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P4.219 A revised and expanded liquid metal property library for MELCOR

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In order to facilitate the modeling of thermal hydraulic transients and accident scenarios in fusion reactors, a number of additional fluids were added alongside water in the original ATHENA code, which was based on RELAP5. The same libraries were later ported to both RELAP5-3D and MELCOR 1.8.6 for Fusion, both in use today. The libraries included a number of liquid metals of potential interest as tritium breeders, primary, or secondary coolants in fusion reactors, including Lithium, PbLi, Potassium, Sodium, and NaK. Thermodynamic properties of the liquid metals were generated using a five parameter "soft sphere" equation of state, for which parameter sets were available in the literature for the pure components.

This work describes a comprehensive update of the liquid metals property library, based on new generalized Helmholtz potentials fit to experimental thermodynamic property data for each fluid, and a revision of the code that uses these to generate properties for MELCOR. The updates rectify certain inaccuracies in the existing libraries, both for the pure metals and the alloys, for which they were particularly acute owing to the approximate way in which the pure component equations of state were mixed. They also resolve some issues with code execution that occasionally arose as a result of the relatively coarse tables previously supplied to the code, and the manner in which empirical saturation relations were imposed on top of the equation of state. Finally, some new fluids have been added to facilitate the modeling of liquid metal plasma-facing surfaces, including liquid tin and SnLi alloys. The latter are used to illustrate some newly implemented methods to generate alloy properties from the pure component equations of state using suitable mixing rules. The new libraries will be available for MELCOR 1.8.6 for Fusion and (for the first time) standard MELCOR 2.2.

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