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Development and experiment of PbLi facilities for fusion nuclear technology

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The liquid lead-lithium (PbLi) blanket concept has become a promising design for fusion DEMO and power plant reactors. To promote the successful application of fusion energy, some RD; activities on the PbLi blanket have been performed, such as structure material corrosion, thermal hydraulics, magnetic-hydrodynamic (MHD) effect, coolant impurities technology and LOCA/LOFA, etc.. Therefore, it is so important to develop experimental facility to perform the out of pile experiments and studies on these key issues before the engineering design of fusion reactor.

Series DRAGON PbLi experimental loops have been developed and constructed in China, including the thermal convection PbLi loops DRAGON-I (500°C) and DRAGON-II (700°C), and the multi-functional liquid PbLi experimental loop DRAGON-IV (800°C, 2T). To perform the integrated experiments under the multi-physical field conditions for DEMO blanket, the dual coolant thermal hydraulic integrated experimental loop DRAGON-V was designed and finished the construction in 2017. It is composed of a lead-lithium loop and a helium gas loop. The maximum flow rate of PbLi and helium gas pressure are 40 kg/s and 10.5 MPa, respectively. The magnetic field is designed up to 5T. It is a unique test platform for the RD; of thermal hydraulic, material corrosion, purification technology and safety issues of liquid PbLi blanket to provide the necessary database for ITER-TBM and DEMO-TBM.

Up to now, some experiments have been conducted to investigate the key issues of PbLi technologies, such as corrosion behaviors of candidate structural materials with and without magnetic field, the PbLi alloy fabrication with high-level controlling of the impurities, purification technology of liquid PbLi coolant in the loop, MHD pressure drop test, and the interaction for typical coolants during accidents etc.. The results can support the development of the in-pile key techniques and components and the engineering design for ITER-TBM and DEMO-TBM, and also contribute to the final application of the advanced reactors.

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