APPROXIMATIONS FOR THE FAST CALCULATION OF WATER PROPERTIES

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The knowledge of accurate physical properties of water is fundamental for the analysis of thermalhydraulic systems and the design of a broad range of equipment in many diverse fields. While formulations do exist for the accurate calculation of these properties, they often prove too slow for many engineering applications. The rapid generation of these properties without sacrificing accuracy has been the purpose of previous works [1-3]. These past works have focused on light water properties with success, although there is still considerable room for improvement in speed, range of pressure and temperature, and properties modelled, as outlined below. There is a more pressing need, however, for extending the exercise to heavy water. One early attempt [4] quoted fit errors of roughly 1 % for a limited number of properties and ranges. This is not adequate for industrial purposes.

For light water, subcooled, saturated and superheated fits for density, enthalpy, entropy, and specific heat are available for pressures and temperatures in the range of 0.085 MPa - 21.3 MPa and 90°C to 450°C respectively. Accuracies of the order of 0.1 % have been achieved. Extensions to lower pressures and temperatures have been performed for the saturated properties. These extensions are needed for the subcooled and superheated properties.

According to preliminary tests, substantial further improvements in speed can be gained by refitting based solely on polynomials rather than the current use of polynomials, logs and exponentials.

The actual process of curve fitting is not automated and is very time consuming since the slopes at the endpoints of ranges must be matched by hand (splines did not prove accurate enough). The fitting process needs to be critically reviewed with an eye to improving efficiency.

In order of priority, efforts in this area should be spent on:

- the automation of the curve fitting process;
- the creation of accurate fits for heavy water;
- the extension of the ranges for light water fits;
- the exploration of further speed increases.

References:

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