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Mechanical/Structural Considerations for Design of a Fusion Breeder

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ABSTRACT

A pebble bed blanket design concept was studied jointly by Lawrence Livermore National Laboratory, Westinghouse, TRW, and General Atomic Technologies. The purpose of the study was to produce a fission suppressed blanket system concept for a Tandem Mirror Fusion Device. The blanket region of the mirror is a cylindrical shell (~70 cm thick) surrounding the plasma.

The blanket modules are constructed of HT-9 ferritic steel because of its compatability with the coolant, fuel and multiplier, its high thermal conductivity, (lower thermal stress) and low swelling. The blanket is cooled by liquid lithium which also cools the first wall and thorium-containing beryllium spheres via a single coolant circuit. The spherical beryllium/thorium combination permits in situ fuel removal/reshuffling. The spheres can be mobile enough to move through the blanket when required.

Key features of the design concept are the first wall structure, piping arrangement and intermodule sealing. The first wall assembly is constructed of double circumferentially corrugated cylinders which form the lithium coolant annulus. The walls are connected with radial ribs which extend between the cylinders.

Further support is provided by regularly spaced radial supports (similar to tube sheets) extending from the outer corrugation to the outer diameter of the blanket module. This provides a neutronically thin structure able to withstand the inwardly acting 1.72 MPa coolant design pressure. Piping is sized to be as large as practical to provide low velocities to limit the MHD pressure drop across the first wall. The piping arrangement allows the fertile fuel region to be approximately 95% of the module length for efficient breeding. This arrangement permits removal of the solenoid magnets without cutting inlet/outlet pipes. A flexible multiple omega intermodule seal at each side of the module contacts a similar adjacent seal to accommodate the expansion of the module between assembly and operating temperature.

Based on the results of the study to date, the concept represents a viable, self-consistent design concept worthy of further development.

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