Cloud Cavitation

In many flows of practical interest one observes the periodic formation and collapse of a "cloud" of

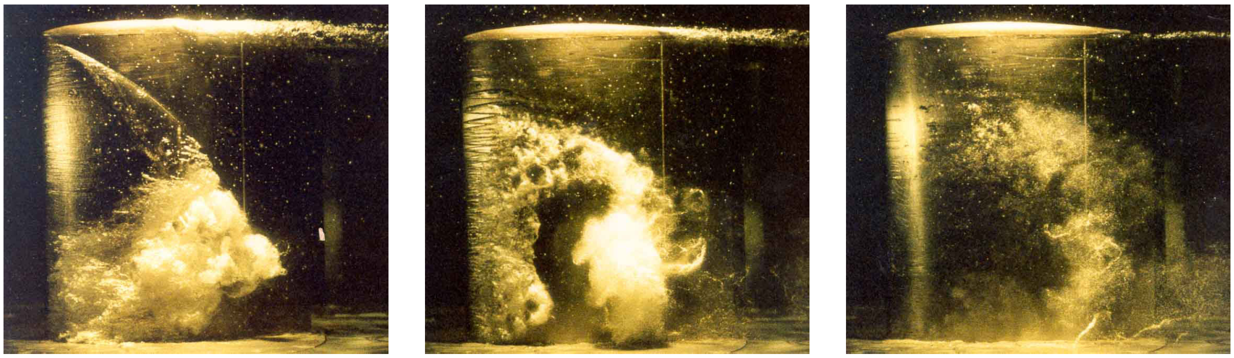

Figure 1: Three frames illustrating the formation, separation, and collapse of a cavitation cloud on the suction surface of a hydrofoil (0.152 m chord) oscillating in pitch with a frequency of 5.8 Hz and an amplitude of $\pm 5^\circ$ about a mean incidence angle of 5°. The flow is from left to right, the tunnel velocity is 7.5 m/s and the mean cavitation number is 1.1. Photographs by E.McKenney.

cavitation bubbles. Such a structure is termed "cloud cavitation." The temporal periodicity may occur naturally as a result of the shedding of cavitating vortices, or it may be the response to a periodic disturbance imposed on the flow (see, for example, Figure 1). Common examples of imposed fluctuations are the interaction between rotor and stator blades in a pump or turbine and the interaction between a ship's propeller and the nonuniform wake created by the hull. In many of these cases the coherent collapse of the cloud of bubbles can cause more intense noise and more potential for damage than in a similar nonfluctuating flow. Bark and van Berlekom (1978), Shen and Peterson (1978), Franc and Michel (1988), Kubota *et al.* (1989), and Hart *et al.* (1990) have studied the complicated flow patterns involved in the production and collapse of a cavitating cloud on an oscillating hydrofoil. These studies are exemplified by the photographs of Figure 1, which show the formation, separation, and collapse of a cavitation cloud on a hydrofoil oscillating in pitch. All of these studies emphasize that a substantial bang occurs as a result of the collapse of the cloud; in Figure 1 this occurred between the middle and right-hand photographs.

Cloud cavitation continues to be a primary concern for propeller and pump manufacturers and is currently the subject of active research. In sections (Nm) we presented some simplified, analytical investigations that provided some qualitative information on the coherent dynamics of these structures. More accurate modeling of these complex, unsteady multiphase flows poses some challenging problems that have only begun to be addressed. The recent numerical modeling by Kubota, Kato, and Yamaguchi (1992) is an important step in this direction.