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A COMPREHENSIVE MATHEMATICAL AND NUMERICAL MODELING OF DEEP-BED GRAIN DRYING

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ABSTRACT

This paper deals with comprehensive mathematical and numerical modeling of deep-bed grain drying. In order to build the process model, it is necessary to analyze the transport in both grain and gas phases. Experimental works were carried out for a layer of grain bed in order to validate the models. The models consider momentum, energy, and mass conservation within grain and drying air phase. The two-dimensional dynamic equations of energy and mass conservation are solved numerically by finite-difference method (FDM) and utilizing alternating direction implicit algorithm within grain and drying air phase, while momentum conservation are solved by finite difference method by utilizing

Semi-Implicit Method for Pressure-Linked Equations (SIMPLE) algorithm. Furthermore, the models will be applied in consideration with developing and designing dryer in order to simulate humidity and temperature profiles of the drying gas together with moisture content and temperature of grain across dryer in term of the dryer performance. The simulations show that the models can be used to predict the dynamic drying characteristic profiles as well as the superficial velocity of drying air phase across dryer.

Key Words: Comprehensive modeling; Deep-bed drying; Grain drying; Momentum; Mass and heat conservation

INTRODUCTION

Computer age has allowed considerable preference to be made in the area of mathematical modeling and numerical simulation in the multi-disciplinary field of drying. The computing process now readily available for relatively low costs makes it possible to develop more complicated mathematical and numerical models which can be used to analyze real industrial drying configurations. Mathematical modeling and numerical simulation not only avoid the expensive and repetitive experimentation but also can be used to know the physical phenomena associated with complicated heat, mass and momentum transport phenomena which are generated within the porous media during the drying process. The results of simulation can help guide of new experimentation, which can allow the design and testing of new drying schedules to be analyzed.

It must be pointed out that experimentation is an essential work within any research and development program since it can assist the understanding of the physics associated with a particular drying process at a fundamental science and lead to the development of more realistic mathematical models. Most importantly, experimental work provides the physical characteristics of the porous media within drying process and must be used to validate the accuracy and credibility of the models and simulation.

Drying is a complex process involves simultaneous heat, mass and momentum transfers. One of the primary objectives of understanding the drying process is to be able to predict the distributions of moisture content, temperature, internal gas pressure and superficial velocity within both the