Vortex suppresion in an oscillating flow

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The motivation for this work was the reduction of losses due to vortex formation at the entrance of a wave driven sea-water pump. Measurements in a wave tank using a prototype had shown a 10% increase in the pumping efficiency when a trumpet like shape was added to the intake. This lead us to search for an intake that would reduce or completely suppress vortex formation.

In this experiment a piston produces an oscillating flow inside a partly submerged duct. At the end of the duct four different shapes were tested. The flow field was visualized either by using silver paint in the water or by injecting diluted fluorescent water paint just outside the diffuser. In both cases the flow was illuminated with a light sheet. A wide range of frequencies and amplitudes of oscillation of the piston, controlled electronically, were studied.

The four shapes are:

(1) A cylindrical duct (Fig. 4). The outflow is similar to that of a circular jet. During inflow vortices are formed along the walls.

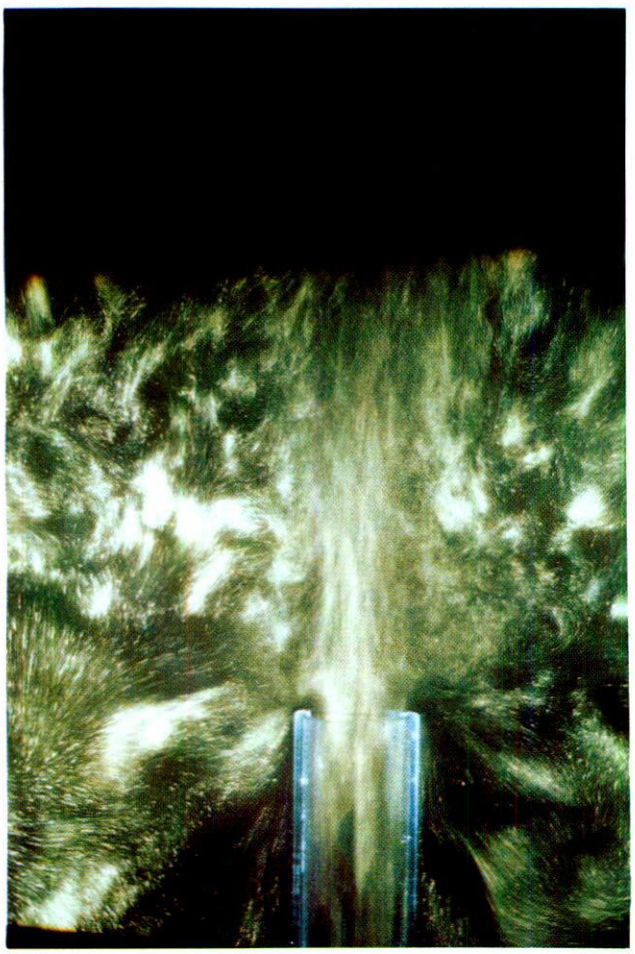

FIGURE 4. Cylindrical duct.

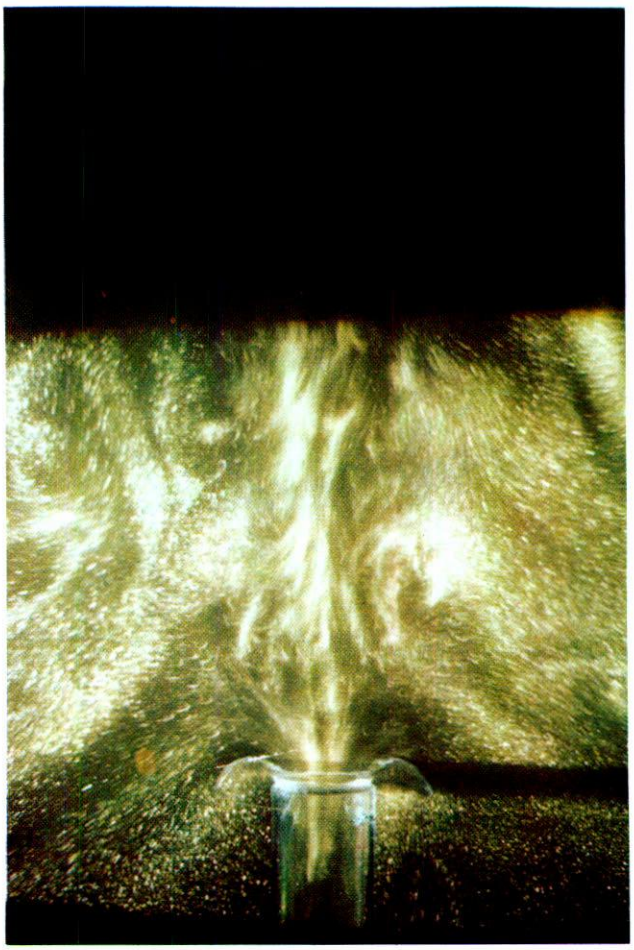

FIGURE 5. Cylindrical duct with circular attachment.

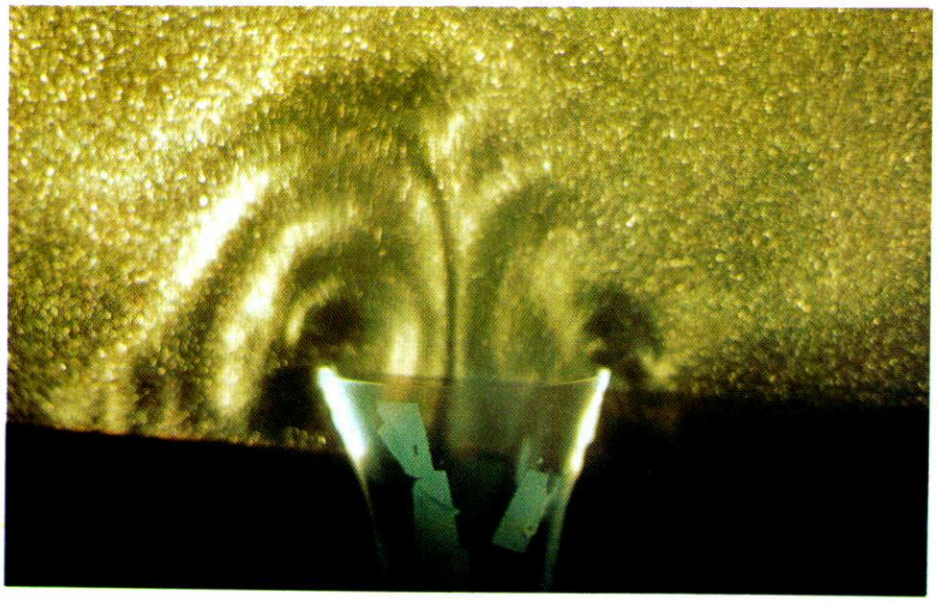

FIGURE 6. Conical diffuser.

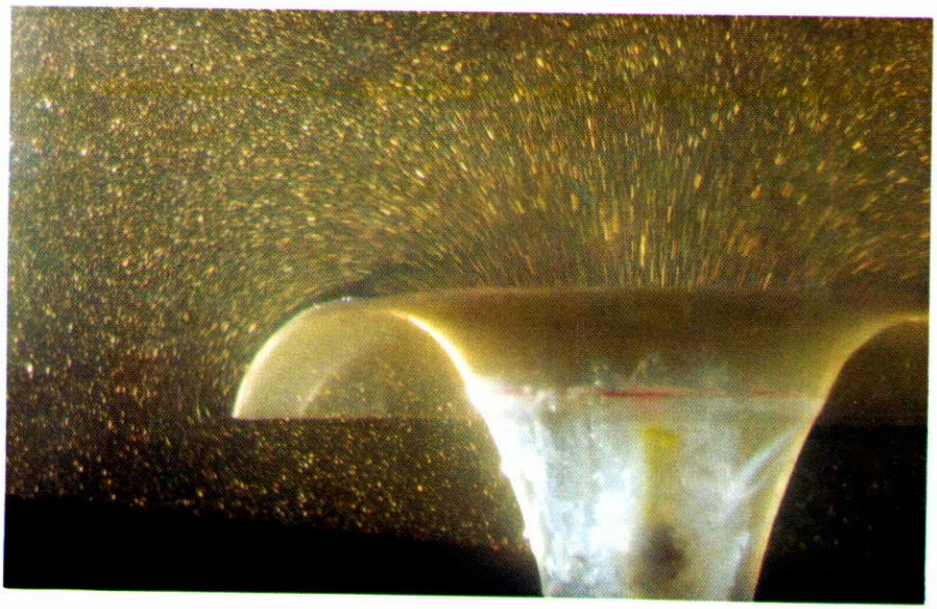

FIGURE 7. Conical diffuser with circular attachment.

(2) A cylindrical duct with a circular attachment (Fig. 5). Outflow is similar to that of a circular jet. The inflow seems quite aligned and no vortices are observed along the wall.

(3) Vortices are formed because there is no equilibrium between inertial and centripetal forces. A diffuser was designed such that a constant relationship between these forces is maintained along the profile. This design produces a large variety of flows strongly dependent on the frequency and amplitude of the oscillation, one example is shown in Fig. 6.

(4) Form (3) with a circular ending. This shape completely suppresses vortex formation, as can be appreciated in Fig. 7.

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