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Mesoscale Modelling of Thermal-Chemical processes during Nuclear Fuel Corrosion

Monday, 31 May 2021 15:10 (15 minutes)

Understanding corrosion mechanisms and processes of UO2 fuel is essential for safe operation of nuclear reactors and storage of spent fuel [1-3]. We develop a 3D physics-based numerical model to simulate the thermal-chemical process during the corrosion of UO2 fuel pellets. Mass transfer, thermal conduction and solid chemical reactions are coupled in the model. The impact of temperature on uranium speciation during fuel corrosion is investigated. The UO2 pellets lifetime under corrosion is compared at same temperature but different reactions. The predicted reaction rates are shown to be dependent on the reaction types. The impact of microfractures on fuel pellets corrosion are studied by modelling reactions in fractured pellets. The composition change caused by radiation is also explored. The fuel with UO2-U3O8 mixture is constructed. The results show the mixed fuel presents faster reaction rates in comparison with pure UO2 samples. The developed model will help quantify the effect of temperature on nuclear fuel dissolution and, help determine the key parameters controlling the physiochemical processes and ultimately inform the nuclear industry.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

[1]Liu, M., Kang, Q., & Xu, H. Grain-scale study of the grain boundary effect on UO2 fuel oxidation and fission gas release under reactor conditions. Chemical Engineering Science, 229, 116026.
[2]Liu, M., Kang, Q., & Xu, H. (2020). Modelling uranium dioxide corrosion under repository conditions: A pore-scale study of the chemical and thermal processes. Corrosion Science, 108530.
[3]Liu, M., & Mostaghimi, P. (2018). Reactive transport modelling in dual porosity media. Chemical Engineering Science, 190, 436-442.

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