Simulation and Experimental Validation of Direct Heating of Dhruva Fuel Rod for β Heat Treatment

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Abstract

β heat treatment of Uranium rods is carried out for randomization of oriented grains (called texture) developed during hot rolling or hot extrusion operation. During this process, Uranium rods undergo heating of up to 740 Deg C followed by water quenching. The objective of this work is to see the feasibility of direct heating technique for heat treatment application. At present, heat treatment of Uranium rod is carried out in vertical salt bath furnace, which is based on indirect heating technique. This paper includes only the heating part of Uranium rod, quenching is not included in this study. Mathematical modeling and simulation of direct heating of Uranium rod of sizes (900mm LX 12 mm φ and 1200mmL X50 mm φ) were carried out and results were tested by making prototype set up. It was observed that experimental results were very close to the simulation results. After validation of simulation and experimental results, the same model was applied for heat treatment of actual size of Uranium rod (3000 mm LX 16 mm dia) and optimized the parameters like current, time, contact size, etc. to achieve the desired result. The 3D simulation was carried out by using COMSOL Multiphysics® software, which is FEM based software. Heating is a multiphysics process i.e. combination of electric field and heat transfer. Electric field and heat transfer can be expressed by Laplace and Fourier equations respectively. Solvers details are also described in this study. This paper also includes different methods used for phase change analysis during mathematical modeling and simulation.