Material Flow Cost Accounting (MFCA): A Brief Introduction

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ABSTRACT

Since the advent of the Industrial Revolution in the early 19th century, man has started to pollute the environment. This was accelerated after the Second World War when synthetic materials began to appear. The production of these materials and other new inventions that greatly impact on the socio-economic conditions of the populace also greatly accelerated pollution of the environment. In the last 20 years, concern for the environment has increased tremendously and it is definitely going to be the issue of concern over the next 20 or 30 years. Over the last 20 years, a lot of methods and standards, such as life cycle assessment (LCA) and the ISO 14000 Series of Standards, respectively, have been introduced to try to reduce or eliminate environmental pollution as much as possible. However, the majority of efforts expended are more qualitative rather than quantitative in nature and hence, their impacts are less obvious or appealing to industry, unless so demanded by consumers.

Material flow cost accounting (MFCA) is a method for costing the wastes generated. Hence, a reduction in wastes, which will impact the environment, will now lead to a reduction in the cost of production. This will help industries to reduce their environmental pollution and hence improve their sustainability. The principle behind MFCA is outlined in this article. This principle is currently being used as the basis for a new ISO 14000 Series Environment Standard to help industries reduce or eliminate environmental pollutions caused by their manufacturing processes in financial terms. This will make it easier for industries to grasp their environment improvement efforts also in financial terms. Thus, it will help to motivate industries to improve their environment record while simultaneously making it easier for companies to justify their environment improvement efforts to their stakeholders and shareholders. The purpose of this article is to bring this latest development on the environment front, in addition to the impending carbon and water foot-printing, to the attention of the Malaysian oil palm industry, as part of MPOB’s continuing effort in helping industry to increase its environment sustainability.

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INTRODUCTION

The Industrial Revolution which began in the early 19th century started the period where goods and materials are produced to make life easier and better for mankind. The amount of manufactured goods has since accelerated, especially after the Second World War. The production of these materials coupled with other new inventions that have a great impact on the socio-economic conditions of the people also greatly accelerated the pollution of the environment. In the last 20 years, environmental issues have taken central stages and they will definitely be issues of concern over the next few decades.

In terms of environment, the ISO 14000 Series of Environmental Management System Standards have come a long way since the inception of the first standard ISO 14001 on Environment System Management (EMS) in the early 1990s. Since then a whole series of standards have evolved dealing with EMS auditing, environment labelling, environment performance evaluation (EPE), life cycle assessment (LCA), greenhouse gas (GHG) emissions and its related activities, and others. Under the umbrella of ISO TC 207, these standards are continuously reviewed and revised every five years while new standards are continuously being drawn up to address the various aspects of environment preservation or protection and to reduce, prevent or mitigate the impacts of pollution through the clean development mechanism (CDM) with zero waste discharge or usage of waste materials, waste reduction and others.

The last two decades of the 20th century were the decades of quality for the Malaysian oil palm industry, while the beginning of the 21st century will undoubtedly be the era of environment consciousness and preservation. The Malaysian oil palm industry was slow to take up environment issues in the past, but the industry looks set to embrace these issues in a big way in the coming years. MPOB is responding to this challenge through the establishment of its Codes of Practice Scheme (CoPS) which also deals with environment issues.

In recent years, the world has been subjected to various environmental events on a gigantic scale, such as earthquakes (especially like the one in Sichuan in China), hurricanes and tsunamis – such as hurricanes Nagis and Katrina which devastated parts of Myanmar and USA, respectively, and the Indian Ocean tsunami which wreaked havoc in Aceh, Indonesia. It is arguable whether these are Mother Nature’s warnings of worse things to come, if humankind continues to pollute the environment. Whatever is the argument, wastes from industries continue to be looked upon as the major culprits of pollution, in addition to the emissions from transportation. Hence, it is timely that attention be focused on reducing industrial wastes.

As mentioned earlier, new standards are continuously being drawn up by the sub-committees (SC) or working groups (WG) under ISO TC 207. Some of the new standards currently being drafted or being proposed are the standards on eco-efficiency (SC5), carbon foot-printing (SC7, WG2), MFCA (WG8) and desertification (under a proposal by a group led by Egypt). Of interest to Malaysia is the development of MFCA, which is currently in the Committee Draft (CD) stage two where the draft is being fine-tuned after considering comments from its member countries, under WG8, which is chaired by Prof Katsuhiko Kokubu of Japan.

In the past, industries in general tend to look at wastes as a necessary part of production that need to be disposed off, incurring costs for their disposal. In helping to reduce the environmental impact by industrial processes, MFCA looks at wastes from a new perspective in relation to the whole production process.

HISTORY OF MATERIAL FLOW COST ACCOUNTING (MFCA)

Material flow cost accounting (MFCA) is an environmental management accounting tool used to reduce environmental impact and the costs of production. MFCA aims to improve business
productivity by reducing costs through waste reduction.

MFCA was first developed at the Institute of Management and the Environment (Institut fur Managementund Umbelt, IMU) in Augsburg, Germany. The method was rapidly embraced by Japanese industries with encouragement by the Japanese government. The original method was modified by the Japanese so that it can be used at the individual steps of the process chain from two major considerations, i.e. raw materials and energy sources, together with their quantification. This new standard, when it comes into being, will impact on and complement some of the other existing standards in the ISO 14000 Series of Standards such as those on environment performance, environment labelling, LCA, etc.

**WHAT IS MATERIAL FLOW COST ACCOUNTING (MFCA)?**

MFCA is a new detailed method for looking at material and energy flows together with their associated costs. Although developed in Germany, it has been successfully used by some major companies in Europe, Japan and the USA.

The objective of MFCA is to increase the data quality of raw materials and energies involved in processing so that material and energy flows are more transparent in terms of quality and quantity. This will help to identify inefficient processes or process steps, leading to the elimination of wastes, i.e. a reduction in the quantity of material used in a manufacturing process through elimination or reduction in wastes. Elimination or reduction of wastes will not only lead to a reduction in the cost of processing, it will also help to streamline the efficiency of the process as well as to reduce the impact of wastes on the environment.

MFCA measures the stock of raw materials in a production process and their flow in terms of physical and monetary units. The costs are classified as material cost, system cost, transportation cost, waste treatment cost, loss cost, etc. Loss cost is due to defective products, wastes and other emissions. By calculating their quantities and the resources used in each step or stage of the manufacturing process and converting them into monetary value, the loss cost can be ascertained. In addition to the cost of raw materials, labour cost, depreciation cost and other processing costs are also quantified under loss cost. Waste cost is calculated in the same way as production cost, and is called a ‘negative product’ in MFCA.

**WHY MATERIAL FLOW COST ACCOUNTING (MFCA)?**

An increasing number of companies are turning to MFCA to increase their economic and environmental competitiveness as it can help them reduce the amount of wastes generated instead of increasing waste recycling. This reduction in waste generation will lead directly to a reduction in input materials and costs, leading to direct cost reduction. In other words, there will be increased processing efficiency and the need for less waste treatment, thereby reducing total manufacturing cost. Reduction in waste generation and material inputs will also help the company lower its environmental impact. In doing so, the environmental awareness of the employees of the company will be increased, and at the same time the company’s environmental image will be enhanced, in addition to the economic gains outlined earlier.

Waste generation is generally considered as part and parcel of the production process. One of the environment-conscious activities undertaken by environmentally-aware companies in the past has been to recycle waste as much as possible to reduce the impact of these wastes on the environment. Although waste recycling is one of the important measures for effective resource use, it must be noted that the recycling process also requires inputs of substantial expense and energy. This is in addition to the raw material lost when it is consumed as waste. Hence, it would be more economical and sensible to reduce waste generation from the outset rather than to deal with waste recycling or disposal at the end of the process.

Hence, the main objective of MFCA is to identify the quantities and costs of wastes generated from each step in the manufacturing process. The costs taken into account include material, processing and waste treatment costs. This will enable an organization to tackle the source of waste generation through identification and quantification of wastes generated during the manufacturing process, leading to their reduction in terms of quantity and costs.

A reduction in waste generation will directly lead to reduced raw material utilization and reduced environmental impact in the manufacturing process. This will enable an organization to reduce raw material purchases without sacrificing production output, resulting in an increase in business operation efficiency. MFCA is considered by many organizations as an effective management tool to help to harmonize environmental aspects
with profitability through improvements in terms of environmental considerations and process cost reduction.

According to Prof Kokubu, an increasing number of Japanese businesses are using MFCA in Japan for the following reasons:

- MFCA helps to reduce the amount of waste generated and to reduce waste recycling/disposal;
- reduced waste generation leads directly to reduced raw material inputs and costs;
- increased efficiency in processing and waste treatment operations leads to reduction in material and manufacturing costs; and
- the environmental impact is lowered due to the reduction in waste generation and raw material consumption.

**METHODOLOGY OF MATERIAL FLOW COST ACCOUNTING (MFCA)**

To clearly illustrate the methodology of MFCA, the following model is adopted from the report entitled *Guide for Material Flow Cost Accounting (Ver.1)*, March 2007 which was compiled by JMA Consultants Inc., a company entrusted with the MFCA Development and Promotion Project of FY2006 by the Japanese Ministry of Economy, Trade and Industry, with instructions and advice from the MFCA Development and Promotion Project Committee of FY2006 chaired by Prof K Kokubu of Kobe University.

Waste from the Manufacturing Process (material loss)

In a manufacturing process, waste and resource losses can occur at the various steps of the manufacturing process. Wastes generated from processing include the following:

- material loss during processing (e.g. listing, swarf), defective products, impurities;
- materials remaining in the manufacturing equipment following set-ups;
- auxiliary materials (e.g. solvents and other volatile materials, detergents used to wash equipment before set-ups, etc.); and
- raw materials, work-in-process and stock products discarded due to deterioration or other reasons.

MFCA traces both the flows of the final products and emissions (wastes) of the process and recognizes emissions as one product. MFCA calls products ‘positive products’ and the wastages or emissions 'negative products'.

Figure 1 shows the types of wastes that can be generated from a manufacturing or production process.

**Material Flow and Material Flow Cost Accounting (MFCA)**

One of the methods to define material loss in the manufacturing process is through material flow analysis. An example of material flow analysis is shown in Figure 2.

In Figure 2, 1000 kg of the raw materials are input into Process A which causes a loss of 100 kg, and inputs 90 kg into Process B. The 100 kg of the main materials lost in Process A are recycled by an external business while the 90 kg in Process B are discarded as waste.

Of the sub-materials input into Process A, 10 kg and 9 kg are lost in Processes A and B, respectively. Thus, a total of 19 kg of the sub-materials are discarded as waste. Auxiliary materials amounting to 1 kg are input into Process B; all of which becomes waste.

Hence out of the 1101 kg of materials put into the total process, 891 kg are utilized in the products and 210 kg are regarded as material losses. As 100 kg are recycled by an external business, the final material loss is estimated at 110 kg.

Material flow cost analysis identifies economic loss (loss cost) as the costs of the main, sub- and auxiliary materials that are wasted. The loss cost is derived by multiplying the individual waste quantities by the purchase unit prices, as shown in Table 1.

A company with data on its material balance can easily calculate the above material loss cost by multiplying the individual quantities (kg) by their unit prices. The figures indicate that even if you recover some material cost by external recycling, it is small compared to the material loss cost (negative product cost). Although external recycling is an important activity, it is evident that it is more significant to reduce waste generation from the economic point of view. Economic loss (loss cost) caused by lost materials is not limited to the material cost. As long as each process requires the inputs of labour, depreciation, energy and other items having a value, material loss will encompass the loss costs on such inputs as well. Emission waste also needs to be treated, and this will incur treatment costs, too.

For the purpose of calculation, MFCA adds all the cost information (material, processing, energy,
TABLE 1. CALCULATION OF MATERIAL LOSS COST

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Main materials</th>
<th>Auxiliary materials</th>
<th>Sub-materials</th>
<th>Materials total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input quantity (materials purchased)</td>
<td>kg</td>
<td>1 000</td>
<td>100</td>
<td>1</td>
<td>1 101</td>
</tr>
<tr>
<td>Positive product quantity (products shipped)</td>
<td>kg</td>
<td>810</td>
<td>81</td>
<td>0</td>
<td>891</td>
</tr>
<tr>
<td>Negative product quantity (material loss)</td>
<td>kg</td>
<td>190</td>
<td>19</td>
<td>1</td>
<td>210</td>
</tr>
<tr>
<td>Material purchase unit price</td>
<td>RM kg⁻¹</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Material purchase cost</td>
<td>RM</td>
<td>100 000</td>
<td>10 000</td>
<td>100</td>
<td>110 100</td>
</tr>
<tr>
<td>Positive product cost (material cost)</td>
<td>RM</td>
<td>81 000</td>
<td>8 100</td>
<td>0</td>
<td>89 100</td>
</tr>
<tr>
<td>Negative product cost (material loss cost)</td>
<td>RM</td>
<td>19 000</td>
<td>1 900</td>
<td>100</td>
<td>21 000</td>
</tr>
</tbody>
</table>
waste treatment and other costs) to the quantity data based on material flow. Hence, the flow of each raw material throughout the process is tracked, and the quantity and cost information is added to that flow.

Thus, with MFCA, a business can analyse its economic loss (loss cost) through material losses not only in terms of material cost but also taking into consideration losses relating to the entire manufacturing cost, including processing, energy, waste treatment and all other inclusive costs.

**Making Material Loss ‘Visible’ through its Quantification and Costing**

MFCA calculates the cost resulting from the production of the negative products as ‘negative product cost,’ which represents an economic loss (loss cost) caused by lost material going to waste. This enables the negative product (material loss) to be ‘visible’ throughout the manufacturing processes, or for every step of the process, as a result of quantification of these lost materials and the overall costs which include the processing costs added to such materials.

By making material loss ‘visible’, MFCA provides a business entity with opportunities to identify problems and to recognize the necessity for improvement (*Figure 3*). Through MFCA, the company will now be able to realize the existence of material loss and the resulting economic loss which may not have been recognized before in a systematic manner.

**Manufacturing Loss Cost Seen through Material Flow Cost Accounting (MFCA)**

The types of manufacturing loss encountered in the scope of the calculation and management of the product process by MFCA are as follows:

- occurrence of material loss by process and materials yield;
- causes of material loss by processes themselves (swarf, listing, set-up loss, defects, tests, etc.);
- procurement cost for lost materials (main, sub- and auxiliary materials);
- waste treatment cost for material loss (materials not becoming products);
- procurement cost for materials lost but sold to external businesses for recycling;
- processing cost put into lost materials (labour, depreciation, fuel, utility and other costs);
- processing cost required to reprocess materials that have been lost and recycled within processes; and
- material and processing costs for stock products, work-in-process or materials that were discarded due to a switch to a newer model or deterioration of quality, or for such stock that has been ageing.

Many companies control the first three items listed above, at least for the main raw materials. Unfortunately, fewer companies control the sub- or auxiliary materials on a corporate basis. The sub- and auxiliary materials are often controlled on a process or equipment basis, and the quantities of materials input (and lost) for each model are usually seldom under control. Sometimes such quantities are controlled in batches by a factory. The overall waste treatment cost (item 4) is generally controlled on a factory basis according to waste type. However, few companies identify such cost by material type, by product model and by generating process.

Businesses are often unaware of the loss in recyclable waste as indicated in item 5, because such waste is reused as resources and sometimes can be sold to external recyclers for some value. Items 6 to 8 are difficult to identify unless calculated throughout the production processes as done in MFCA.

Many companies identify time loss due to equipment downtime, set-up and other reasons.

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*Figure 3. Advantages of material flow cost accounting (MFCA).*
Some of them promote improvement activities such as Total Productive Maintenance (TPM). Such loss is considered to be part of the input cost which is included in the equipment depreciation cost, and, hence, should be used in combination with MFCA.

**Material Flow Cost Accounting (MFCA) Makes Loss ‘Visible’ for Each Process**

Figure 4 shows the calculation of MFCA for a product manufacturing process. The diagram shows the calculation flow chart with cost figures but with waste treatment cost omitted.

In this example, the cost of total material loss is RM 19.30 based on the quantity of material becoming waste. MFCA includes the costs of processing and energy which are accountable by negative products (wasted materials) as ‘negative product cost’. In the example, the total negative product cost pertaining to processing cost and overheads throughout the manufacturing process is RM 40.70, while the total negative product energy cost is RM 4.10. By adding these two costs to the negative product material cost above, the overall loss cost in the manufacturing process would be RM 64.10. This accounts for up to 29.8% of all costs (RM 215).

Such negative product cost is identified on a process-by-process basis in MFCA. In the above example, respective negative product costs for material processing, parts processing and finishing processes are RM 15.80, RM 21.60 and RM 26.60. The quantity percents for positive and negative products are calculated as 15% and 85%, respectively, in terms of materials put into each process. As processing and other costs from the previous processes are included in the negative product cost, manufacturing loss would give rise to a greater negative product cost in later processes.

**THE DIFFERENCE BETWEEN MATERIAL FLOW COST ACCOUNTING (MFCA) AND NORMAL COST ACCOUNTING**

Standard cost accounting is aimed at calculating gross profit on sales. Normally all the costs occurring in a factory are compiled to give the manufacturing cost for a product. Therefore, the scale of loss in a manufacturing process is not identified as part of the cost in standard cost accounting.

In standard cost accounting, the organization defines the standard costs which are actual costs. Causes for the ‘cost variance’ are then analysed.

Figure 4. An example of a material flow cost accounting (MFCA) calculation.
and addressed. Cost variance in standard cost accounting does not reflect all material losses because the pre-defined ‘standard’ costs already include materials which are lost as waste, and only materials used beyond such pre-definition are considered as loss. On the other hand, MFCA regards all materials that do not become products as loss. Their quantities are identified as negative product, and their costs are recorded as negative product material cost. While MFCA identifies all material losses, standard cost accounting does not consider material loss (Figure 5).

In the case of processing and fuel costs, standard cost accounting also regards any difference from standard costs as loss (Figure 6). For example, if you need to work more hours than as defined as standard, the excess working hours are considered as loss. The relevant processing cost is identified as cost variance. On the other hand, MFCA does not look at processing cost beyond the standard as loss, but instead all processing and fuel costs used for negative products (material loss) are classified as negative product system cost (SC) and negative product energy cost (EC).

For many companies, the cost for waste treatment is accounted for by each factory, separate from the cost of manufacturing that is identified on a product basis. This is why businesses only regard the cost of waste treatment as a type of business expense. However, MFCA includes this cost as a loss, i.e. as one of the components of the cost of producing a negative product.

MFCA regards all the materials that did not become company products as loss (negative product), and makes ‘visible’ all the relevant costs as negative product cost (loss cost). This is the main difference between MFCA and other cost accounting methods.

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**Material Flow Cost Accounting (MFCA): A Brief Introduction**

**Cost variance**

<table>
<thead>
<tr>
<th>Material cost in standard cost accounting</th>
<th>Material cost in standard cost (Includes cost for material loss incorporated in standard cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost variance</td>
<td>All the waste that has generated is included in “negative product.”</td>
</tr>
<tr>
<td>Difference in concepts of standard cost accounting and MFCA</td>
<td>Both standard and actual amounts of use are converted into costs, but not all waste is included in such costs. It is also possible that actual cost is smaller than standard cost.</td>
</tr>
<tr>
<td>Material cost (MC) in MFCA</td>
<td>Positive product MC (Cost for materials that became company products)</td>
</tr>
<tr>
<td></td>
<td>Negative product MC (Cost for materials that became waste)</td>
</tr>
</tbody>
</table>

**Processing and fuel costs in actual cost**

<table>
<thead>
<tr>
<th>Processing cost in standard cost accounting</th>
<th>Processing cost in standard cost (Processing and fuel cost based on standard operators and hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost variance</td>
<td>Standard cost accounting does not use this loss concept.</td>
</tr>
<tr>
<td>Difference in standard cost accounting and MFCA</td>
<td>Margin beyond processing and fuel costs based on standard operations and hours; MFCA does not use this loss concept.</td>
</tr>
<tr>
<td>System cost (SC) and energy cost (EC) of MFCA</td>
<td>Positive product SC &amp; EC (Processing and fuel cost for materials that became company products)</td>
</tr>
<tr>
<td></td>
<td>Negative product SC &amp; EC (Processing and fuel cost for materials that became waste)</td>
</tr>
</tbody>
</table>

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Figure 5. Difference in definitions for material costs in standard cost accounting and in material flow cost accounting (MFCA).

Figure 6. Difference in definitions for processing costs in standard cost accounting and in material flow cost accounting (MFCA).
THE DIFFERENCE AND LINK BETWEEN LIFE CYCLE ASSESSMENT (LCA) AND MATERIAL FLOW COST ACCOUNTING (MFCA)

Life cycle assessment (LCA) identifies a product’s total impact on the environment from the time of its manufacture to the time of its final disposal. Once identified, steps can then be taken to remove or reduce the causes of these impacts on the environment. MFCA, on the other hand, identifies the wastes generated during a manufacturing process – either as a whole or at a particular stage of the process – and assigns costs to them, which also includes the energy and processing costs associated with the waste. Hence, the losses are ‘visible’ in economic terms. Reducing such loss will therefore lower the processing costs per unit of the product, and reduce the impacts of the waste produced on the environment. This will not only enable a company to become more competitive, but will also enhance the image of the company in terms of environment responsibility. Thus, it can be seen that there is a lot of commonality between LCA and MFCA. In short, MFCA is a method of cost accounting to identify losses whereby the quantities of wasted materials are regarded as ‘negative products’ and the costs of the material, processing, energy and all other inputs associated with the waste generation are put into the waste materials ‘negative product cost’. This is why many companies and factories adopting MFCA have successfully reduced their costs, waste emissions and material consumption.

MFCA can therefore be considered as a tool for simultaneous economic improvement and environmental impact reduction on a micro scale during processing, while LCA is focused on the whole life cycle of the product, i.e. on a more macro scale. Hence, in a more effective pursuit for economic improvements and environmental impact reduction, integration of MFCA with LCA is necessary, if MFCA is to be more effectively used to reduce negative environmental impact. Such integration will enable companies to reduce their internal production and external environmental costs with respect to the generation of waste products and their treatment or disposal.

POTENTIAL OF MATERIAL FLOW COST ACCOUNTING (MFCA) IN THE MALAYSIAN OIL PALM INDUSTRY

The adoption of the Environment Management Assurance System (EMAS), based on ISO 14001 or the ISO 14000 Series of Standards, by the Malaysian oil palm industry has been slow. This is probably due to the high costs of installing and maintaining such systems, and to the demands by consumers having moved on to higher issues such as LCA and sustainability, rather than just EMAS. MFCA, like LCA, on the other hand is of immediate and obvious benefit to the Malaysian oil palm industry in terms of savings and achieving more streamlined and efficient processes.

MFCA can be applied to many places and processes in the oil palm industry, right from the initial stage in terms of the amount of waste metal generated from the construction of infrastructures, through to the milling, refining, kernel crushing and handling processes.

First of all, let us consider an example from the milling process. In the mill, wastewater is the main waste that is generated from the process as a result of the dilution water being applied in the gutter prior to the desanding or crude oil tank. Water in the tailings from the vibrating screen is increased from 35% to 54% as a result of the addition of 41% of dilution water based on the composition of the tailings. Concurrently, the oil concentration drops from about 51% to 39%. As a result of this addition of dilution water, a large volume of wastewater is generated. This wastewater has to be treated as it also contains oil that is lost. By applying MFCA to the wastewater generated, the cost of the wastewater together with the processing cost for its treatment can now be quantified. This quantification can then be used as the baseline for process and cost improvement with a resultant decrease in the amount of waste generated, and hence, a reduction in the amount of wastewater generated.

It must be remembered that from the environment and sustainability point of view, the treatment of wastewater is associated with a bad environment impact due to the methane produced from employing a ponding treatment. Methane is an emitted greenhouse gas (GHG) which is 21 times worse than carbon dioxide generated from the burning of fossil fuels. From this point of view, it is obvious that the less dilution water used, the less wastewater will be generated. This will in turn lead to less wastewater treatment required and hence, less methane generated. Although methane can be trapped and used for other purposes, the ideal situation would be when no methane is produced, i.e. zero wastewater treatment, or an alternative method of treatment that does not produce methane is adopted. This may lead to a re-evaluation of the reason for carrying out the dilution of the tailings in the gutter as there are various schools of thought on this issue. One school of thought professes that no dilution is necessary, and that the final clarification step can be substituted with a decantation step. With MFCA, the pros and cons for the two processes can be better evaluated in
terms of the total costs involved from the initial capital investment costs to the processing cost for wastewater treatment and the costs involved in treating the GHG emitted. In fact, the application may lead to a fresh reconsideration of the whole milling process, and give an impetus to its total modification or stages of it. If dilution water can be avoided, one of the worst environment impacts associated with the oil palm industry can then be completely removed. This will greatly improve the LCA of the industry as a whole.

From the palm oil refining sector, spent bleaching earth is one of the major wastes generated from the process, and the burning of fossil fuels is probably one of the main emitters of GHG in terms of carbon dioxide, both contributing to negative environment impacts. MFCA applied to these two aspects of the refining process will again form the basis for gauging improvements. A focus point for spent bleaching earth could be on oil recovery to reduce the GHG emitted during oil decomposition when the waste is used as a land fill, or to reduce its chemical oxygen demand (COD). Alternatively, uses of other materials or the reduced use of bleaching earth could be explored. A focus point for burning of fossil fuels could be on improved furnace efficiency, better logistic practices and other measures.

Hence, from the two examples given, it can be seen that the application of MFCA will be of benefit to the oil palm industry. It can act as a catalyst by establishing the baseline from which improvements can be gauged and savings quantified, while at the same time contributing to environment improvement by reducing the negative impacts on the environment. It will also provide a fresh angle from which improvements on the industry could be approached.

**CONCLUSION**

MFCA is different from that of traditional flow cost accounting. In traditional flow cost accounting, waste products are assigned zero values while in MFCA waste products or negative products are assigned a value that is considered as a loss from the process. Hence, attention is now focused on these losses and steps to be taken to minimize or eliminate them. This will lead to less or zero negative products resulting from the manufacturing process through better process or product management or design, or both. This will in turn enable the company to become more competitive and advanced, while at the same time producing less impact on the environment.

MFCA is an advancement from LCA in that whereas LCA identifies the impacts on the environment, MFCA quantifies these impacts and provides a basis for improvements. The Malaysian oil industry could benefit tremendously from applying MFCA to its processes in the various sectors of the industry.

**REFERENCES**


