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P3.179 Evaporation and condensation model for a cooling system of the LiPb cold trap device

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The eutectic liquid metal LiPb is considered as one of the tritium breeders of the first fusion power reactors. The flowing liquid metal dissolves alloying elements of the structural steels and thus causes their corrosion. The proposed type of the cold trap is a device providing extraction of corrosion products from liquid metal by gravity separation, which occurs at lower temperatures than the operating conditions of LiPb in the fusion reactor blankets.
The developed cold trap consists of three loops. The primary loop is for LiPb liquid metal flow purifying. The proposed cooling of the primary loop is based on the water-steam natural convection with two basic principles - evaporation and condensation. An evaporation section supports the optimal heat transfer from the primary loop, and, for the final heat removal from the trap body, the condensation section then transfer the accumulated thermal energy to the tertiary loop via a condenser. Due to high maintained temperatures of the liquid metal, the high saturation conditions with the corresponding temperatures in the secondary loop can be expected. To ensure reliable conditions at all operational thermal loads the presence of the inert gas (argon) in the secondary loop is provided. However, adding of the inert gas into the steam significantly reduces the heat and mass transfer to the condenser and consequently leads to degradation of the heat removal potential of the condensation. A model based on dimensionless numbers is developed and applied to solve these processes. Validation of this model for the operational conditions and achieved results for the cold trap operational states are analysed and discussed.

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