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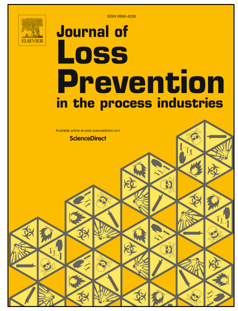

Containing hydrogen deflagrations

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Containing Hydrogen Deflagrations

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Abstract

Schroeder and Holtappels (2005) published data on the explosion characteristics of hydrogen-air mixtures, looking at the effect of pressure and temperature on upper and lower explosive limits and the effect of pressure, temperature, and composition on explosion ratio, P_{EX}/P_O. They showed that the effect of increasing pressure on UEL and LEL is negligible to slightly advantageous, while the effect of increasing temperature was disadvantageous. They also showed that the explosion ratio was largely independent of operating pressure, but very dependent on temperature and composition of hydrogen-air mixtures. However, they did not develop their data to the point that it could be used as the basis of design and risk assessment.

This paper uses the data published by Schroeder and Holtappels to develop equations that can be used to predict the extent of a hydrogen-air deflagration in a vessel and correlates those predictions to the nature of pressure vessel failures that are likely to be experienced as a result of such a deflagration.

Keywords

Containment, Deflagration, Equipment design data

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1 Hydrogen Is Dangerous

Hydrogen is the most common element in the universe. As a molecule, H_2 is colorless, odorless, and tasteless. It is not toxic, not a carcinogen, and has no threshold limit value. Nonetheless, it is dangerous for a number of reasons. It is an asphyxiant. It is frequently used as a cryogen. It causes hydrogen embrittlement. Also, hydrogen is very flammable, burning easily to form water.

While non-toxic, it is not air, so it is a simple asphyxiant. People will feel adverse effects of a hydrogen release when it forces the oxygen concentration in the gas they are breathing to less than 19 %. When a release of hydrogen forces the oxygen concentration to less than 10%, people will become unable to move, lose consciousness, and suffer convulsions. At an oxygen concentration less than 6%, death occurs in minutes.

In most industrial applications, hydrogen is used as a gas, which is the state of H_2 at standard conditions. However, its boiling point is 20.3 K (-423°F), which means that both liquid hydrogen and hydrogen gas vaporized from liquid hydrogen have the potential to be very, very