Propagation Behavior of Detonation Waves in Hydrogen-Oxygen Mixtures with Concentration Gradient

M. Kojima, K. Ishii, T. Tsuboi

Department of Mechanical Engineering, Faculty of Engineering
Yokohama National University, 79-5 Tokiwadai, Hodogaya-ku, Yokohama
240-8501 Japan

Detonation waves propagating in a mixture with concentration gradient was studied experimentally. The detonation chamber has a cross-section of 40 mm × 20 mm and its total length was 500 mm. The dilution gas chamber was attached to the detonation chamber and was separated from it by a partition plate. To form mixtures with concentration gradient normal to a direction of detonation propagation, oxygen or hydrogen was diffused from the dilution gas chamber into the detonation chamber in which a stoichiometric hydrogen-oxygen mixture was initially charged. By using ethane as alternative of oxygen, mixture concentration was measured by infrared absorption method.

The experimental results show that mixture strength changes monotonically for oxygen diffusion, whereas for hydrogen diffusion it changes in a complex manner with time due to buoyancy and high diffusivity of hydrogen. From velocity measurement it is also found that a detonation wave propagates at a speed corresponding to the Chapman-Jouguet one of a local equivalence ratio. The smoked foil record reveals two different regions of cellular pattern in the case of hydrogen diffusion. One region shows irregular cellular structure which has almost the same feature of a stoichiometric hydrogen-oxygen mixture. The other has relatively regular rhombus pattern whose size is smaller than the irregular cell mentioned above.