Hydrogen release and distribution experiments in closed cylindrical vessel

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The general goal of the study is to create an experimental database to be used in subsequent development of the rational (non-empiric) guidelines for a minimal number and spatial allocation of the indoors hydrogen sensors.

To develop the rational guidelines for sensor allocation, it is necessary 1) to study the basic flow patterns during hydrogen release and dispersion inside a room for representative hypothetical accident scenarios, 2) to collect quantitative data on averaged speed propagation of the critical concentration front (envelope of explosive/flammable gas cloud) under well-controlled boundary and initial conditions.

The report presents the preliminary experimental results on hydrogen subsonic leakage in a closed vessel under well-controlled boundary/initial conditions. The formation of the hydrogen-air gas mixture cloud was studied for a transient (15 min) hydrogen leakage, which was followed by subsequent evolution (30 min) of the explosive cloud. Low-intensity ($2 \cdot 10^{-2}$–$5 \cdot 10^{-2} m^3$/sec) hydrogen release was performed via circular (diameter 0.014 m) orifice located in the bottom part of the horizontal cylindrical vessel (≈4 m^3). A spatially distributed net of 24 hydrogen sensors and 24 temperature sensors was used to permanently track the time dependence of hydrogen concentration and temperature fields in the vessel. Analysis of the simultaneous experimental records for different spatial points permits to delineate the basic flow patterns and stages of hydrogen subsonic release in a closed vessel in contrast to hydrogen jet release in an open environment. The quantitative data were obtained for the averaged speeds of explosive cloud envelop (50% fraction of the Lower Flammability Limit (LFL)) propagation in the vertical and horizontal directions. The obtained data will be used as an experimental basis to develop the guidelines for an indoors allocation of hydrogen sensors. The data can also be used as a new benchmark case to validate the reactive Computational Fluid Dynamics codes.

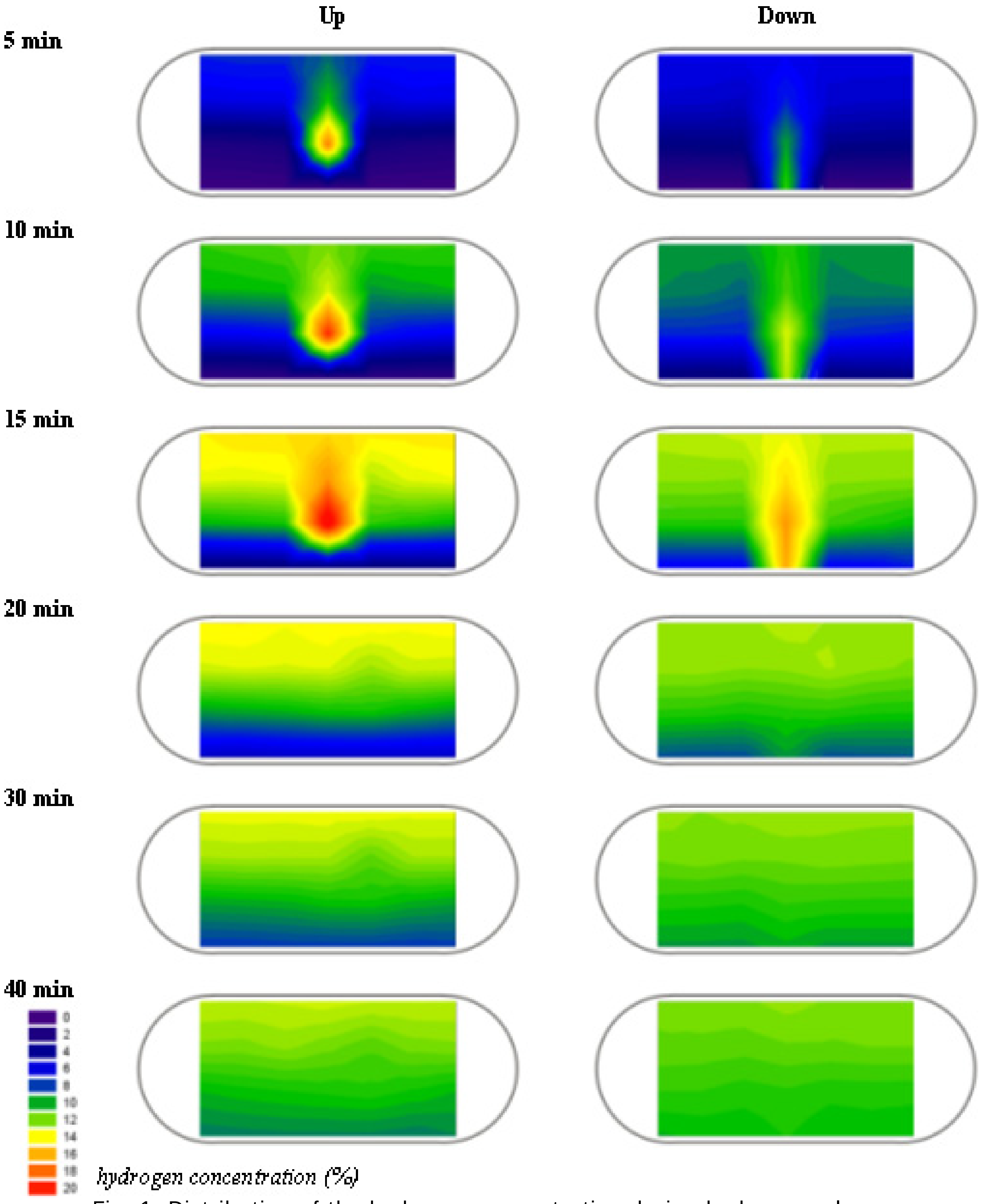

Fig. 1. Distribution of the hydrogen concentration during hydrogen release and dispersion at orientation of hydrogen input tube (orifice) "up" and "down" (hydrogen flow 0,42 (0,038) l/s (g/s))