



**UNIVERSITI PUTRA MALAYSIA**

***COMPARISON OF VERTICAL AND CONTINUOUS STERILIZERS IN  
PALM OIL MILL***

**HERI PURWANTO**

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**COMPARISON OF VERTICAL AND CONTINUOUS STERILIZERS IN  
PALM OIL MILL**

**HERI PURWANTO**



Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfillment of the Requirement for the Degree of Master of Science

January 2012

## DEDICATIONS

*To my dearest parents, Samiyem and Suparno, who always pray and encourage me sincerely.*

*To my beloved wife, my brother and family for their doa, understanding, patience and support throughout my study.*

*Words cannot express alone my gratitude to the people above for their endless and boundless love, and most of all for their ever continuous do'a for my life..*

*When you have come to a decision, place your trust in God alone.  
He loves those who place their trust in Him.  
If God is there to help you, none will overcome you, and if He forsake you,  
who will help other than Him?  
So only in Allah should the faithful place their trust.*

*Q.S. Ali Imran 159-160*

Abstract of thesis presented to the Senate of Universiti Putra Malaysia  
in fulfillment of the requirement for the degree of Master of Science

## **COMPARISON OF VERTICAL AND CONTINUOUS STERILIZERS IN**

### **PALM OIL MILL**

By

**Heri Purwanto**

**January 2012**

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Sterilization is one of the keys processed in palm oil mill. Some new sterilization methods has been developed and modified, and the two most common methods that is used are continuous sterilizer and vertical sterilizer. There was no work reported before on comparison of performance between this two sterilizer. Therefore the objectives of this research is to study the comparison of performance between two methods of sterilisations. This research is also conducted to predict the time needed for the fruit to get fully sterilized by using heat transfer simulation. The research was divided into three activities, first is mill observation and analysis at the site of palm oil mill for purpose of data collection and measures the performance of sterilizer, and second is experimental work conducted to analyse the chemical (free fatty acid and deteriorated oil bleachability index) and physical (texture profile and microstructure image) changes of the fruit and oil as the effect of sterilization.

The two-dimensional, time-dependent, unsteady state, heat conduction mathematical model was created for rectangular block simulating FFB using the finite-difference-explicit method, this model was to study the simulation of heat transfer penetration during penetration to predict the time required for the bunch to get fully penetrated by heat. The simulation was used iteration methods using spreadsheet on Ms. Excel. Result on microstructure image taken from sterilized fruit related to oil expression shows that vertical sterilizer has better result compare to continuous sterilizer. The microstructure image of conventional and vertical sterilization compared to fresh fruit it has shown that there is complete rupture of cell wall and disintegration of the cell, can be seen that oil start to flow out from the cell. Meanwhile on continuous sterilization, even there is still partial collapse of the cell wall, some of the oil cell still retained their architecture.

Heat that is applied in vertical sterilizer also gives better effect on texture profile compare to continuous sterilizer. The softening effect is better in vertical sterilizer is better showed by the lower hardness and fracturability. Result on FFA measurements after sterilization show that vertical sterilization shows lower result compare to continuous sterilization. On evaluating the steam consumption during sterilization process, the vertical sterilizer shows lower steam demand compare to continuous sterilizer, and the trends of BPV graph shows a lesser fluctuations on vertical sterilizer. The simulation of heat penetration during sterilization on palm oil mill results is prediction of resident time of heating through sterilization process, that is determined to be **83.2 minutes** for the continuous sterilization with bunch crushing and **102.7 minutes** for the continuous sterilization without bunch crushing, for the vertical sterilization the prediction of resident time is **105.2 minutes**.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Master Sains

**PERBANDINGAN ALAT PENSTERILAN MENEGAK DAN BERTERUSAN  
DALAM KILANG MINYAK SAWIT**

Oleh

**Heri Purwanto**

**Januari 2012**

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Pensterilan adalah salah satu proses utama dalam kilang minyak sawit. Beberapa kaedah pensterilan baru telah dibangunkan dan diubah suai, dan kedua-dua kaedah yang paling biasa digunakan adalah sterilizer berterusan dan sterilizer menegak. Walau bagaimanapun, tiada kerja yang dilaporkan pada perbandingan antara prestasi kedua-dua alat pensterilan. Oleh itu, objektif kajian ini adalah untuk membandingkan prestasi antara kedua-dua kaedah pensterilan. Kajian ini juga dijalankan untuk meramal masa yang diperlukan untuk buah-buahan untuk sepenuhnya disterilkan dengan menggunakan simulasi pemindahan haba. Kajian ini telah dibahagikan kepada tiga aktiviti; pertama ialah kajian kilang dan analisis di tapak kilang minyak sawit bagi tujuan pengumpulan data dan pengukuran prestasi sterilizer; kedua ialah kerja-kerja eksperimen untuk menganalisis sifat kimia (asid lemak bebas dan minyak merosot perubahan indeks bleachability) dan fizikal (profil tekstur dan imej mikrostruktur) buah-buahan dan minyak sebagai kesan pensterilan. Model matematik pemindahan haba konduksi dua dimensi, bergantung kepada masa,

keadaan tak mantap telah diwujudkan untuk blok segiempat simulasi BTS menggunakan kaedah-jelas perbezaan terhingga, dan model tertentu telah digunakan untuk mengkaji simulasi daripada penembusan pemindahan haba semasa penembusan dengan tujuan meramal masa yang diperlukan untuk tandan ditembusi sepenuhnya oleh haba. Kaedah lelaran menggunakan spreadsheet Microsoft Excel telah digunakan untuk penyelakuan.

Keputusan imej mikrostruktur yang diambil daripada buah disterilkan berhubung kepada ungkapan minyak mendedahkan bahawa sterilizer menegak menghasilkan keputusan yang lebih baik berbanding dengan sterilizer berterusan. Khususnya, imej mikrostruktur yang sterilizations konvensional dan menegak menunjukkan bahawa terdapat pecah lengkap dinding sel dan penyepaian sel, seperti yang dapat dilihat dari minyak yang mula mengalir keluar daripada sel-sel. Untuk pensterilan berterusan, walaupun keruntuhan sebahagian daripada dinding sel yang boleh dilihat, beberapa sel-sel minyak masih mengekalkan bentuk mereka.

Adalah penting untuk ambil perhatian bahawa haba yang digunakan untuk sterilizer menegak juga memberi kesan yang lebih baik pada profil tekstur berbanding dengan sterilizer berterusan. Kesan melembutkan telah didapati lebih baik dalam sterilizer menegak seperti yang diperhatikan oleh *Hardness* dan *Fracturability* yang lebih rendah dan. Keputusan yang diperolehi daripada pengukuran FFA selepas pensterilan menunjukkan bahawa pensterilan menegak menghasilkan keputusan yang lebih kecil berbanding dengan pensterilan berterusan. Oleh itu berdasarkan penilaian yang dijalankan ke atas penggunaan stim semasa proses pensterilan, sterilizer menegak menunjukkan wap permintaan yang lebih rendah berbanding

dengan sterilizer berterusan, dan trend graf BPV menunjukkan turun naik yang kurang pada sterilizer menegak. Simulasi penembusan haba semasa pensterilan atas buah sawit adalah ramalan masa yang bermastautin pemanasan melalui proses pensterilan, dimana dari hasil peramalan didapatkan hasil dengan masa 83,2 minit untuk pensterilan berterusan dengan perlakuan awal penghancuran, dan 102,7 minit untuk pensterilan berterusan tanpa perlakuan awal penghancuran. Untuk pensterilan menegak, ramalan masa pemastautin didapati 105,2 minit.





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**I certify that a Thesis Examination Committee has met on 06/01/2012 to conduct the final examination of Heri Purwanto on his Master of Science thesis entitled “Comparisson of Vertical and Continuous Sterilizers In Palm Oil Mill”. In accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A)106] 15 March 1998. The Committee recommends that the student be awarded the relevant degree, Master of Science.**

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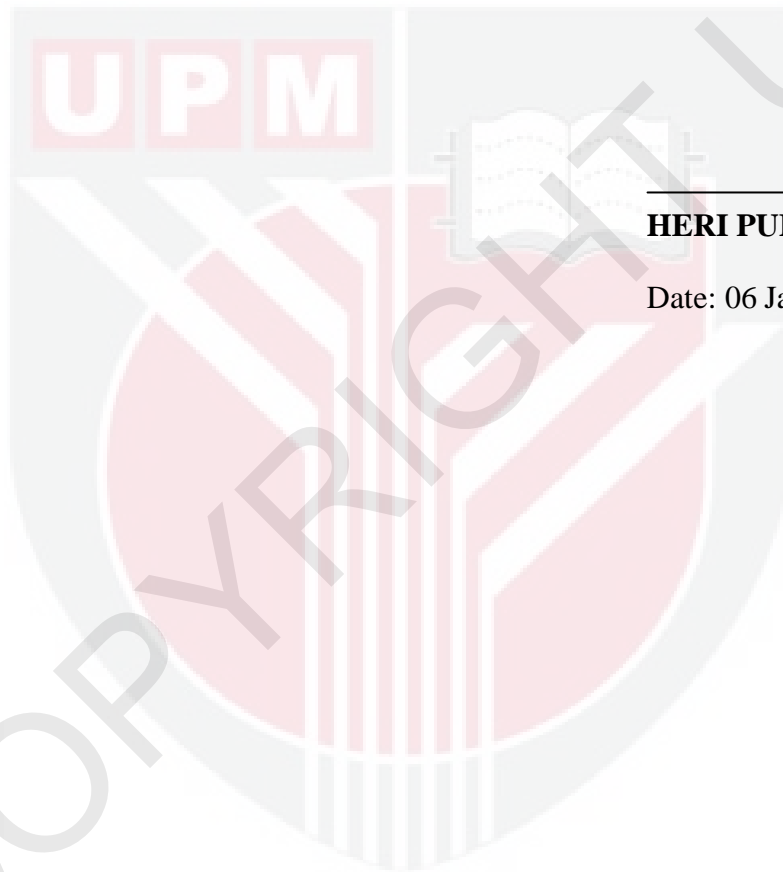
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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**HERI PURWANTO**

Date: 06 January 2012

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