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Experimental evaluation of wall shear stress in double contraction nozzle for structural soundness evaluation for liquid Li target of intense fusion neutron source

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This paper reports on an experimental evaluation of wall shear stress in a double contraction nozzle to produce a liquid lithium (Li) target being intended for use as a beam target for the intense fusion neutron sources such as the International Fusion Materials Irradiation Facility (IFMIF), the Advanced Fusion Neutron Source (A-FNS), and the DEMO Oriented Neutron Source (DONES). The current design of the neutron sources requires that the thickness of the liquid Li target be maintained to within ± 1 mm while operating under normal conditions (target speed: 15 m/s, inlet Li temperature: 250 ℃, and vacuum pressure: 10−3 Pa). In the IFMIF/EVEDA project, we designed and constructed the IFMIF/EVEDA Li Test Loop (ELTL), and we performed experiments to validate the stability of the Li target. After the end of this project, the ELTL has completed its disassembly work in Feb. 2017 and structural soundness evaluation of the configuration components of the ELTL is being prepared.
Prior to the structural soundness evaluation, we have investigated the flow characteristics in the nozzle which is a key component producing the stable Li target. The wall shear stress is an essential physical parameter to understand erosion-corrosion by a high speed liquid Li flow, and therefore we evaluated by using an acrylic mock-up of the target assembly experimentally. The working fluid was water whose kinematic viscosity coefficient is similar to that of liquid Li. The velocity distribution in the nozzle was measured by laser-doppler velocimetry and momentum thickness along the nozzle wall was calculated by Buri's equation. Based on the calculated momentum thickness, we estimated the variation of the wall shear stress along the nozzle wall and showed an importance indicator for erosion-corrosion of the nozzle for the future structural soundness evaluation.

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