Aerosol generation from silicon carbide particles over prolonged durations

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Introduction

SiC powders have recently been used as a heat transfer and storage fluid (HTF) for concentrated solar thermal plants (CSP) for its excellent physical and mechanical properties (high strength, durability and heat capacity) (García-Trinanes et al., 2016). However, the pneumatic or mechanical conveying of the powder across different sections of the solar thermal plant releases aerosol particles due to the stresses generated from particle-particle and particle wall-interactions.

This study analyses the effect of time-scale on powder dust generation while considering the effect of dustiness testing on the particle and bulk properties. Based on the time-evolution of dust generation, we propose stages of dust generation mechanisms which can possibly provide explanations concerning the emission of dust and its subsequent effect on physical properties of the powder sample.

Methods

Two sets of silicon carbide powders, SiC F220 (x_{50} = 68µm) and SiC F320 (x_{50} = 39µm) with the same particle density were used "as-received" following the EN standard 15051 (CEN, 2006). The powder samples were characterized for different bulk and particle properties. The vortex shaker (Le Bihan et al., 2014) was used for the 6-hours dustiness test due to its low requirements of sample sizes, ease of operation and the ability to retain the powder sample after the test. The experimental setup used has been comprehensively described in the recent publication (Chakravarty et al., 2018).

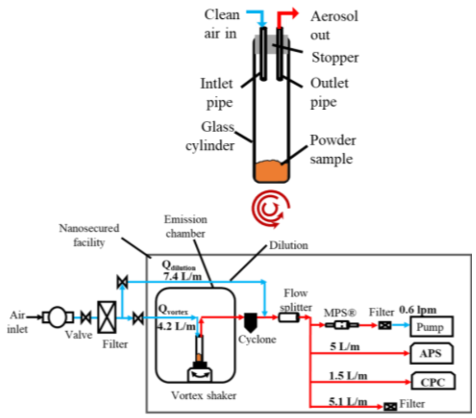

Figure 1. The vortex shaker experimental setup.

Results and Conclusions

Both samples release respirable aerosol particles, but F220 is found to be more prone to generate dust than F320.

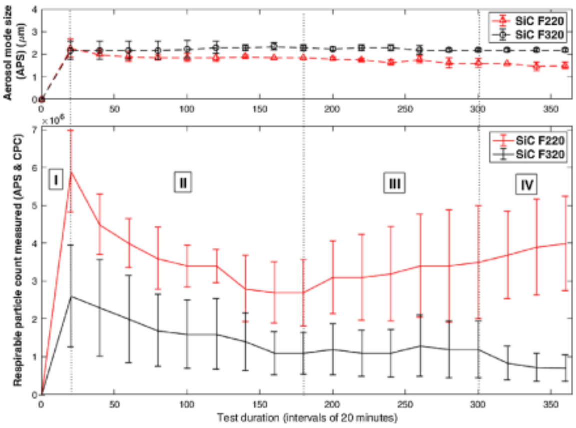

Figure 2. Evolution of aerosol mode particle size (top) and total respirable aerosol counts (bottom).

F220 and F320 not only differ in dustiness but also in the mechanism of dust generation and release. While, dust generation is related to the presence of aerosolizable fine-scale particles already present in the bulk, the tested F220 powders show changes in particle size distribution and shape properties compared to their pristine form, indicating abrasion as the dominant source of attrition and aerosol generation. On the contrary, the F320 powders show barely any changes in particle size distribution or shape factors with vortex testing. Our study underlines the importance of characterizing both before and after the dustiness test, as changes in its properties are crucial to understand the underlying dust generation mechanisms.

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