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Liquid wall chambers for HIF

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Heavy Ion Fusion (HIF) energy releases are in the form of neutrons, X rays and target debris whose energy is about a GJ. Early on inventors suggested using liquid chambers without solid first walls because liquids unlike solids do not undergo radiation damage and vaporization of the liquid surface is acceptable. The form of the liquid is in a vortex oriented either horizontally or vertically with gas bubbles injected to help cushion the sudden expansion from the thermal spike. The spin rate of the vortex over comes gravity and forms a boundary between the liquid and the vacuum region inside of low enough vapor pressure to allow propagation of the beam to the target. The vortex can be a "rigid rotor"with the liquid containing solid walls mechanically rotated, in which case the liquid will tend to be quiescent or the vortex can be maintained by jets, injecting and extracting liquid, in which case there will be strong turbulence induced by shear flow. Other geometries considered were waterfalls and jets both stationary and oscillating. The liquids considered must contain lithium to breed tritium and they include: liquid lithium, a mixture of LiF+BeF2 called flibe, and a lithium-lead mixture. If strong magnetic fields are present for example from the magnetic focus system or intentionally imposed the liquid almost surely must be flibe owing to its low electrical conductivity thus reducing MHD affects. The frequency of producing micro explosions is set by the time the chamber can be cleared and ready for the next target to be injected and the beam to propagate to the target. X rays cause evaporation of liquid that has to be pumped and condensed. Neutrons cause liquid ejecta (spalled blobs of liquid) that need to be cleared.
Design of liquid chambers depends strongly on the geometry of the target illumination and final focus system and therefore cannot be done independently but rather must be integrated with the entire plant design. Further, the design also depends strongly on the expected target yield and desired pulse rate. The speed of the liquid is limited to ~5 m/s for flibe and probably other liquids by erosion where it passes through inlet and outlet tubing.
There is still the issue of radiation damage to components that "look"directly at the target that emits neutrons and other radiation such as the final focus magnets. However, these are usually further away (>5 m) from the neutron source than the first wall that is typically 1 to 2 m away. A serious problem threatens success of fusion power development and that is the development of a material to withstand this much closer and therefore stronger neutron flux for a long enough time to be of commercial interest. This problem is substantially avoided in HIF by use of liquid walls. Liquid walls of about 0.5 m thick of flibe or about 1 m for lithium or lithium-lead can reduce the neutron energies to those familiar to fission reactors and increase the predicted life of the structural components to the range of the life of the power plant.

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