IMPROVEMENT OF SCREW PRESS PRODUCTION IN PALM OIL MILL USING FUZZY LOGIC SYSTEM

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A thesis submitted in
fulfillment of the requirement for the award of the
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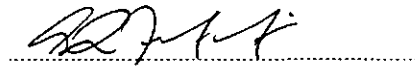
Signature	:	
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Dedicated to
my beloved wife and children

ACKNOWLEDGMENT

Bismillaahirrahmaanirrahiim...

Praise be all to Allah SWT, the Most Gracious, the Most Merciful. Shalawat and salam be to Rasulullah Muhammad saw. By the grace of Allah SWT, this thesis is finally completed and submitted to Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, to full fill the requirements for the Degree of Master of Mechanical Engineering.

I would like to take this great opportunity to express my warmest gratitude to my supervisor Professor Dr. Sulaiman bin Hassan and co-supervisor Assoc. Professor Dr. Mohd Nor bin Mohd Than for their guidance, concern and strong support throughout the completion of this thesis. Their enthusiasm has been a great source of inspiration to me and it gives me a great sense of honour to be under their wings.

Great thanks to my friends who have assisted in making this thesis a wonderful one and finally to those who have contributed to the success of this thesis, especially Kumpulan Kilang Sawit RISDA Bhd. Without them this thesis would not have been possible.

ABSTRACT

A screw press machine is used to compress the fruit mash between the main screw and the travelling cones to extract the palm oil. The position of the cones against the discharge end of the press cage determines the pressure. The pressure controller is an important factor in determining the oil loss and nut breakages. A conventional control system which is the band control system, uses a kilowatt meter as a controller in adjusting the press cage pressure. However, the screw press machine can be improved in order to reduce the oil loss and nut breakages. Not much researches has been conducted on reducing the nut breakages as well as oil loss. Therefore, the objective of this study is to minimise the oil loss and broken nuts. The objective can be achieved through upgrading the screw press machine and the use of fuzzy control system. During the course of this research project, the hydraulic system of the screw press machine was upgraded by utilising the proportional pressure relief valve. A current transducer was used to measure the motor current load. A ladder diagram program and fuzzy logic algorithm were written and downloaded into the programmable logic control to regulate the press cage pressure. For comparison purposes, a band control system and fuzzy control system were implemented in the control environment. The performances of both systems were compared in a number of tests. The first test was the oscillation of motor current load with the performance of fuzzy control system that was stabilised at 8.33mA. This is due to the reaction of fuzzy pressure controller in regulating the proportional pressure relief valve. The fuzzy control system is able to reduce 1.20% of oil loss compared to the band control system. The percentage of the broken nuts of the fuzzy control system was reduced by 3.55%. This implies that the objective to reduce the breakages is achieved. Thus, the screw press machine with a fuzzy control system is found to be significantly more efficient than the band control system.

ABSTRAK

Mesin penekan skru digunakan untuk memampatkan leceken buah antara skru utama dan kon penggerak bagi tujuan mengekstrak minyak sawit. Kedudukan kon di hujung keluaran sangkar pemerah menghasilkan tekanan. Pengawal tekanan merupakan satu faktor yang utama terhadap kehilangan minyak dan biji pecah. Sistem kawalan lazim yang sedia ada iaitu sistem kawalan jalur, menggunakan kilowatt meter sebagai pengawal bagi tujuan melaras tekanan di dalam sangkar pemerah. Oleh yang demikian, prestasi pemprosesan mesin pemerah skru ini, berpotensi untuk dimajukan bagi mengurangkan lagi kehilangan minyak dan biji pecah. Tidak banyak penyelidikan yang telah dijalankan dalam mengurangkan kehilangan minyak dan biji pecah. Oleh itu, objektif kajian ini adalah untuk mengurangkan kehilangan minyak dan biji pecah. Objektif kajian ini boleh dicapai dengan menaik taraf mesin penekan skru dan penggunaan sistem kawalan kabur. Sepanjang projek penyelidikan ini, sistem hidraulik mesin penekan skru telah dinaik taraf dengan menggunakan injap pelega tekanan berkadar. Pencerap arus elektrik telah digunakan untuk mengukur muatan arus elektrik motor. Aturcara PLC dan algoritma logik kabur telah ditulis dan di muat turun ke PLC bertujuan untuk mengawal tekanan sangkar pemerah. Perbandingan antara sistem kawalan jalur dan sistem kawalan kabur telah dilaksanakan dengan mengadakan beberapa ujian. Ujian pertama adalah ayunan muatan arus elektrik motor dan didapati prestasi sistem kawalan kabur adalah stabil pada 8.33mA. Ini adalah disebabkan oleh tindakan pengawal tekanan kabur dalam mengatur injap pelega tekanan berkadar. Sistem kawalan kabur didapati mampu mengurangkan 1.20% kehilangan minyak berbandingan sistem kawalan jalur dan peratusan biji pecah sistem kawalan kabur adalah lebih baik dengan perbezaan sebanyak 3.55%. Ini menunjukkan, objektif kajian iaitu untuk mengurangkan kehilangan minyak dan biji pecah telah dicapai. Oleh itu, mesin penekan skru dengan sistem kawalan kabur adalah lebih baik berbanding dengan sistem kawalan jalur.

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NOMENCLATURE

SYMBOL	DESCRIPTION
A	Ampere
A_1	Rod side piston area
A_2	Piston surface area
d	Relative distance
F	Force
i_a	Actual current
i_e	Current error
i_r	Desired current load
mA	Milliampere
P_1	Pressure acting on the rod side of the hydraulic piston
P_2	Pressure acting on hydraulic piston surface
P_{pc}	Press cage pressure
P_r	Hydraulic pressure
u	Output of Fuzzy Controller
Δi_e	Current error change
Δp_f	Fuzzy output variable
Δp_r	Hydraulic pressure output variable
$\mu(c_j)$	Membership grade of the j th
μ_z	Membership grade of the i th

ABBREVIATIONS

A/D	Analogue to Digital
AC	Alternate Current
COG	Centre of Gravity
CPU	Central Processing Unit
CT	Current Transducer
D/A	Digital to Analogue
DC	Direct Current
DM	Data Memory
FFB	Fresh Fruit Bunch
FSS	Fuzzy Support Software
HMPB	Harrisons Malaysian Plantations Berhad
I/O	Input/Output
IR	Internal Relay
KW	Kilowatt
MPD	Mass Passing to Digester
NL	Negative Large
NM	Negative Medium
NS	Negative Small
PD	Proportional-Derivative
PI	Proportional-Intergral
PID	Proportional, integral and derivative
PL	Positive Large
PLC	Programmable Logic Controller
PM	Positive Medium
PPRV	Proportional Pressure Relief Valve
PS	Positive Small
rpm	revolutions per minute
SBB	Binary Subtraction
ZR	Zero

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CHAPTER I

PALM OIL SCREW PRESS

1.1 Introduction

The palm oil mill processes is shown in Figure 1.1. On the arrival of the fresh fruit bunch (FFB), the FFB are steam sterilised where the fruits soften and easily detached from the stalk. These detached fruits are further softened with steam in digesters. The digester mash is then passed to the screw press where the oil and the nut are extracted.

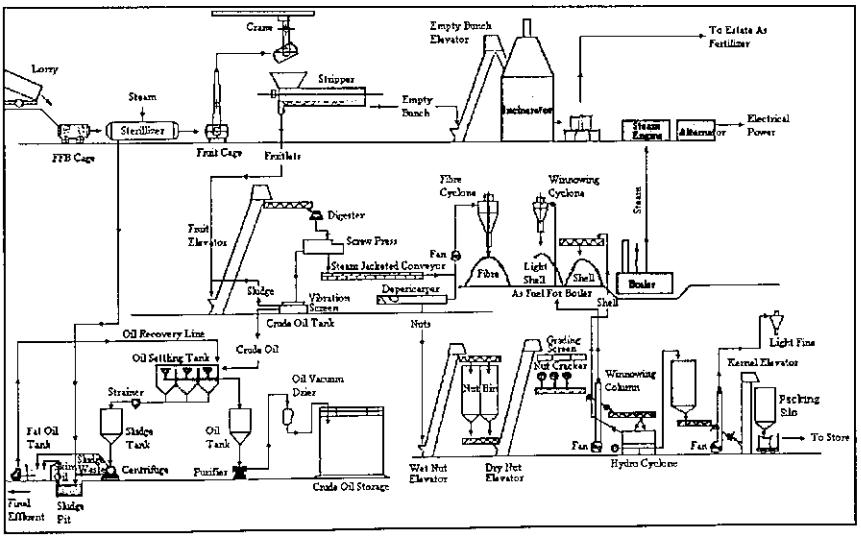

Figure 1.1: Palm oil processing

There are various types of screw presses used for the extraction of palm oil. The earliest was introduced to the palm oil industry in the early 1960's. This type of machine had been developed for a multitude of applications, both for extraction and extruding (Sivalingam, 1999).

The concept of the screw press is to compress the fruit mash between the main screw and the travelling cones to extract the palm oil. The position of the cones, as shown in Figure 1.2, against the discharge end of the press cage determines the pressure maintained on the mash i.e. smaller slot between cone and press cage will result in higher pressure and vice versa.

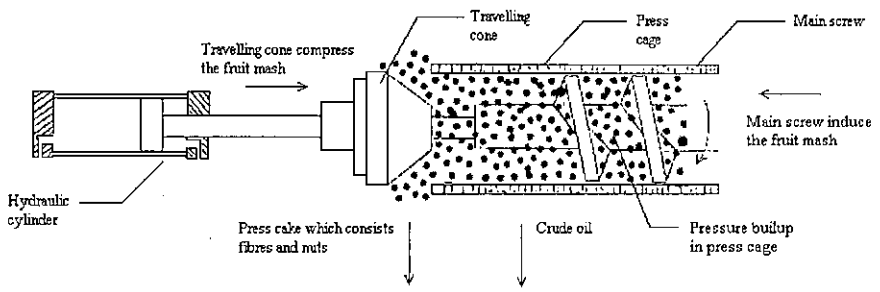

Figure 1.2: The operation of screw press

In the screw press, the stability of the press cage pressure is an important factor in determining the oil loss and nut breakage in the press cake. A high pressure causes a better recovery of the oil but unfortunately produce a higher nut breakage.

The effectiveness of the screw press is very critical in optimising the oil extraction. Ineffective press will result in oil loss and nut breakage and also high maintenance cost of the machine. Engineers and researches have always tried to optimise the oil press operation and this research is studying one method of achieving this. Therefore a fuzzy logic system has been chosen in this research to stabilise the pressure in the press cage.

Fuzzy logic system has been successfully used for a wide number of applications dealing with complex and non-linear processes, wherein they are proved to be robust and less sensitive to parametric variations and noise than conventional controllers (Roger Jang and Gulley, 1997). In addition, fuzzy logic system has been proven to reduce the oscillations, smoothing the output as far as the error decreases. This nonlinear characteristic of the controller is a great advantage and was not possible by a linear Proportional-Derivative (PD) controller (Corbet and Lawrence, 1996).

1.2 State of The Art in Palm Oil Mill Screw Press

The screw press system is one of the least understood processes in a palm oil mill even though it is one of the most important. Hence, very little progress in the quantitative understanding of screw presses has been achieved even though they have been used in palm oil mills for the past fifty years. In view of the oil losses improvement, the extraction method has gone through some evolution in term of method of extraction, design and control (Sivasothy, 1993).

One method of controlling the press cone is utilising kilowatt set point. The press cone movement depends on the kilowatt set point. When the measurement is less than set point, the press cone will move in and vice-versa (Yee, et. al., 1987). These conventional pressure control systems are used extensively in the palm oil industry. This controller is sometime referred to as band control system. However, these controllers do not take the interaction effect into consideration and the design and adjustment are difficult despite of their high performance (Burhan Sidek, 1988).

The pressure inside the cage must be measured accurately to ensure effective control. Thus the method of measuring the pressure is therefore very important. Pressure can be measured indirectly by the measurement of the power consumed by the screw press. In general, the pressure can be controlled and it relies on the precision of the instrument and the screw press condition (Sivasothy, 1993).

To summarise, an extensive review of the literature have shown that there are limited number of published papers on the topic of palm oil mill screw press control system. As such, that this will remains as an area in which substantive research needs to be conducted. This research project will attempt to introduce another mean of controlling pressure in the palm oil mill screw press.

1.3 Problem Statement

In conventional screw press control system, as shown in Figure 1.3, the press cage pressure is measured via the screw press motor current load by using the current transducer. If the level is rises, the travelling cone will move away from the press cage opening. By doing this, the pressure inside the press cage will be reduced. However the regulating pressure in the press cage efficiency is relatively poor and produces a fluctuation pressure. The fluctuation press cage pressure cause the increment of oil losses and nut breakage.

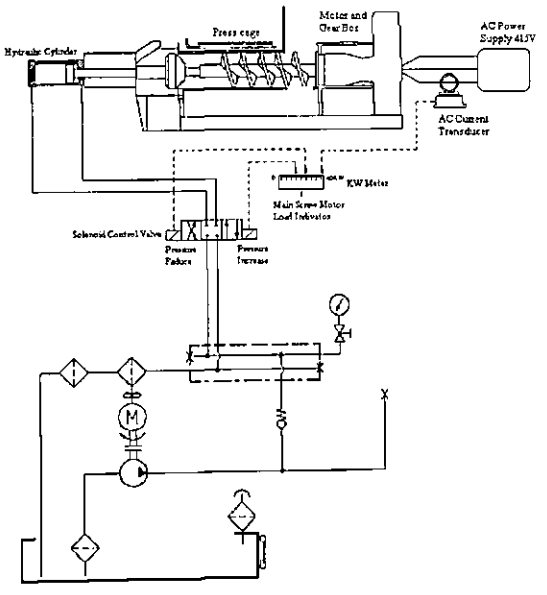

Figure 1.3: Schematic diagram of the hydraulic system for the band control system (Bosch Rexroth, 2000)