Fluid-Structure-Acoustic Interactions

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Computational analysis of fluid-structure interactions (FSI) represents a considerable challenge for most computational analysis codes. Simple one-way coupled problems, in which the fluid pressure deforms a structure but does not substantially affect the fluid flow characteristics, can be solved by a variety of techniques. Solutions to the more complex two-way coupled fluid-structure interactions are more elusive. These occur when pressure of the flow of fluid deforms a structure in such a way that the resulting deformation alters the flow of fluid. The two-way coupled approach solves this problem and produces accurate, time dependent results.

Through the use of COMSOL Multiphysics, Altasim of Columbus, LLC has developed practical solutions to realistic FSI problems across a wide range of applications in the biomedical, automotive and petrochemical industries. Examples of FSI problems in these industries include: blood flow through flexible systems, characteristic acoustic signatures of valve components, structural vibration due to intermittent transient flow through compressors and control of fluid cavitation around a vibrating structure.

COMSOL Multiphysics has been used to develop a specialized multiphysics model describing the response of a vibrating needle in a liquid. The vibration of the needle generates a pressure wave and causes bending of the flexible needle.

The FSI solution couples the continuum equations of solid mechanics with the Navier-Stokes equations of fluid mechanics. COMSOL Multiphysics solves these equations simultaneously over the same computational domain using an Arbitrary Lagrangian-Eulerian formulation (ALE). The moving mesh capabilities in the ALE formulation of COMSOL allow a stable solution while increasing the amounts of needle movement and deformation.

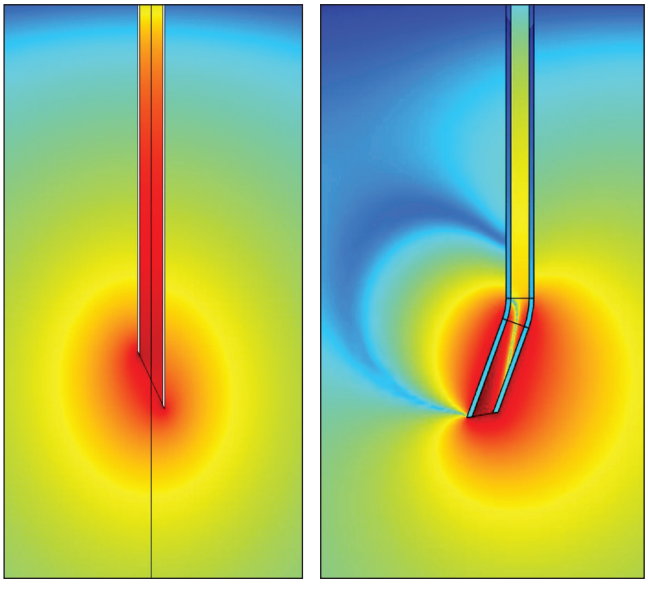

Figure 1. Sound pressure levels developed from two needle designs. These designs seek to maximize local pressure levels and minimize pressure at a specified distance.

Solutions of this type can quantify the influence of key design variables of the system. For example, the operating stress experienced by the needle, stream lines of the fluid flow, and the acoustic sound pressure levels developed (see Figure 1).

The results of fully coupled FSI analyses have allowed AltaSim to resolve performance issues with new products prior to mass production, significantly reducing the time and cost of new product development and manufacture.

This work was performed by Dr. S.P. Yushanov, Dr. J.S. Crompton, and Dr. K.C. Koppenhoefer using COMSOL Multiphysics. For more information please contact: K. Koppenhoefer, 130 East Wilson Bridge Rd, Suite 140, Columbus, OH 43230, or visit ***www.altasimtechnologies.com****.* ■

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