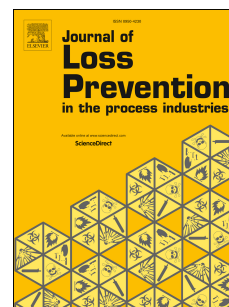


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Numerical investigation on inner particle effects in Lycopodium/Air dust deflagrations

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Abstract

Dust deflagration is a rapid combustion process with the spread of flame at subsonic speed. Standard numerical modeling approaches using pyrolysis/evaporation are neglecting phenomena determined by transport limitations inside the dust particle. Main objective of this paper is the investigation and understanding of relevant transport phenomena in the inner structure of a Lycopodium particle. This was achieved by three individual models. The first model describes the dust deflagration, using a flame speed approach. After the evaluation of model by the flame front propagation and associated temperature, data is used in a second model. This model uses Lagrangian tracer particles, placed in the flame front. The flame front is passing these particles, which are used for metering data, such as composition and temperature of the gas to calculate the heat transfer coefficient and the mass transfer coefficient of each species. These results are used as boundary conditions for the third model, a single particle model, which considers a mobile gaseous phase in the pores and a stationary phase for the solid and liquid substances by using an Eulerian approach. In addition, the gaseous phase includes heat and mass transport by convection and diffusion/conduction in the pores, whereas the stationary phase considers only heat conduction. The pyrolysis in this model includes the primary pyrolysis, the tar cracking and heterogeneous char reactions, as well as the set of homogenous reactions for the gas phase. With the single particle model four different geometries were observed: two 3D geometries with different lycopodium spores, a 1D radial symmetric geometry and a 0D geometry. All simulations are based on OpenFOAM 1.7.1.

Keywords: *inner particle effects, dust deflagration, transport effects, modelling, Lycopodium*

1. Introduction

The effects of inner particle transport phenomena are usually neglected because of the computational resources requirements due to high number of representative parcels. Pollhammer [1] used 4083337 parcels, representing approx. 16 million particles to model a dust deflagration in a vertical duct. These inner particle transport effects are difficult to observe by measurement and their relevance is unknown. A better understanding of the inner particle effects would clarify which physical mechanisms under consideration are eventually negligible. Furthermore, better understanding of those phenomena could lead to development of numerically more efficient and precise particle models avoiding discretization of the particle itself.

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