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Electro-vortex flow in a liquid metal battery electrode with annular current collector AVISHEK RANJAN, SAKSHAM JINDAL, Indian Inst of Tech-Bombay — Electro-vortex flow (EVF) develops when electric current lines converge or diverge inside a conducting fluid, when the curl of the Lorentz force is non-zero. In a three-layered liquid metal battery (LMB), the EVF occurs near the current collectors and drives a flow away from the wall. In a recent study [1] on an Mg-Sb LMB with circular current collector, it was observed that even in a moderate size LMB, the EVF could be strong enough to pinch the thin electrolyte layer and cause short-circuit. In this study, we conduct numerical simulations of the flow in the top LMB electrode using electric potential based solver incorporated in the code OpenFOAM. With the same value of the imposed current as in [1], we find that the choice of annular current collector geometry mitigates the pinching of the electrode-electrolyte interface. With this geometry, instead of a strong central EVF jet, the flow consists of two weaker jets which curl upwards resulting in much lower velocity near the interface. This result is valid even in the presence of an imposed temperature gradient, with hot (cold) bottom (top) boundary, at a large Rayleigh number. These results can be of relevance in a practical LMB to avoid short-circuiting. [1] Herreman et al. (2019) Phys. Rev. Fluids 4, 113702.

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