Contribution ID: **24** Type: **not specified**

A DEM/FFT approach to compute the effective thermal conductivity of fragmented fuels under accident conditions

Wednesday 6 November 2019 11:20 (20 minutes)

Simulation of the effective properties of granular media such as thermal conductivity is of a great interest for many applications. Under accident conditions the nuclear fuel may crack and relocate inside its cladding. In this case, the relocation leads to a degraded conductivity of the fuel. Thermal conductivity evaluation is interesting to evaluate the temperature in the fuel rod.
We developped a chained method involving Discrete Element Method (DEM)[1] and Fast Fourier Transform (FFT)[2] : We first compute the packing microstructure,
according to the grains kinetic, with DEM. The microstructure is voxelised and finally the FFT method is employed to compute the effective thermal conductivity of the granular media. This method allows us to compute accurately the effective thermal conductivity of a granular media taking its real microstructure into account.
We also performed a sensitivity analysis over the discretisation parameters, the size of the seed as well as the definition of interfacial voxels having both solid and gas phases (called fuzzy voxels). Thus we propose to define several bounds and estimates of the effective thermal conductivity depending on the definition of the fuzzy voxels. Finally, we compare the results of the DEM/FFT method to experimental measurements available in the litterature[3, 4] and show a good agreement between our simulations and the measurements.

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Authors: Mr CALVET, Tristan (CEA Cadarache); VANSON, Jean-Mathieu (CEA Cadarache); Dr MASSON, Renaud (CEA Cadarache)

Presenter: VANSON, Jean-Mathieu (CEA Cadarache)

Session Classification: Session 6