Howard A. Stone
Donald R. Dixon '69 and Elizabeth W. Dixon Professor
Department of Mechanical and Aerospace Engineering
Princeton University

"Elementary flows with surprising responses: (I) Biofilms and flow and (II) Trapping of bubbles in stagnation point flows"

Abstract

In this talk we describe two distinct problems that we have studied where seemingly modest variations in an elementary channel flow produce new effects. First, we investigate some influences of flow on biofilms. In particular, we identify the formation of biofilm streamers, which are filaments of biofilm extended along the central region of a channel flow, and show how these filaments are capable of causing catastrophic disruption and clogging of industrial, environmental and medical flow systems. We present a mathematical model to rationalize the rapid growth of the streamer. Second we consider flow in a T-junction, which is perhaps the most common element in many piping systems. The flows are laminar but have high Reynolds numbers, typically Re=100-1000. It seems obvious that any particles in the fluid that enter the T-junction will leave following the one of the two main flow channels. Nevertheless, we report experiments that document that bubbles and other low density objects can be trapped at the bifurcation. The trapping leads to the steady accumulation of bubbles that can form stable chain-like aggregates in the presence, for example, of surfactants, or give rise to a growth due to coalescence. Our three-dimensional numerical simulations rationalize the mechanism behind
this phenomenon.