

Condensation in the Presence of Noncondensables

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A study of condensation in the presence of noncondensables led to an improvement in RELAP5-3D.

Background

In 2015, a study conducted at the University of Wisconsin on the effect of noncondensables on the condensation of steam found differences with RELAP5-3D condensation performance. This was documented at NURETH-16 (Fu 2015) and submitted as User Problem #14030. The report indicated that the calculated condensation heat flux was under-predicted due to an incorrect modeling of the mass transfer in the gas mixture. Currently for calculating the vapor mass flux, RELAP5-3D uses $\rho_v(T^{sat}(P_p))$, the saturation vapor density at vapor partial pressure. The report concluded that the RELAP5-3D code should instead use $\rho_v(T^{sat}(P))$, the saturation vapor density at the saturation temperature of total pressure.

ACTION

The original source documentation describing the implementation of the model was reviewed to determine the appropriateness of the change. Based on the comparison to the model literature, coding to match the calculation of the vapor mass flux in the documentation was written for testing purposes.

The effect of modifying the calculation of the vapor mass flux was evaluated by comparing the results to experimental data that was based on an assessment performed by Shumway (Shumway 1995). In this assessment, condensation experiment results were used to evaluate the performance of the condensation model (with and without noncondensables present). The RELAP5 input models originally used to simulate the various tests were recovered and used for the current assessment. The results generated from running the input models showed that the comparison to data are slightly worse for one set of data, and improved for a second set.

This coding change was shown to not affect the condensation model when noncondensables are not present. The modified coding has therefore passed acceptance testing and will be incorporated into the main development line of RELAP5-3D.

References

1. Fu, W., Yoon, D., and Corradini, M. L. "Assessment of the MELCOR and RELAP5-3D Code for Condensation in the Presence of Noncondensable Gas." *NURETH-16*. Chicago: American Nuclear Society, 2015.
2. Shumway, R. W. *Assessment of RELAP5/MOD3.2 Condensation Models*. Developmental Assessment Test Report, Idaho Falls: INEL, 1995.