Metal Water Reaction

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Improvements have been made to the metal water reaction model in RELAP5-3D. Improvements to the metal-water reaction model include allowing additional fuel geometry types and allowing the model to use other cladding materials besides zirconium.

To augment the geometry options beyond the default cylindrical heat structures, the reaction depth and heat generation equations were modified to include rectangular and spherical heat structures.

The metal-water reaction model in RELAP5-3D is used to model the heat added to the cladding as the zirconium-steam reaction occurs. The reaction is treated by using the correlation developed by Cathcart for the base code calculations. This correlation uses a parabolic rate law. Previously, the only allowed user input was the initial oxide thickness on the outside of the cladding. The calculation was only applicable for cylindrical heat structures.

Specification of materials other than zirconium required the modification of card 1CCCG003 to accept various user input parameters. The parameters that were added and their associated variables include the following:

- Material density
- Activation energy
- Reaction rate constant
- Reaction heat release constant
- Molecular weight of cladding
- Molecular weight of reaction product divided by molecular weight of cladding
- Initial reaction depth

The metal-water reaction model was modified to allow additional fuel geometry types and the metal-water reaction model can now be used for other cladding materials in addition to zirconium. The test showed no changes to the results of the installation or developmental assessment test problems, as none of these problems utilize the metal-water reaction model.

Test problems were developed to test the metal-water reaction model for rectangular, cylindrical, and spherical heat structures. These problems showed that there is a temperature increase in the heat structure due to the occurrence of the metal-water reaction. The metal-water reaction results were compared to analytic calculations, which showed very similar results to the code calculations.