EFFECT OF DUAL SURFACE COOLING ON THE TEMPERATURE DISTRIBUTION OF NUCLEAR FUEL PELLET

Odii Christopher Joseph
National Research Tomsk Polytechnic University,
Russia, Tomsk, Lenin Avenue, 30, 634050
E-mail: monoexiton@yahoo.com

Heat removal from nuclear reactor core has been one of the major Engineering consideration in the construction of nuclear power plant. At the center of this consideration is the nuclear fuel pellet, the efficiency of the burning of the fuel, determines the rate of heat transfer to the coolant. In this research, we would study the Temperature distribution of solid fuel, the Temperature distribution of annular fuel with external cooling and finally, the Temperature distribution of annular fuel with internal and external cooling. We analyzed the different distribution and made a conclusion on the possibility of improving Temperature management of Nuclear fuel rod, by designing fuel pellets based on this geometrical and thermal Analysis. To date, a lot of studies has been done on the thermal and geometrical properties of Nuclear fuel pellet, it is observed that annular fuel pellet with simultenous internal and external cooling can achieve better temperature distribution which leads to high linear heat generation rate, thus generating more power in the design. It has also been observed that annular fuel pellets has low fission gas release. In large LOCA, the peak cladding temperature of annular fuel is about 600℃ which is significantly less than that of solid fuel (920℃), this is due to the fact that annular fuel cladding has lower initial temperature and the thinner annular fuel can be cooled more efficiently than the solid fuel. One of drawbacks of annular fuel Technology is "the fuel gap conductance assymmetry" which is caused by outward thermal expansion, it has a potential effect on the MDNBR (Minimum Departure from Nucleate Boiling Ratio), which is the minimum ratio of the critical to actual heat flux found in the core. In this model, we used the ceramic fuel pellet of UO2 as our case study. All the parameters in this model are assumed parameters of UO2. The Heat Transfer tool (ANSYS APDL) was used to validate the Analytical Model of this research. The Temperature distributions for the Solid, Outer cooled (OC) and Dual surface cooled (DC) fuel pellets, are presented here as follows:

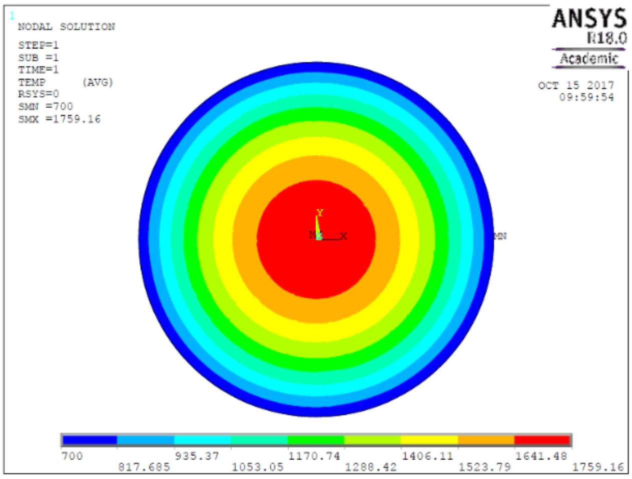

Fig 1. Temp. Distribution contour for solid fuel

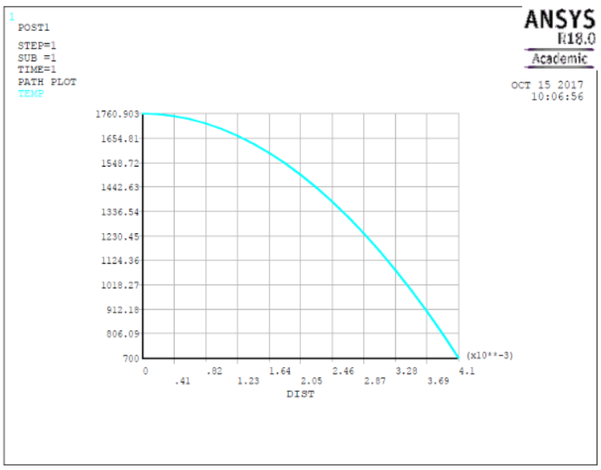

Fig 2. Temp. Distribution graph for solid fuel

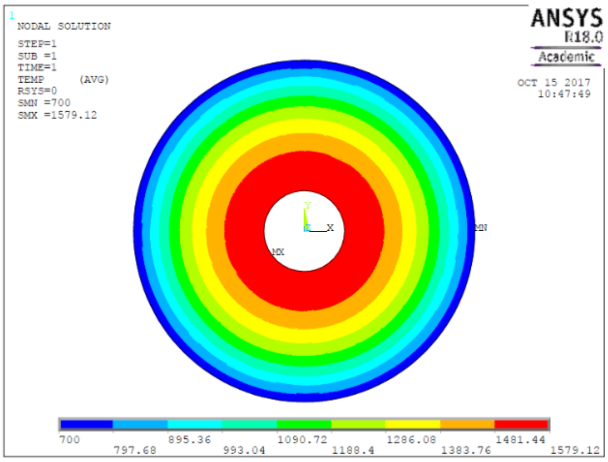

Fig 3. Temp. distrib. contour of OC annular fuel

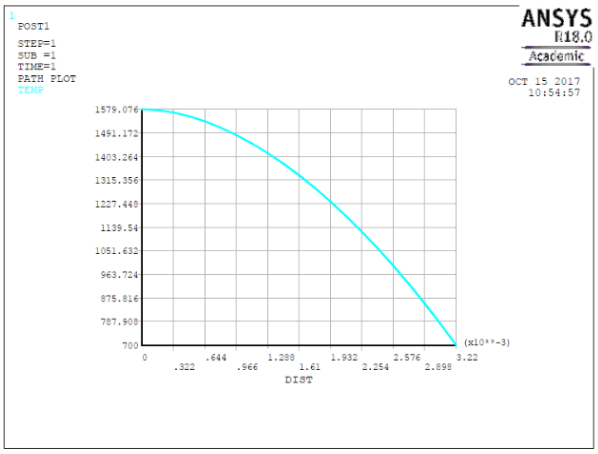

Fig 4. Temp. distrib. graph of OC annular fuel

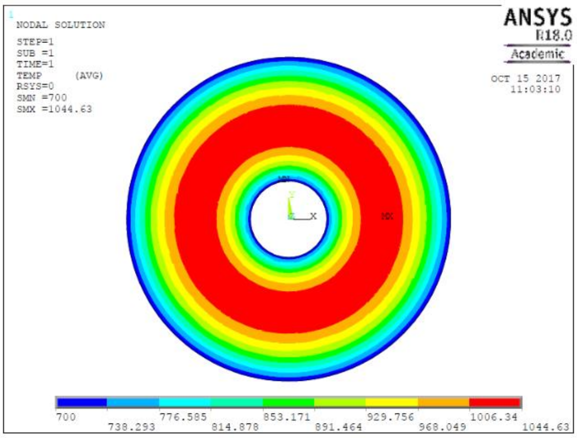

Fig 5. Temp. distrib. contour of DC annular fuel

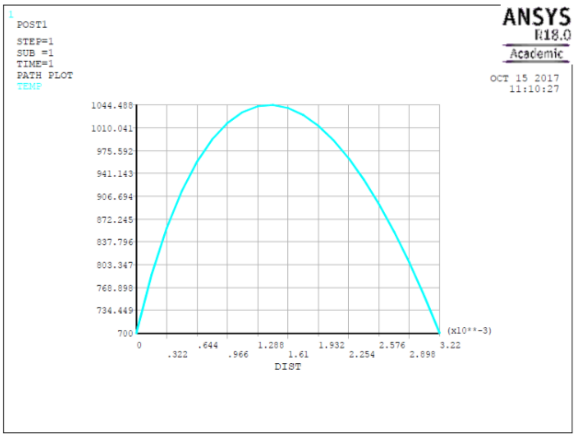

Fig 6. Temp. distrib. graph of DC annular fuel

REFERENCES

1. Neil Todreas and Majid Kazimi, "Nuclear System, Volume 1 "Thermal Hydraulic Fundamentals", Massachusetts Institute of Technology, 2011
2. Kayla Kruper, "steady state in clad nuclear fuel rod in COMSOL", Rensselaer Polytechnic Institute, 2014
3. Rozhgar Othman, "Steady state and transient analysis of heat conduction in nuclear fuel elements", masters degree project, KTH-Stockholm Sweden, 2004
4. Phillipp Hangi, " Investigating BWR stability with a new linear frequency domain method and detailed 3-D neutronics"
5. R.T Lahey and F.J Moody, "The thermal hydraulics of Boiling Water Nuclear Reactors" American Nuclear Society, 1993
6. Neil Todreas, Majid Kazimi and Franci, "Nuclear System elements of thermal hydraulic design", Massachussets Institute of Technology, 1990.
7. Nikolay Ivanov Kolev, "Nuclear Thermal Hydraulics", springer international, 2015.