UNIVERSITI TEKNOLOGI MARA

HOMOGENEITY ANALYSIS OF PARTICLE MIXING IN A FLUIDIZED BED BY USING COLOUR HISTOGRAM AND ARTIFICIAL NEURAL NETWORK ANALYSES

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my work, unless otherwise indicated or acknowledge as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

In pharmaceutical industry, mixing is a critical process that plays a significant role towards the quality of the final product. The mixing process, therefore, must be scrutinized to ensure homogeneity of the mixtures. Homogeneity of the process can be analyzed by either invasive or non-invasive method. Because of disadvantages of invasive methods, non-invasive methods such as Digital Image Processing (DIP) have shown great potential in the field of particle mixing and in this study. However, the DIP methods that have been used by many researchers used expensive image acquisition devices and complicated techniques. Hence, low cost web camera as image acquisition device and a simple technique called colour histogram was implemented in this research to analyzed particle mixing in a fluidized bed. There are three objectives in this study which are; to develop an image acquisition system and analyze on mixing images in fluidized bed for determination of homogeneity time, to study the effect of air velocity and particle size on mixing performance of particles in fluidized bed by colour histogram analysis and to develop an Artificial Neural Network (ANN) based system. This study begins with image acquisition of mixing image in a fluidized bed using web camera. Then, the mixing images have been analyzed by colour histogram analysis to determine mixing time, segregation time and homogeneous time. ANN analysis has been done to support the finding. From the results, the homogeneous times for random position were in the range of 44 to 82 second and 48 to 86 second for layered position. The homogeneous time was decreasing as the air velocity increased for all experiment. For set 2 and 3 that consist of different particle size, the homogeneous time was slightly higher compared to set 1 and 4 that had the same particle size. It was found that layered position gave higher homogeneous times compared to random position. ANN analysis has showed that most of the data set produced acceptable performance accuracy which is above 80 % which means that the data was considered a good data. The proposed method serves as a proof of concept that particle mixing alters the colour distribution in the image, thus can be used to analyze the quality of the mixing process.

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CHAPTER ONE

INTRODUCTION

This chapter will cover background of this research, problem statement, research objective, scope and limitation of research. In this study, an alternative non-invasive method which is image processing technique has been used to study mixing and segregation of particles in fluidized bed. Hence, a study on suitability of a low-cost camera coupled with image processing analysis has been proposed. The proposed approach begins with an acquisition of an image of a mixing process in a fluidized bed. Parameters such as air velocity and particle size that influenced mixing process have been investigated. The image will be analyzed using colour histogram technique to determine the homogeneity time of mixture. Then, Artificial Neural Network analysis has been done for verification of homogeneity analysis. All analyses have been done by using MATLAB software.

1.1 RESEARCH BACKGROUND

Mixing or in some industries called blending can be defined as a process that combines two or more materials to form one substance or mass. The purpose of mixing process is to increase homogeneity of mixture or to enhance rate of some processes or reaction. This process involves physical and chemical changes and in some industrial applications, blending and packaging constitute the entire production process, while in others, blending or mixing is a minor step in a series of long and complex process flow. Several mixing types exists, namely single-phase liquid, liquid-liquid, solid-solid, solid-liquid and gas-liquid mixing (Rhodes, 2008). This study will focused on solid-solid mixing or also known as particles mixing.

Mixing process is widely used as a procedure in several industries such as pharmaceutical, food and chemical industry where quality of final product is the utmost importance. In some industries, it is consider as a simple process and does not have any important or significant step in the overall process. But, for industries like pharmaceutical and food industries, mixing process is an important and detail