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NUMERICAL ESTIMATION OF WALL HEIGHT FOR PROTECTING HUMANS FROM ACCIDENTAL HYDROGEN EXPLOSION CONSEQUENCES

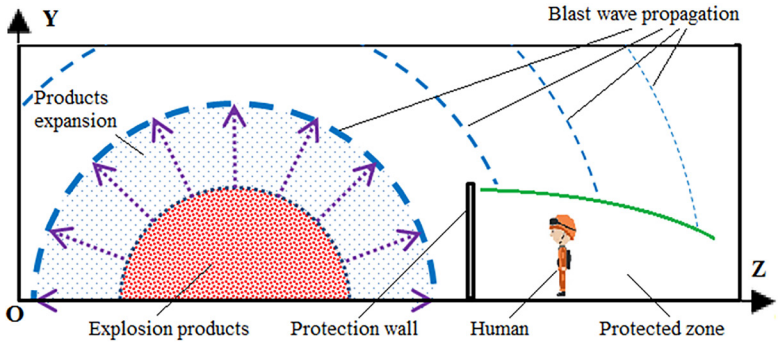
Yurii SKOB[1*], Sergiy YAKOVLEV[2], Oksana PICHUGINA[3], Oleksii KARTASHOV[4], Igor BYCHKOV[5], Volodymyr KHALTURIN[6]

[1–6] *Kharkiv National Aerospace University 'KhAI', 17, Vadym Man'ko Str., 61070 Kharkiv, Ukraine*

[*] ***Corresponding author.*** *Email address: y.skob@khai.edu*

Abstract – The purpose of the study is to numerically determine the height of a wall designed to protect people from the negative effects of a blast wave, ensuring a specified level of safety. An accidental explosion of a hemispherical hydrogen-air stoichiometric cloud is considered. Near the epicenter of the accident, a person is subjected to shock-impulse loading as the blast wave front passes. A protective wall is installed between the accident epicentre and the person's location to mitigate the explosion's impact on human health. The wall's transverse size (width) is sufficiently large to ensure that it does not affect the safety of a person whose location remains unchanged. The required height of the protective wall can be determined by solving an inverse problem in gas dynamics, focusing on the movement of a multicomponent mixture of hydrogen combustion products through the surface layer of the atmosphere at the accident site. The gas flow disturbed by the explosion collides with the wall barrier, partially reflects off the wall, and moves around it in a vertical longitudinal plane, exerting a baric effect on a person. Solving the combined gas-dynamic and safety problem of human damage by a blast wave helps determine whether the current height of the protective wall is sufficient to ensure a safe level of conditional probability of human damage. A series of computational experiments were conducted for different heights of the protective structure using the mathematical model of a gas explosion and probit analysis. As a result, the relationship between the conditional probability of human injury and the vertical size of the wall was established in the form of a plot. Using this plot, a safety expert can determine the required wall height to ensure a sufficient level of human safety in the event of a hydrogen explosion accident.

Keywords – Blast wave front; environmental consequences; gas dynamics direct problem; hydrogen explosion; overpressure; probit analysis; shock-impulse load



Model diagram of the hydrogen accidental explosion process.