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NUMERICAL SIMULATION STUDY ON OXIDATION COKING OF HYDROCARBON FUEL IN THE PRESENCE OF ELECTROSTATIC FIELD

Abstract

Hydrocarbon fuel heated in the fuel supply pipeline of an aeroengine can react with dissolved oxygen to form coke. Free radicals and reaction pathways in the oxidation process are influenced by the electric field force and Joule heat owing to the addition of electrostatic field. In order to study the effect of electrostatic field on oxidation coking of hydrocarbon fuels, a mathematical model of hydrocarbon fuel flowing in the channel combined with detailed oxidation coking reaction mechanism in the presence of electrostatic field was established. Where, Navier-Stokes, Poisson Equation and Current Continuous Equation were used to describe the flowing of fluid, a detailed low temperature oxidation coking kinetic model of n-pentane containing 826 species and 4618 reactions was used to reflect the reaction process. The interaction mechanism among electrostatic field, flow, chemical reactions, mass and heat transfer have been discussed in detail. The effects of the introduction of electrostatic field on the important free radicals, intermediates and coking amount in the oxidation coking process of hydrocarbon fuel were analyzed. The results indicated that compared with E=1000000Vm–1 and E=0, the weights of coke decreased by 17%on the average. By analyzing the flow field, it was found that existence of electrostatic field will affect the temperature field through Joule heat, which is the most significant factor to the rate of formation of coking precursors. According to the reaction mechanism, the free radicals are difficult to polymerize to generate the coking precursors and intermediates because of electrostatic field, which cause the decrease of coking deposition. In conclusion, an inhibition effect on oxidation coking could be obtained via the introduction of electrostatic field.