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Liquid immersion blanket design for use in a compact modular fusion reactor BRANDON SORBOM, JUSTIN BALL, HAROLD BARNARD, CHRISTIAN HAAKONSEN, ZACHARY HARTWIG, GEOFFREY OLYNYK, JENNIFER SIERCHIO, DENNIS WHYTE, MIT Plasma Science and Fusion Center — Traditional tritium breeding blankets in fusion reactor designs include a large amount of structural material. This results in complex engineering requirements, complicated sector maintenance, and marginal tritium breeding ratios (TBR). We present a conceptual design of a fully liquid blanket. To maximize tritium breeding volume, the vacuum vessel is completely immersed in a continuously recycled FLiBe blanket, with the exception of small support posts. FLiBe has a wide liquid temperature window (459 C to 1430 C), low electrical conductivity to minimize MHD effects, similar thermal/fluid characteristics to water, and is chemically inert. While tritium breeding with FLiBe in traditional blankets is poor, we use MCNP neutronics analysis to show that the immersion blanket design coupled with a beryllium neutron multiplier results in TBR > 1. FLiBe is shown to be a sufficient radiation shield for the toroidal field magnets and can be used as a coolant for the vacuum vessel and divertor, allowing for a simplified single-phase, low-pressure, single-fluid cooling scheme. When coupled with a high-field compact reactor design, the immersion blanket eliminates the need for complex sector maintenance, allows the vacuum vessel to be a replaceable component, and reduces financial cost.

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