Reductions in Hydrogen Detonation Velocity and Range through the Addition of Incombustible Gases Composed of Polyatomic Molecules

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In recent years, there has been significant interest in the use of hydrogen as an alternative energy source. In order to allow the safe handling of hydrogen, however, it is important to reduce the associated risk of explosion. This study demonstrated that both the detonation velocity and detonation range of a mixture of hydrogen (H2) and oxygen (O2) gases are decreased by the addition of carbon dioxide (CO2) or water vapor. This work investigated changes in the detonation velocity on adding incombustible gases composed of polyatomic molecule to a mixture of gaseous H2 and O2 held in a long plastic tube. A combination of H2, O2 and CO2 exhibited a detonation velocity less than that predicted by the Chapman-Jouguet theory, attributed to a retardation of the combustion reaction caused by the large specific heat of CO2, which in turn prevented chemical equilibrium from being established. Additional trials were performed using mixtures of H2, O2 and water vapor, which also has a high specific heat value, and again slower detonation velocities were observed. Other trials showed that detonation would still occur even when adding helium or argon at more than 50% of the total gas volume, while detonation did not occur when adding CO2 at 25% or more. Thus, the observed decrease in the detonation range was attributed to the high specific heat of CO2. These results suggest that the addition of CO2 can reduce the risk of explosion and may have applications in allowing the safe use of hydrogen.