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Mechanical Engineering

INFRARED THERMAL AND VISUAL IMAGE ANALYSIS FOR THE MODELLING OF PROPERTIES IN CASCADING PARTICLE CURTAINS

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1 Introduction

Understanding temperature distributions in Engineering applications plays an invaluable role toward understanding the effectiveness of design. As one of the most frequently measured physical quantity, the quantification of temperate values and their distributions allows for design goals to be achieved in a far more succinct manner and plays a key role in a diverse range of engineering systems. One particularly challenging engineering process that proves problematic in obtaining thermal data for is the particle curtain.

Particle curtains are defined as a stream of particles falling a fixed distance through a gas or fluid phase [1]. They are very common in industrial drying, particularly in the minerals and food industry [1]. Furthermore, particle curtains are steadily emerging in promising new renewable energy technologies for use in concentrating solar power (CSP) plants. These solar particle receiver designs are currently in the early demonstration phase, delivering improved thermal efficiency through their direct storage of heat within sand-like particles [2, 3]. With regards to the Industrial and Mineral Industries a common technique for particle drying is the use of Flighted rotary dryers (FRD). Flighted rotary dryers are used extensively in a large range of industries for the control of temperature and moisture content of free flowing, particulate solids such as grains, sugar and mineral ores [4]. However, Whilst flighted rotary dryers are widely used, their complex solids transport behaviour, and the difficulty of separating solids transport and heat and mass transfer phenomena within the dryer, has proven to be a significant issue in regards to understanding their behaviour. Given the complex behaviour of flighted rotary dryers, and the lack of design and control procedures, there is a need for a model for flighted rotary dryers [4].

Currently there are two major branches of research being conducted on particle curtains. The first is of which relates to computational modelling of particle curtains, one of which is the development of Computational Fluid Dynamics (CFD) based models. CFD has been applied successfully to model particle curtains in isothermal conditions; however, there are relatively few CFD studies of hot particle curtains. Furthermore, the use of CFD to approximate bulk curtain behaviour has not been described [1]. Another of these methods relates to DEM

References

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