Numerical Study of SiO_2 Particle Formation in H_2-Air Premixed Flame

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In this study, we use the commercial CFD-code FLUENT to analyze numerically the hydrogen combustion and SiO2 particle formation in the premixed flame reactor. The three-coaxial burner was used: H2 mixed with air flows through the central tube of the burner, H2 through the middle annulus and air through the outer annulus. The computational domain is confined by a coaxial pyrex tube surrounding the flame. The rate of hydrogen-air mixture combustion and SiO2 formation are calculated as the Arrhenius rate and the mixing rate.
We calculated the profiles of fluid flow and temperature for various process conditions. Gas flow was considered in both: burner tube and reactor tube. Changing the velocities of gas mixture, we found that at low gas velocities, backfire appeared in the burner tube. Increasing gas velocity higher than 1.8 m/s, flame appeared at the burner tip. In the central tube of the burner, H2 and air are well mixed, so the flame propagation speed should be slower, than gas velocity. As the gas velocity increases, the flame front moves upward along the central tube of burner to the reactor inlet. We considered SiCl4 as a precursor for SiO2 particle formation in premixed flame (SiCl4 + O2 → SiO2 + 2Cl2, Cl2 + H2 → 2HCl) and calculated species transport inside the premixed flame reactor.