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Adding Some Gas Can Completely Change How an Object in a Liquid-Filled Housing Responds to Vibration J.R. TORCZYNSKI, T.J. O'HERN, J.R. CLAUSEN, Sandia National Laboratories — Adding a little gas can completely change the motion of an object in a liquid-filled housing during vibration. A common system exhibiting this behavior is a spring-supported piston in a liquid-filled cylinder, where the gaps between them are narrow and depend on the piston position. When gas is absent, the piston's vibrational response is highly overdamped due to forcing viscous liquid through narrow gaps. When a small amount of gas is added, Bjerknes forces cause some of the gas to migrate below the piston. The resulting two gas regions form a pneumatic spring that enables the liquid to move with the piston, with the result that very little liquid is forced through the narrow gaps. This "Couette mode" has low damping and thus has a strong resonance near the frequency given by the pneumatic spring constant and the piston mass. At this frequency, the piston response is large, and the nonlinearity from the gap geometry produces a net force on the piston. This "rectified" force can be many times the piston's weight and can cause the piston to compress its supporting spring. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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