NUMERICAL METHOD FOR SOLVING MULTIPOINTS ELLIPTIC-PARABOLIC EQUATION FOR DEHYDRATION PROCESS

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Abstract—*Drying is the oldest and efficient form of preserving fruits. This research focuses on the mathematical modeling of tropical fruits dehydration using instant controlled pressure drop (Détente Instantanée Controlée or known as DIC) technique. We proposed a modification of mathematical modeling to enhance the previous modeling from Haddad et al. [10]. The mathematical modeling presents the dehydration process of DIC technique which involves parameters such as pressure, water content, time dependency, dimension of region and temperature behavior. The modification of the mathematical modeling has been done by transforming the quadratic equation to partial differential equation (PDE). The simulation of the dehydration process will be illustrated through Jacobi method based on two, three and five points forward difference schemes. The sequential algorithm is developed by using Matlab 7.6.0 (R2008a) programming. The numerical analysis of finite difference schemes in terms of number of iteration, time execution, maximum error and computational cost are compared.*

Keywords:*DIC technique, Elliptic-parabolic equation, Sequential algorithm, Finite difference schemes*

I. INTRODUCTION

Dehydration of fruits and vegetables is one of the most ancient and efficient preservation methods [1]. It is necessary to remove the moisture content of fruits to a certain level after harvest to prevent the growth of mould and bacterial action [2]. Recent years, the advances in dehydration techniques and the development of novel drying methods have enabled the preparation of a wide range of dehydrated fruits and vegetables in meeting the quality, stability and functional requirements coupled with economy [3]. For numerous new process, instant controlled pressure drop (DIC) technology could greatly intensify the limiting transfer phenomenon, reduce energy consumption and provide environmental friendly process [4,5].

The DIC technique was initially developed by Allaf (1988) in the University of La Rochelle [1,4,6,7]. DIC technique consists of applying instant pressure drop to modify the texture of the material and intensify functional behavior [8]. A vacuum condition is created at the beginning, followed by injection steam to the material keeping for several seconds and proceeds with the sudden pressure drop toward vacuum. The sudden pressure drop causes quick cooling of the treated material and massive evaporation of water from it. The diagrammatic layout of the DIC can be shown in Figure 1 [9].

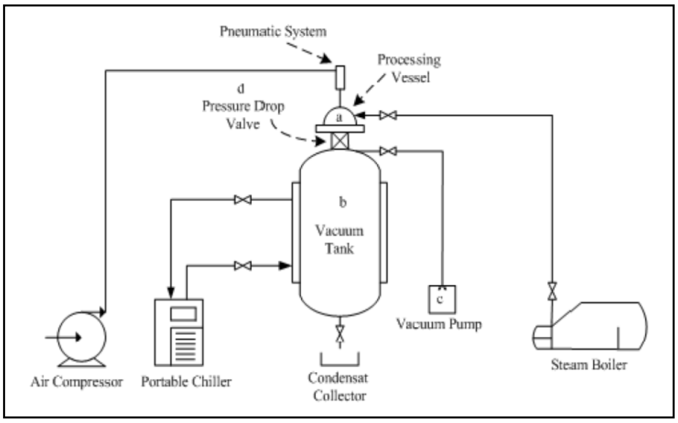

Figure 1. Schematic diagram of the DIC reactor: (a) treatment vessel with heating jacket, (b) vacuum tank with cooling liquid jacket, (c) vacuum pump and (d) instant pressure drop valve.

Many experimental studies were carried out to analyze and foresee the moisture content, steam pressure and treatment duration in foodstuff [9-11]. However, based on the latest literature review, there are only a few mathematical modeling deals with DIC. The contribution of this paper is to select the appropriate drying model to evaluate the drying distribution which is crucial in order to get best prediction of drying behavior [12].

In this paper, a mathematical modeling based on partial differential equation (PDE) with elliptic-parabolic type is proposed to describe the drying potential of fruits to enhance the mathematical modeling from [10]. The numerical simulation of the elliptic-parabolic equation is well suited in