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Liquid PbLi atomization in vacuum for tritium and heat recovery

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The authors proposed a concept of tritium and heat simultaneous recovery from lithium-lead (PbLi) in vacuum in 2016. Hot and tritium rich liquid PbLi is transformed into small size droplets (atomization) through nozzles in a vacuum recovery chamber. While falling, tritium is released by advection mass transport and recovered by a vacuum pump. Heat is transferred by radiation to the counter-flow secondary medium through a chamber wall. Both mechanisms can function in vacuum. The first hurdle of this concept is the PbLi atomization in vacuum. Conventional spray mechanism in air or in gas, is not applicable in vacuum. Hence different instability mechanism which occurs on a velocity inflection is applied. By a preliminary experiment using a water in room air, surface mean droplet diameter was shown to be as small as 0.17 mm at the velocity of 10 m/s. It obeyed approximately power of minus 0.5 on the flow velocity. Obtained mean diameter was small enough for higher than 90% tritium recovery efficiency within 1 second of vertical drop, by a previous study result. As for the heat recovery, design window was identified by the case study as the function of the temperature difference (ΔT) between droplet and surrounding wall, and the emissivity(ε). PbLi droplet temperature of 973K in and 823K out is expected to be possible with (ΔT, ε) of (100K, 0.5), (150K, 0.4) and (200K, 0.3). However, even a same material, many factors were reported to strongly affect the emissivity. An experimental setup using a low temperature melting alloy (GaInSn) in vacuum is under fabrication for further verification. The atomization in vacuum and the emissivity value of GaInSn spray will be verified before final experimental using PbLi.

Eligible for student paper award?

No

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