MECHATRONICS BOOK SERIES SYSTEM DESIGN AND SIGNAL PROCESSING

VOLUME 1

Editors
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CHAPTER 33

Simulation of Airflow and Temperature Distribution in Yam Storage System

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33.1 Introduction

A uniformly distributed air flow is a key factor affecting the quality of yam tuber during storage period. The storage with non-uniform air flows often suffer from condensation, consequent rotting or poor quality of the yam tuber. A good storage can limit the losses of good quality yam tuber over long periods of up to six months. Improper storage can result to high losses due to rotting, disease, dehydration and poor processing quality over quite short periods.

Computational fluid dynamics (CFD) is a modeling technique that entails representing a fluid flow problem by mathematical formulation. These formulations are based on the fundamental laws of physics. In general, the equations involved are those for the conservation of momentum, conservation of mass, and the transport equations [1]. CFD has been used in construction modeling for almost 30 years. This method was first applied to buildings in the 1970's [3]. Since then it has developed into an invaluable tool for predicting fluid dynamics. The very rapid development of computers and the increased user-friendly CFD software has led to cost effective building analysis using [5]. CFD is commonly used in building design, particularly for fluid flow modeling and simulation studies [4]. For these reasons, the simulation of the airflow and temperature distribution in a yam storage system has been carried out using COMSOL Multiphysics. The research considers airflow and temperature in a full-scale storage system. The airflow and temperature pattern is evaluated by numerical analysis.

33.2 Modeling of the Storage System

The simulation tool to produce the flow of air and temperature distribution inside the yam storage system is based on a Finite Element Method (FEM), used in COMSOL Multiphysics release 3.3 (Comsol Inc.) commercial packages. Specifically, the Navier-Stokes equations implemented in the "Chemical Engineering Module" of COMSOL Multiphysics, is adopted to describe the fluid motion and temperature distribution [2]. The simulation model was run on a 2.4 GHz Pentium M PC, with 2GB RAM memory, under Windows XP professional platform.

Fig. 1 shows the geometry of the storage system. The volume of the yam storage system is assumed to be $36m^3$. The storage system has two inlets and two outlets window whose size is $0.25m^2$ and the air flow is $200m^3/hr$. The velocity of air when it enters the yam storage system is calculated from

$$v_o = \frac{Q}{3600\,A} \tag{33.1}$$

which gives an initial inlet air velocity of 0.22 m/s for the geometry and inlet temperature of 15°C (See Table 33.1).