Numerical simulation of combustion and detonation of dust particle-air cloud

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Solid particles and gas mixtures are encountered in many scientific and industrial fields such as combustion, pollutant dispersion, filter technology, ventilation systems or fluid catalytic crackers. Reactive gas-particle interaction is also a key process nowadays in the field of Renewable Energies. In certain fields like agricultural, chemical, metallurgical or nuclear industry (including thermonuclear fusion), special interest has been paid to these mixtures due to safety reasons. The analysis of accident scenarios in the ITER Fusion facility such as loss of coolant accidents (LOCA) or loss of vacuum accidents (LOVA) is of primary importance in order to evaluate pressure and temperature loads generated by a potential dust explosion or detonation. Modeling of dust combustion and detonation processes in a gas mixture using computational fluid dynamics (CFD) and, in particular, the approach used in the CABARET code requires the development and implementation in the code of a number of physical models of various phenomena observed during dust combustion and detonation (namely, chemical kinetics of dust, particle resistance, heat exchange with gas and dust gravity). A modified model of hybrid combustion of carbon, tungsten and aluminium dust adapted for the CABARET code is presented. Thermodynamic properties of the substances under consideration, including tungsten, molecular transfer coefficients and expressions for the rate of surface oxidation reactions of the tungsten dust fraction are given. A model of detonation of carbon and aluminium gas-dust mixture in the limit of fast chemical transformations is presented, with different models of chemical kinetics for carbon and aluminium.