INFLUENCE OF AIR SPEED AND SPRAY PRESSURE ON UREA GRANULE PHYSICAL PROPERTIES

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2016

B051310035 BACHELOR OF MANUFACTURING ENGINEERING (MANUFACTURING PROCESS) (HONS.) 2016 UTeM

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

By

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920719-08-6119

FACULTY OF MANUFACTURING ENGINEERING

2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **INFLUENCE OF AIR SPEED AND SPRAY PRESSURE ON UREA GRANULE PHYSICAL PROPERTIES**

SESI PENGAJIAN: **2015/16 SEMESTER 2**

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Signature	:	………………………………………..
Author's Name	:	MOHAMMAD KHAIRUL AZMI BIN MOHD KASSIM
Date	:	14 JUNE 2016

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The members of the supervisory committee are as follow:

………………………………
(Dr Ridzuan bin Jamli)

………………………………
(Mr Mohd Fairuz bin Dimin)

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………………………………

(Mr Mohd Fairuz bin Dimin)

ABSTRAK

Kertas kerja ini mendedahkan kajian mengenai kesan terhadap mengaplikasi kelajuan angin dan tekanan semburan dalam menghasilkan butiran baja yang mempunyai kriteria yang terbaik. Kajian ini bertujuan untuk mendapatkan kelajuan angin yang optimum berserta tekanan semburan. Jarak parameter yang digunakan bagi menjalankan eksperimen ini adalah 15 Hz sehingga 45 Hz bagi kelajuan angin. Bagi tekanan semburan pula adalah bermula dari 0.2 MPa sehingga 0.5 MPa. Peratusan bagi larutan yang digunakan adalah 50% dimana menggunakan 100 g urea dan 100 ml air suling. Selain daripada itu, suhu yang digunakan sepanjang eksperimen ini adalah dimalarkan dimana menggunakan 60 darjah Celsius bagi proses pengeringan dan 42 darjah Celsius bagi proses ‘agglomeration’. Eksperimen ini dijalankan menggunakan mesin ‘Fluidized Bed Granulation’ berserta perisian ‘Design Expert’. Segala eksperimen yang dijalankan akan menghasilkan produk baja dan akan ditapis mengikut saiz yang akan dianalisis iaitu dari 2.0 mm sehingga 5.0 mm. Produk yang dihasilkan akan dijalankan ujian kekerasan dan densiti mengikut ‘standard’ yang telah ditetapkan. Seterusnya, perisian ‘Design Expert’ akan digunakan bagi menjalankan analisis terhadap data yang telah direkodkan. Keputusan yang diberikan oleh perisian ‘Design Expert’ tersebut perlu untuk dijalankan eksperimen lagi bagi mengukuhkan parameter optimum yang telah dicadangkan oleh perisian tersebut. Hasil daripada eksperimen tersebut, akan memberikan maklumat mengenai parameter yang optimum bagi menghasilkan baja yang mempunyai kriteria yang terbaik.

ABSTRACT

This paper presented an investigation to the influence based on the application of air speed and spray pressure in producing granule with good criteria. This research is aimed to obtain the optimal value of air speed and spray pressure. The range of parameter that used in this experiments are from 15 Hz until 45 Hz for air speed while for spray pressure are form 0.2 MPa until 0.5 MPa. Percentage of the concentration that are used in this experiments are 50%. That's mean the concentration use 100 g of urea and 100 ml of distilled water. Besides that, the temperature that used in this experiments are remained constant which are 60 degree Celsius for drying or dehumidifying process and 42 degree Celsius for agglomeration process. This experiment are run using Fluidized Bed Granulation machine and apply the parameter by using Design Expert software. All the produced granule will be analyze with an acceptable size which are from 2.0 mm until 5.0 mm. After that, granule that have been produced will be run hardness and density test according to the standard that have been assigned. Design Expert software will be run the analysis according to the data that have been recorded. Result from Design Expert software need to run another experiments for validation of the parameter. Finally, this experiments will give an enough information for the optimum parameter to produced the good quality of granule. Finally, the optimum parameters for air speed are 28.30 Hz while 0.50 MPa for spray pressure.

DEDICATION

For my beloved parents and siblings.

ACKNOWLEDGEMENTS

Firstly, I would like to express my greatest gratitude to Allah SWT for giving me chances to explore and gain new knowledge throughout the period of completing my Final Year Project. I would also like to thank my family especially my beloved mothers for never ending support and courage in terms of financial and emotion as well as their prayers in order to provide me with better education for a better and brighter future.

Not to forget, millions of thanks I wish to my supervisor and co-supervisor, Dr Ridzuan bin Jamli and En. Mohd Fairuz bin Dimin for his continuous guidance and support throughout my learning process and completing this study. I would also like to thanks each and every one in Faculty of Manufacturing Engineering; the lecturers, staffs and technicians for the cooperation in sharing their experiences and knowledge as well as their time and energy.

I would also like to express my deepest appreciation to all my friends for their efforts and willingness in sharing every knowledge and information without any difficulties. Last but not least, I am also thankful to all those people who have directly or indirectly helped me throughout this period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The introduction elaborates the main ideas of the project where as it introduces the title, the project background, objectives, problem statement and scope of the project. The specification of the study are enlighten in this chapter as guidance and information about this project.

1.1 Background of Project

In any industries that involve in fluidized bed granulation have known as a thermal treatment process for granular solids based on improving heat and mass transfer characteristics. Fluidized bed granulation are a process of converting from a liquid product into a granular solids. This process are governed either by coating or agglomeration, which depends on the operating condition and the properties of the raw material. During coating, the solute in the solution will deposited on the surface of the particles to form a thick layer. This mechanism are observed when the wetted particles can be dried before their collision or when the strength is weak. Besides that, during agglomeration, the larger size of the particles or granules are formed by smaller particles adhering to one another by liquid bridges. The solidification of the liquid bridges will leads to the formation of the solid granule.

Process of fluidized bed granulation are difficult to control as it involves of simultaneous wetting, drying and mixing of particles. If the liquid is excessive, most of the bed will may defluidize and particles will stick together as much as wet lumps that’s called wet quenching. While, if the excessive particle growth because of the minimum fluidization velocity will leads to defluidization or known as dry quenching.

During the process of fluidized bed granulation, there is a parameter that need to be finalized. There are type of binder or known as urea solution, urea powder, pressure, air speed, temperature and filter type. All of this parameter will give a result that need to be used to get a better urea. In order to achieve the goal, it is a must to understand the mechanism of particle growth and the effects of various parameters. Granulation with a film-forming of binder probably is the most common in wet-granulation technique for preparing tablets in industries. This method are used for both water-soluble and water-insoluble compounds. The formation and agglomeration of granules depend on the properties of binder, type of binder and the concentration of the solution that will use.

Urea is the important thing that will be used in this process. Urea is an organic compound with the chemical formula $CO(NH_2)_2$. Urea have the important role in the metabolism of nitrogen that containing a compounds by animal and is the main nitrogen that containing substance in the urine of mammals. The characteristic of the urea should be colorless, odorless, highly soluble in the water and practically are non-toxic. Urea are widely used in fertilizers as a source of nitrogen and is an important element of raw material for chemical industry.

The granule size distribution are the major importance to the final quality of the granulated product. This is because of the influence of density, flow ability and dustiness. That’s mean the understanding and control of granule growth during the manufacturing are the major importance to the delivery of a high quality end product. The focus of this study are to investigate the relationship of pressure and air speed that will be used during fluidized bed granulation process. The methodology that will be used to carry out this project is experimental procedures. The evaluation for properties of the granule will according to the parameters that will be used.

1.2 Problem Statement

In any manufacturing process, the parameter to conduct the experiment or the process are the most important. Parameters incorporate type of binder or urea solution, urea powder as a fertilizer, pressure and air speed may impact during the producing the best granule. During the processing, there is a range for spray pressure and air speed that will be used to completed the fluidized bed granulation. Therefore, this study will involve the research to find the optimum process parameters in order to produce a good properties of granule.

1.3 Objective of Project

The specific objectives for analysis the optimum parameters during process fluidized bed granulation are:

(a) To evaluate the optimum value of spray pressure and air speed during process fluidized bed granulation.

(b) To examine the relationship of the spray pressure and air speed during the process fluidized bed granulation.

(c) To analyze the properties of granule that have been process according to the parameters that have been finalized.

1.4 Scope of Project

The extent of the project is to perform the experiment by using the optimum value of spray pressure and air speed to produce a good properties of granule. This experiment are carried out by using the same type of binder or urea solution and type of urea binder or fertilizer. The impact of the different range of pressure and air speed will be analyze.

CHAPTER 2

LITERATURE REVIEW

This chapter elaborates the meaning and information regarding the project where it informs on the details of the project. The idea, data and information are collected from various resources in order to understand the concept and useful information or knowledge for the project.

2.1 Fluidized Bed

Fluidized are method of wet granulation that are famous in industries as a one-step, enclosed operation (Saurabh Srevastava *et al*, 2010). During process of fluidized, several different types of materials are consolidated, granulated and will dry in the same vessel. This process will reduced material handling and will shorten the process time compared to the other method of granulation process. During the fluidized bed process, it can be classified into three categories (Rao Patnaik *et al*, 2010). First categories are the solid phase when their contains the enzyme to immobilized on its surface or trapped inside it. Next are the liquid phase, this category contains the substrate to be converted into products. During this stage, the solid phase will be kept in a fluidized state by the upward flow of the medium. During this stage also, the diameter of the particle will be increased. Lastly, the microorganism will grows as a film on the media particles.

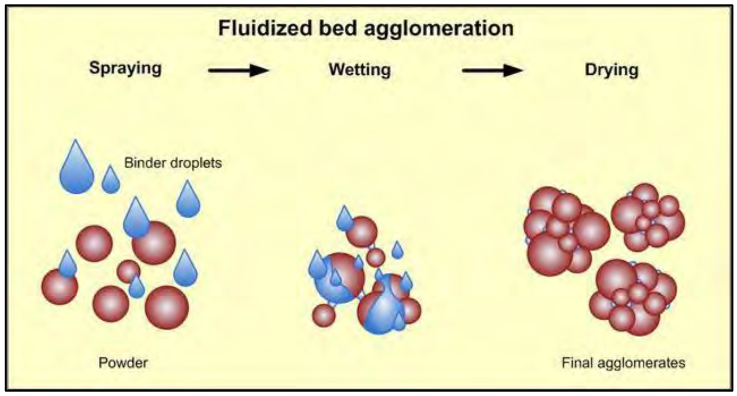

Figure 2.1: Fluidized bed agglomeration particle process (Sources: https://www.neuhaus-neotec.de/partikel_ws/en/wirbelschicht/agglomeration/).

2.1.1 Granulation

According to the J.P. Remon *et al*. (2011) the fluidization industry, has been adopted extensively beforehand to improve powder properties such as flowability and compressibility for downstream processing. The addition of a binder liquid will causes the particles to aggregate and become granules during the process that includes spraying and drying. The granule size distribution is the importance output that need to be consider for the final quality of the granulated product because it will influences the physical properties of the granules such as density, flowability, and dustiness. That's mean, the understanding and control of granule growth during manufacturing are of major importance to the delivery of a high-quality for the end product.

Granulation processes are usually known based on the binder nature such as wet, dry or melt (Sussy Veliz Moraga *et al*, 2015). For wet granulation, the solution or dispersion that known as liquid binder is distributed on the seeds and the granules will leaves dried to evaporate the solvent. In dry granulation, a solid particles will be added to the seed bed and the powder bond is promoted by Van der Waals or electrostatic forces. During melt granulation, powders are enlarged by using liquid materials. These last binders solution are included into the frameworks either powders that dissolve during the granulation process or atomized liquid fluids. The principal melt granulation procedure is normally called co-melt or in melt granulation, while the second strategy could be known as spray-on melt granulation. Absolutely, co-melt granulation is not appropriate to those systems in which seeds and binders have a comparative melting temperatures.

2.1.2 Agglomeration

Theoretically, agglomeration is a procedure framing another molecule size where the particles are sticks to each other based on Wolfgang Pietsch (2008). While the items can be created in granules, tablets, beds, or compacts after agglomeration with includes procedures are nucleation, blend and layering.

In addition, the variables which is affected in the agglomeration were break time, agglomerate smash resistance, sphericity, porosity, size appropriation and yield. The cover consistency which content strong particles is affected agglomerate size and higher thickness prompted bigger agglomerates and tight clamp versa. While, auxiliary change of the grid is not in view of progress of binder molecule size; both variables which are porosity and break time are not altogether modified (Anette Pauli-Bruns *et al*, 2010).

Attractive forces because of liquid between fluidized particles is directed to the molecule agglomeration. Contact points between particles makes surface energies between strong disseminated fluid, and sodden encompassing were observed to be an introductory marker for molecule agglomeration. In the arrangement of agglomeration, conveyance stage can sodden the particles, fluid tying in a static framework is primarily identified with the interfacial pressures acting between the coupling fluid and strong surfaces, while thick strengths which restrict the division of agglomerated particles may have a critical effect in element frameworks.

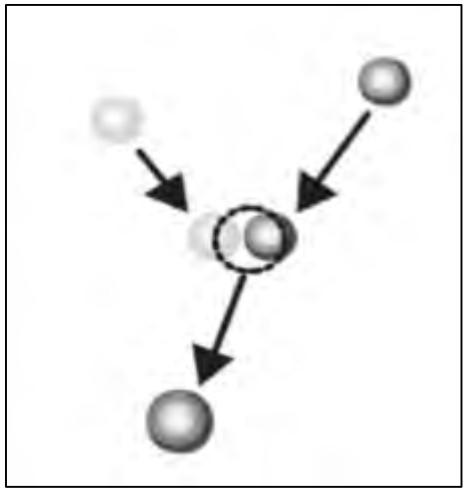

Figure 2.2: Repositioning and merging of particles upon coalescence or agglomeration (Sources: http://www.sepscience.com/).

From this study, round granules with sizes of 2–4 mm. Figure underneath demonstrates the granules created with unadulterated $(NH_4)_2SO_4$ and $(NH_4)_2SO_4$ with 5% micro $CaCO_3$ added substances.

From the model above demonstrates the movement of particles and bead which is meet together under Newton's comparison of movement, where the gas stage a persistent grouping in which neighboring components are not recognizably not the same as one another. In the development of granules, the models include are molecule bead combination, molecule impacts and agglomeration. These reproductions is occurred while the binder in fluid state sprayed all through spout and happen on top of bed. The procedure tying of molecule through layering though item with just as size, bed infiltration by beads or wet particles not by any stretch of the imagination happened (M.J.V. Goldschmidt, *et al*, 2004).

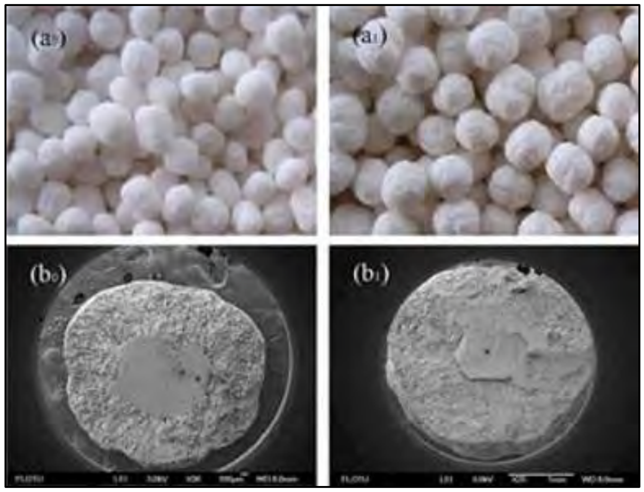

Figure 2.3: The produced granules and their cross section structure: (a) granules and (b) cross section of a single granule (subscript 0 for pure $(NH_4)_2SO_4$; 1 for $(NH_4)_2SO_4$ with 5% micro-$CaCO_3$).

According to Jeongjin Lee *et al*, (2010) utilizing ammonium sulfate $(NH_4)_2SO_4$ as a binder that sprayed to pick up of ammonium sulfate powder utilizing fluidized bed innovation yet give result has low covering productivity. They are makes tentatively with including little added substances covering to the arrangement, the effectiveness expanded from 58% to more than 90%. The impact of distinctive added substance particles on expanding covering effectiveness was in the request: small scale $CaCO_3$ > nano-$CaCO_3$ > nano-SiO_2. $(NH_4)_2SO_4$ granules. With utilizing these added substances, the consequence of created granules verging on same with spray covering granulation with 2-4mm granules size and squashing quality scope of 20-40 N. The granule squashing quality expanded with the measurement, and the devastating quality was higher when an added substance was utilized.

The extra added substances from trial, demonstrated the outcome that they are induced the ammonium sulfate and bringing about the item turn out to be consistently take shape and structure turn out to be more minimized contrasted with ammonium arrangement with little added substances. This new arrangement named heterogeneous crystallization that gives more minimal on delivered item with expanded debilitating resistance in the fluidized bed while expanding the covering effectiveness. Along these lines, the reduced