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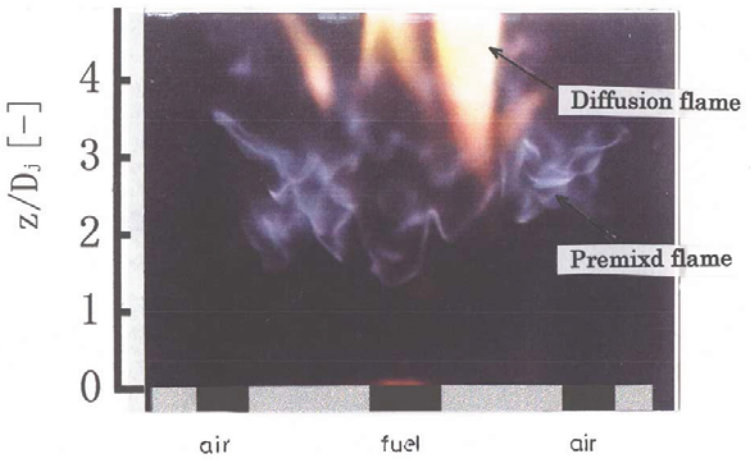
Lift-Off of Non-premixed Flames on a Bluff-Body Burner

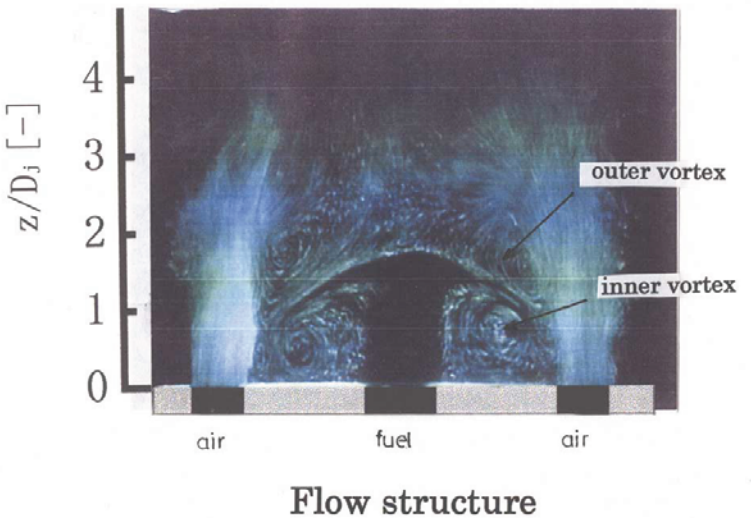
***Nishimura, T.*[1)] *, Morio, K.*[1)] *and Kawahara, H.*[2)]**

1) *Department of Mechanical Engineering, Yamaguchi University, 2-16-1 Tokiwadai, Ube, Yamaguchi 755-8611, Japan*

2) *Shipping Technology Department, Oshima National College of Maritime Technology, Oshima 742-2193, Japan*



Lift-off flame behavior



Flow structure

Non-premixed propane and air flame stabilized by a bluff-body burner in which a central fuel jet issues into a surrounding annular air flow is often used industrially. A direct photograph of lifted flames on a bluff-body burner and the corresponding streak pattern visualized by particle tracers are shown under the conditions of the fuel velocity u_f = 0.637 m/s and the air velocity u_a = 2.69 m/s. The base of lifted flame consists of a circular ring-shaped premixed flame, i.e., separated, broken flamelets. The flamelet structure is not clear but is suggestive of a triple flame. This is because in the approaching flow field a mixture fraction gradient exists. There is also a diffusion flame in the central region above the premixed flame. The two flames violently oscillate due to the unsteady vortical motion behind the bluff-body, but never blow out. It should be noted that this phenomenon occurs at a low central fuel velocity and that the structure of the lifted flame is quite different from that for pure jet diffusion flame. This is due to a recirculation zone behind the bluff-body. This zone is established as a result of the expansion and entrainment of the annular air flow. A pair of counter-rotating vortex rings is observed in this zone, and inner and outer vortices are generated by the central fuel jet and the annular air flow, respectively. The base of lifted flame is found to be located in the edge of the outer vortex, where enhanced fluid mixing occurs because of the unsteady vortical motion.