CLEANER PRODUCTION IN PALM OIL INDUSTRY, SRI LANKA

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This thesis was submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfilment of the requirements for the degree of Master of Science.

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DECLARATION

This thesis is a report of research out in the Department of Civil Engineering University of Moratuwa between August 2003 and October 2004. Except where references are made to other work the contents of this thesis are original and have been carried out by the under signed. The work has not been submitted in part or whole to any other university. This thesis contains 83 pages.

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ABSTRACT

Oil palm was introduced to Sri Lanka from Malaysia in late nineteen sixties. As of now, after approximately three and a half decades, it has spread over 10,000 acres of the southern part of the Island. Watawala, Namunukula, Agalawatta and Elpitiya are the four key companies that share oil palm plantations, which are distributed mainly in the Galle District.

However the country has only one palm oil mill owned by Watawala Plantations Ltd. located at Nakiyadeniya in Galle District, processing over 19,000 tonnes of fresh fruit bunches annually.

The main objective of the research is to identify the applicability of cleaner production in to the Sri Lankan palm oil industry and to present places where CP can be adopted in the Sri Lankan palm oil industry through technical, financial and environmental evaluation of CP options and identification of their priority levels in implementation. In addition, development of a proposed Industry-Specific Effluent Discharge Standard for Sri Lankan Palm Oil Industry is considered as a key objective in this study.

After comparing some of the Life Cycle Assessments (LCAs) performed for similar products in other countries, it was identified that the crude palm oil extraction process is the area that we have to concentrate, as it was the main stage of energy usage and environmental pollution. Therefore the scope of the study was narrowed down to factory operations, which covers all the stages of crude palm oil extraction.

To fulfil the main objective of developing cleaner production options for the factory operations, a walk-through audit was carried out followed by a detailed audit considering each and every process step of the factory. Detailed assessments were conducted in areas including material handling & consumption and waste generation with their characteristics. Electrical & thermal energy utilisation was analysed in detail to evaluate the current operational efficiencies and methods to minimise the losses. Energy and material balances were done in calculating actual process requirements and estimating existing losses. A Boiler heat balance and evaluation of electrical efficiencies of each and every process machinery were conducted with industry experts to find out the losses and to identify the places where improvements can be made without drastic changes to the existing operational methods. Calorific values and moisture contents of key waste streams of the plant were analysed in order to determine energy inputs and evaluate the possibilities of operating the plant self-sufficiently, energy wise. Opportunities of modifying the physical state of raw material and recycling of utilities & waste materials from the process were assessed during the audit. Observations and conversations with the employees were major tools used in the audit and the employee recommendations or comments on CP improvements were considered important in identifying and prioritising the final CP options. Technical feasibility and environmental sustainability were the main evaluating criteria of selecting the key cleaner production options for the factory processes.

The measured moisture-free base calorific values of EFB, PPF & PKS indicate that it is possible to have a cogeneration plant onsite which could fulfil the Plant's electrical and heat (steam & hot water) requirements. The flue gas analysis carried out in the factory boiler indicates that the excess air percentage is higher than the recommended value. Correcting this will increase the boiler efficiency as the flue gas losses decrease. In addition, complete burning of the fuel will decrease the amount of hazardous pollutants being emitted into the surrounding environment. According to the measured values and the boiler heat balance carried out it is seen that there is a possibility of using flue gas heat to replace steam at some processes. Blow down losses of the boiler could be further reduced by treating (reducing TDS) inlet water to the boiler. As a result of the electric power analysis of almost all the plant electrical machinery it is seen that most of the machines (over 60%) are operated at less than half load conditions, which contributes to low operation efficiencies, low power factors and due to all these considerable wastage in electrical energy consumption.

It was identified that by making effortless changes to the existing handling systems could minimise the product losses and at the same time improve the final product quality, making the operation more profitable. In addition, income from by-products will enhance the economic viability of implementing the selected cleaner production options.

Wet extracting of crude palm oil from palm fruits generates large quantities of wastewater. Raw Palm Oil Mill Effluent (POME) can be considered as one of the highest industrial polluting sources having BOD, COD and TDS values as high as 26,000, 67,000 and 72,000 mg/l respectively. As there is no industry specific standard for palm oil industry in Sri Lanka, the factories have to comply with the General Effluent Discharge Standards specified by the Central Environmental Authority (CEA). The treated effluent quality of the range BOD_5^{20} 1,000 – 1,360 mg/l, COD 2,371 – 2,880 mg/l and TDS 21,800 - 22,410 mg/l achieved in the existing pond system of Nakiyadeniya Pail Oil Mill does not comply with the CEA general standards. Analysis of POME treatment technologies in practice and in experimental scale revealed that achieving compliance with set CEA General Standards is a difficult task. Further, the effluent discharge standards laid out in other countries, applicable to POME discharge, shows the stringent nature of the Sri Lankan general standards and difficulty in complying with the set standards. The generation of the proposed standard considered applicability of treatment technologies used worldwide in Sri Lankan conditions (Best Practical Technologies) and effluent disposal standards adopted in other countries.

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ABBREVIATIONS

AAS	- Atomic Absorption Spectrophotometer
ADB	- Asian Development Bank
BA	- Boiler Ash
BC	- Belt Coupling
BOD_5^{20}	- Biochemical Oxygen Demand, 5 day at 20^0C
CEA	- Central Environmental Authority
COD	- Chemical Oxygen Demand
CP	- Cleaner Production
CPO	- Crude Palm Oil
DC	- Direct Coupling
DC – GB	- Direct Coupling with Gear Box
DEC	- Decanter Cake
EFB	- Empty Fruit Bunches
FFA	- Free Fatty Acid
FFB	- Fresh Fruit Bunches
ITI	- Industrial Technology Institute
KO	- Kernel Oil
NCPC	- National Cleaner Production Centre
NERD	- National Engineering Research & Development
O & G	- Oil and Grease
PKC	- Palm Kernel Cake
PKS	- Palm Kernel Shells
POME	- Palm Oil Mill Effluent
PPF	- Palm Press Fibre
RBD	- Refined Bleached Deodourised
SMED	- Small & Medium Scale Entrepreneur Development
TDS	- Total Dissolved Solids
Temp.^{0}C	- Temperature, degrees Celsius
Total N	- Total Nitrogen
Total P	- Total Phosphorus
TSS	- Total Suspended Solids
UOM	- University of Moratuwa