Sound and Vibration due to Fluid-Structure Interaction

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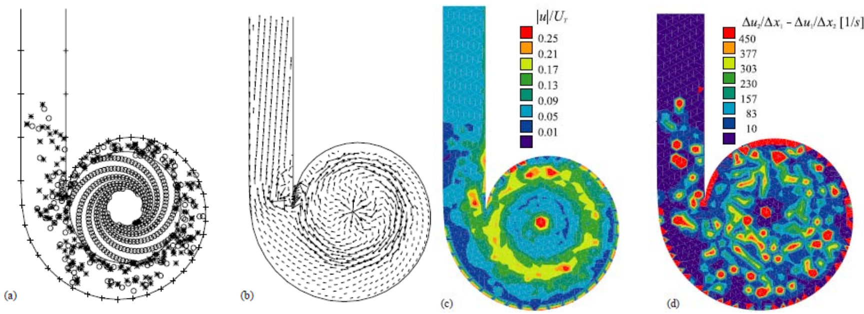

Fig. 1. (a) Flow in a centrifugal pump modeled by discrete vortices. (b) Velocity vectors. (c) Iso-velocity levels. (d) Iso-vorticity levels.

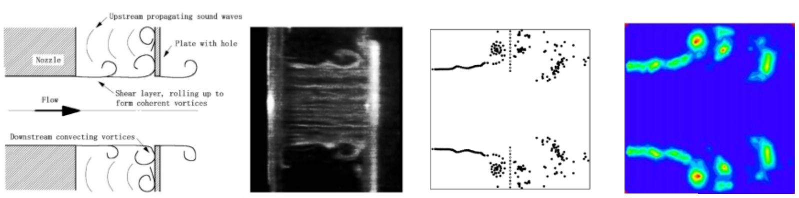

Fig. 2. (a) Principle of the hole-tone feedback problem. (b) Experimental flow-visualisation (by Prof. Nakano, Tohoku Univ.) (c) Flow simulation using discrete vortex rings. (d) Iso-vorticity levels.

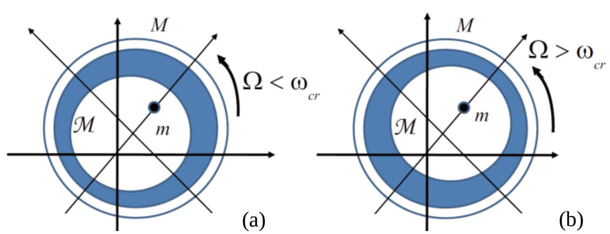

Fig. 3. Working principle of the fluid balancer. (a) Below critical angular velocity; the unbalance mass *m* and the fluid center of mass are on the same side. (b) Above critical angular velocity; mass balance is observed.

Content :

I'm interested in mathematical/numerical modeling and analysis of problems involving the interaction of fluids and structures, and the resulting generation of sound and/or structural vibrations. Some problems that have been, or are being, analyzed are as follows.

①*The hydroacoustics of the centrifugal pump* (Fig. 1) is becoming of increasing importance as pump are being made more and more efficient – and thus also more noisy. The most important sound sources have been indentified and modeled mathematically.

② *The hole-tone feedback problem* (Fig. 2), also known as Rayleigh's bird-call problem, is utilized in the common teapot whistle. The intrinsic dynamics of this classic problem is studied thoroughly.

③ *The fluid balancer* (Fig. 3) is typically used in modern household washing machines. It is a hula hoop ring-like structure, containing a small amount of liquid which, during rotation, is spun out to form a thin liquid layer on the inner surface of the ring. The liquid is able to counteract the unbalance mass (i.e. the laundry). The aim is to understand the mechanism behind the stabilization.

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