ON THE CRITERIA OF HYDROGEN SELF-IGNITION DURING ITS RELEASE FROM A HIGH-PRESSURE VESSEL

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Abstract: The paper presents results of the numerical modeling of high-pressure hydrogen release into air followed by self-ignition. Two problem statements are studied: release through a slit from a tube or a vessel into the space with an obstacle and release through two separated slits. The modeling is performed in two-dimensional approach in Cartesian coordinates. In the framework of the first statement, the initial pressure of hydrogen and the distance to the obstacle are varied, the half-width of the slit is set equal to 1 mm. In the framework of the second statement, the size of slits and the distance between them are varied while the initial pressure of hydrogen is 350 atm. It is shown that the mentioned parameters of the problem determine regimes of hydrogen flow: with and without ignition. For the first statement, two regimes of flow with ignition are observed: before the jet reaches the obstacle and as a result of the reflection of the flow from it. The obtained results could be interesting for the elaboration of hydrogen safety systems.

Keywords: hydrogen; jet flow; self-ignition; criteria of self-ignition; mathematical modeling

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Figure Captions

Figure 1 Statements of two problems: *1* (gray region) — high-pressure chamber; *2* (white region) — low-pressure chamber; *3* — diaphragms; *4* — plane of symmetry; *5* — solid wall (obstacle); *6* — overall dimensions of a high-pressure vessel whereof hydrogen flows (two cases were considered: release from a vessel and release from a tube of $2h$ width); *7* — wall with slits; and *8* (hatched region) — region with coarse grid. Dimensions are given in meters

Figure 2 Temperature fields at 8 (*a*) and 14 μs (*b*). Conditions of simulation: $L = 1.2$ cm, $p = 300$ atm, and release from a tube. Number designations are presented in the text

Figure 3 Diagrams of hydrogen release regimes in coordinates p–L. Squares correspond to ignition before the jet reaches the obstacle; circles — self-ignition as a result of jet reflection from the obstacle; and triangles — absence of ignition. Small symbols correspond to the release from a tube and the large ones — from a vessel

Figure 4 Density gradient field at 6 μs for the case of hydrogen release through two slits of a total width of 3.52 mm (h_Σ), the distance between slits is 5 mm (h_0). Number designations are presented in the text

Figure 5 Diagram of hydrogen release regimes in terms of the width of two slits and the distance between them. Empty signs refer to the cases of ignition occurrence and filled signs to its absence

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