

Preliminary Engineering Design of Vacuum Thermal Shielded Pb-Li Loop Section for Potential Nuclear Fusion Application

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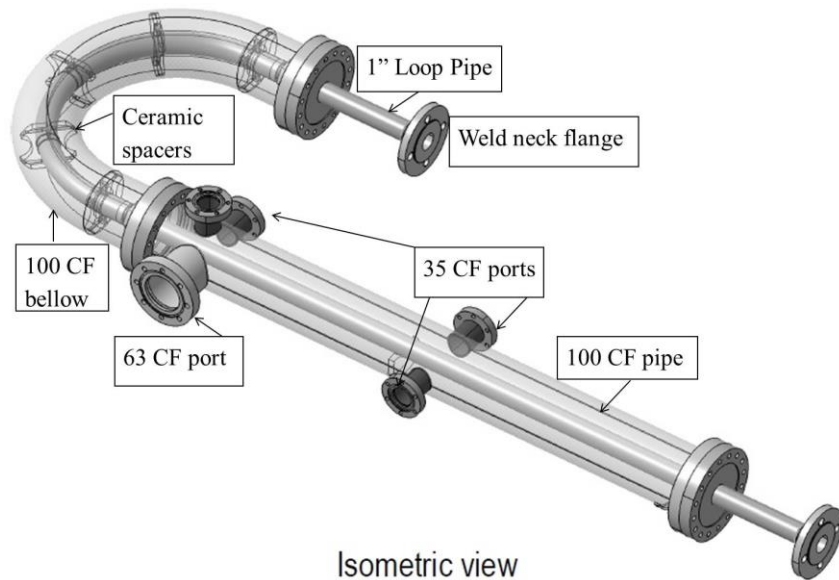


Figure Caption: A 3D isometric view of basic vacuum envelope chamber and Pb-Li loop section pipe assembled within.

Efficient design is the core of any machine. In Nuclear Fusion reactor with Liquid Metal Breeder Blanket, complex network of heated pipes carrying Lead-Lithium (Pb-Li) liquid metal is inevitable. Such pipes (1) occupy large space required due to substantial increase in diametric size due to conventional thermal insulation, (2) loses the bred tritium (a radioactive isotope) by permeation through hot wall. Tritium retention in conventional thermal insulation poses tritium accountability and health issues. We propose a solution to these problems through a vacuum envelope over such pipe. The vacuum isolation will take care of thermal insulation for heat loss and, the pumping port of the envelope will recollect all the lost tritium. In order to demonstrate the feasibility of the concept from thermal shielding viewpoint, we have prepared a conceptual and preliminary engineering design of such envelope on a segment of the Pb-Li pipe of 1" diameter, with a straight part and one 180° U bend too. The design is to maintain the envelope temperature less than 50° C while the loop pipe is maintained at 350° C. Calculation of thermal conductivity of low pressure air is done and compared with that of conventional insulation. The fabrication, integration and maintenance schemes are designed.