside the containment and a considerable stratification of hydrogen always presents some likelihood
to compromising the safety of a NPP. Water Spray Systems homogenize the hydrogen distribution and may lead to "de-inertization" of the mixture through the condensation of steam on water droplets. If the mixture is opportunely ignited, it may lead to a dangerous regime of combustion: flame acceleration that could transit to detonation that will challenge and compromise the containment integrity. For what concerns the propagation of a hydrogen-air-vapor Flame in presence of water droplets, the state of art doesn't allow to quantify clearly in what measures and in what conditions, the use of Water Spray (WS) can intensify the severity of the explosion. Experimental Data will be collected through 2 Facilities: ENACCEF 1 and 2 which are two vertical setups highly instrumented with Photomultipliers, Pressure Sensors and equipped with obstacles with different shapes and dimensions. These Vertical Acceleration Tubes are equipped with windows which allow using Advanced Optical Diagnostics: Schlieren Technique, Tomography and Particle Image Velocimetry.
Preliminary Calculations and 1D Flames Simulations are conducted by using COSILAB software. The goal was to obtain basic information about Hydrogen Laminar Flame Thickness and Laminar Flame Speed which allow defining the sprays's features suitable for this study.
The chosen nozzles, different in terms of generated droplets size, are selected to act on different aspects of the flame propagation: Thermal, Kinetic, Global.
By considering the Experimental set up which will be used to study the flame in presence of droplets, it is necessary characterize the behavior of the spray in a vertical pipe.
By using Laser Particle Diffraction, at different quote of the pipe, 5 nozzles are characterized during the injection phase in terms of: Volume Diameter trend, the Probability Density Function and the Cumulative Function.
By combining Information about the Optical Density and Light Scattering, the Spray Density for each injector, is characterized in qualitative terms.
The next step will be to employ the injector on the ENACCEF1 and 2 and to study the behavior of the Flame Propagation.

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