OPTIMIZED DESIGN & NUMERICAL EFFICIENCY QUALIFICATION OF AN ON-LINE PERMEATOR (FUSKITE®) FOR TRITIUM RECOVERY FROM PB-LI EUTECTIC

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A fast and efficient recovery of bred tritium is a major milestone of tritium breeding technologies R&D for the demonstration of a fusion reactor tritium self-sufficiency. Diverse tritium recovery technologies from lead-lithium eutectic have been investigated with different degree of qualification.

Permeator Against Vacuum (PAV) runs as a single-step process for tritium on-line recovery, acts as passive systems allowing to be thermally governed can be easily in-pipe integrated in LiPb loop systems and can be conceived with high compactness. An optimal design of a PAV requires a detailed hydraulic design optimization for established operational ranges (HCLL at low mm/s velocity or DCLL in the ranges of tens of cm/s).

Key design issues determining PAV efficiency under LiPb alloy in laminar regime are: (1) the hydraulic channels cross-section between permeable walls establishing diffusive path length, (2) specific LiPb/wall wetted area and (3) a proper choice of permeable wall materials (high solubility ratio with respect to LiPb at highest diffusivities).

For high velocity options (> 10 cm/s) optimized design choices should manage turbulent flow regimes. PAV thermal and structural design should guarantee turbulence at manageable pressure drops.

An optimal PAV design is proposed with detailed design parameterization of tritium recovery efficiency at two velocity ranges from numerical simulation based on properly developed Openfoam® CFD code BelFoam® customized solver.

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