Dynamics of Liquid-Protected Fusion Chambers

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Thick liquid jets can provide vital protection for inertial fusion power plants by shielding solid structures inside the reaction chamber from high-energy neutrons and x-rays. Fluid mechanics problems then replace the complex and costly materials testing and development path required to develop alloys capable of surviving an unattenuated neutron spectrum.

At U.C. Berkeley, thick liquid protection is being studied for several inertial fusion energy (IFE) concepts via numerical and experimental tools. TSUNAMI, a gas dynamic code, is being used to model the venting of debris and vaporized liquid following fusion micro-explosions in various thick-liquid protected chambers. These simulations set the initial conditions for the liquid response studies that are investigated experimentally.

A scaled impulse delivery system able to deliver precise loads is being implemented to study the response of target facing jets to the forces generated by fusion reactions in both thick-liquid protected Z-Pinch and heavy-ion fusion chambers. Those experiments are conducted in a sealed vacuum container called the Vacuum Hydraulics EXperiment, VHEX.

The thickness and surface smoothness of vortex flows needed to protect heavy-ion beam tubes in these latter chambers have been investigated optically. A mineral oil that allows a close match of the molten salt flibe dynamic similarity has been identified and used for these experiments.

The development of new larger vortex flows, which could potentially be used with solenoid focused heavy-ion beams and even magnetic Fusion Energy applications, is underway. The possibility to obtain and control a stable layer is being investigated.