ULTRASONIC MEMBRANE ANAEROBIC SYSTEM FOR WASTEWATER TREATMENT

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EXECUTIVE SUMMARY

Oil palm is the major plantation in Malaysia and Indonesia. As the world palm oil demand is increasing generation of waste is also increasing. If they are discharged untreated, they may cause serious problem and deteriorates the environment in contact. Thus environmental management through waste sustainable development should be given main emphasis. There is a need of appropriate waste minimization or recycling technology which should be easy to operate and cost effective.

H_2O TREAT Company has furthered their commitment to finding innovative ways to extract renewable economic value from wastewater to wealth. The company has completed the design, development and testing of a novel and proprietary green product with a view to provide an everlasting solution at competitive price.

The company provides the invention relates to an improved membrane anaerobic method for treating wastewater with ultrasonic transducers. More particularly, it relates to a considerably cost effective and environment friendly improved membrane anaerobic method and system for better treatment of waste water from POME, sewage sludge, slaughterhouse water, beet sugar, etc.

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LIST OF ABBREVIATIONS

POME : palm oil mill effluent

AD : Anaerobic Digestion

COD : Chemical Oxygen Demand

BOD : biochemical oxygen demand

HRT : hydraulic retention time

MAS : Membrane anaerobic system

UMAS:Ultrasonicated Membrane anaerobic system

CUF : cross flow ultra-filtration membrane

TSS : total suspended solid

SRT : solid retention time

ASM : Conventional Activated Sludge Method

PKS : palm kernel shell

EFB : empty fruit bunch

FFB : fresh fruit bunch

CPO : crude palm oil

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND :

Industrial wastewaters (including agro-industrial wastewaters) are effluents that result from human activities which are associated with raw-material processing and manufacturing.

These wastewater streams arise from washing, cooking, cooling, heating, extraction, reaction by-products, separation, conveyance, and quality control resulting in product rejection. Water pollution occurs when potential pollutants in these streams reach certain amounts causing undesired alterations to a receiving waterbody. While industrial wastewaters from such processing or manufacturing sites may include some domestic sewage, the latter is not the major component.

Domestic sewage may be present because of washrooms and hostels provided for workers at the processing or manufacturing facility. Examples of industrial wastewaters include those arising from chemical, pharmaceutical, electrochemical, electronics, petrochemical, and food processing industries. Examples of agro-industrial wastewaters include those arising from industrial-scale animal husbandry, slaughterhouses, fisheries, and seed oil processing.

Agro-industrial wastewaters can be very strong in terms of pollutant concentrations and hence can contribute significantly to the overall pollution load imposed on the environment. It is perhaps ironic that the very resources which promoted industrial development and urbanization in the first place can subsequently come under threat from such development and urbanization because of over and inappropriate exploitation. Appropriate management of such development and resources is a matter of priority. The South Johore coast was such a case [1]. This was then,

economically, one of the fastest growing areas in Malaysia and potential damage to the environment of such development, if not properly managed, was recognized.

Agro-industrial wastewaters, as a sub-class of industrial wastewaters, can have considerable impact on the environment because they can be very strong in terms of pollutant strength and often the scale of the industry generating the wastewater in a country is large. Citing ASEAN countries in Asia as examples, agro-industrial wastewaters had and in some instances still contribute very significantly to pollution loads. For example in 1981 the Malaysian palm oi and rubber industries contributed 63% (1460 td^{-1}) and 7% (208 td^{-1}) of the BOD (Biochemical Oxygen Demand) load generated per day respectively. This is compared with 715 td^{-1} of BOD from domestic sewage [2] . In the Philippines, pulp and paper mills generated 90 td^{-1} of BOD load [3]. Agro-industrial sites are therefore often the largest easily identifiable point sources of pollutant loads. While there are exceptions, individual industrial wastewater sources associated with manufacturing in Asia are, in contrast, more often small to medium sized compared to the former

Malaysia is the second largest exporter of palm oil in the world after Indonesia. In Malaysia and Indonesia, there are over fourfifths of world's palm oil exports are produced. In year 2010, the number of palm oil products exportation was rocketed to achieve 16.5 million tones. Table-(1.1) shows the world palm oil production [4] .

Table-(1.1) 2008 World palm oil production [4]

Countries	Tonnes	%Share
Indonesia	19000	44.5
Malaysia	17735	41.3
Thailand	1160	2.7
Nigeria	860	2.0
Columbia	800	1.9
Others	3250	7.5

There are several stages of processing the extraction of palm oil. The process is through operational processes such as sterilizing, striping and threshing of bunches to free the palm fruit[5]. Subsequently process the crude oil is extracted from the digested palm fruit by pressing and purification. Unforgettably, large quantities of water are required at certain stage processes.

While the other operational processes in the palm oil mills produce wastes load in the form of gaseous emissions from boilers and incinerators, solid wastes materials and by-products such as empty fruit bunch, potash ash, palm kernel, fiber and shells and liquid waste. During the process, more than 50% of the water will be discharged to the environment as palm oil mill effluent (POME), while the rest are lost as the way of steam in the boilers blow down, wash water and leakage [6] .

Undeniably, the oil palm industry and its processing affecting the level of our environment and it may contribute to the alarming rise in the environmental pollution. Plus, negative impact of the environment also caused by palm oil mill effluent.

This industry has been identified as one of the generating of the largest pollution load to rivers in whole country [7]. POME is a thick brownish viscous liquid waste which is non toxic but has unpleasant odor which contains soluble materials that may have a significant impact on the environment. The composition of POME are mainly water, oil, suspended solid, dissolved solid and sand. In year 2008, where approximately 53 million tones of POME were generated in Malaysia [8].

POME of palm oil mills should be treated well before discharging it into streams and rivers. The final effluent samples need to follow the standard methods just then the results are required to be reported to the Department of Environment, Malaysia. Any change in the natural quality of water resources may interrupt the equilibrium of ecosystem [9]. A bad criticism is exerted or expelled to all countries in the entire world as a result of their less attention to the environmental impact issue of economic activities. Thus, even as benefit from profitable the plantation commodity, but harmful environmental impact from this industry cannot be neglected. POME should be treated properly to reduce the impact of POME to the environment before being discharged into watercourses.

Currently, one of the challenging problems faced by Malaysia and many countries in the world is how to manage all type of wastes especially liquid wastewater. Many researchers around the world have studied the characteristics and treatments of various type of liquid wastewater, including synthetic wastewaters [10,11,12]. Oil palm industry needs to conduct a characteristic study on POME because the characterization would provide the necessary information for a proper POME treatment plant design and monitoring purposed.

The palm oil industry has grown tremendously in the recent years and accounted for the largest percentage of oil and fats production in the world in 2011. Based on Fig.(1.1), production of palm oil superseded soybean oil from just 13% in 1990 to 28% of total oil and fats production in 2011. This is because oil palm has higher annual oil yield per hectare compared to other oilseeds crops including soybean [13] .and palm oil has a relatively lower price as compared to the major alternative vegetable oils [14] . With the higher global demand of palm oil, Malaysia has developed its palm oil industry to become one of the largest palm oil exporters and producers in the world. Malaysia's palm oil export accounted for 46% of world exports and 37% of world palm oil production in 2011 [15] . Although the expansion of palm oil industry has boosted the national economy, it also concurrently generated abundant of by-products such as palm oil mill effluent (POME), empty fruit bunch (EFB), palm kernel shell (PKS) and mesocarp fiber in palm oil mills during the processing of palm oil from fresh fruit bunch (FFB) [16,17] . Out of these by-products, POME still remained relatively untapped and will be a threat to the environment if directly discharged to the watercourse [18].

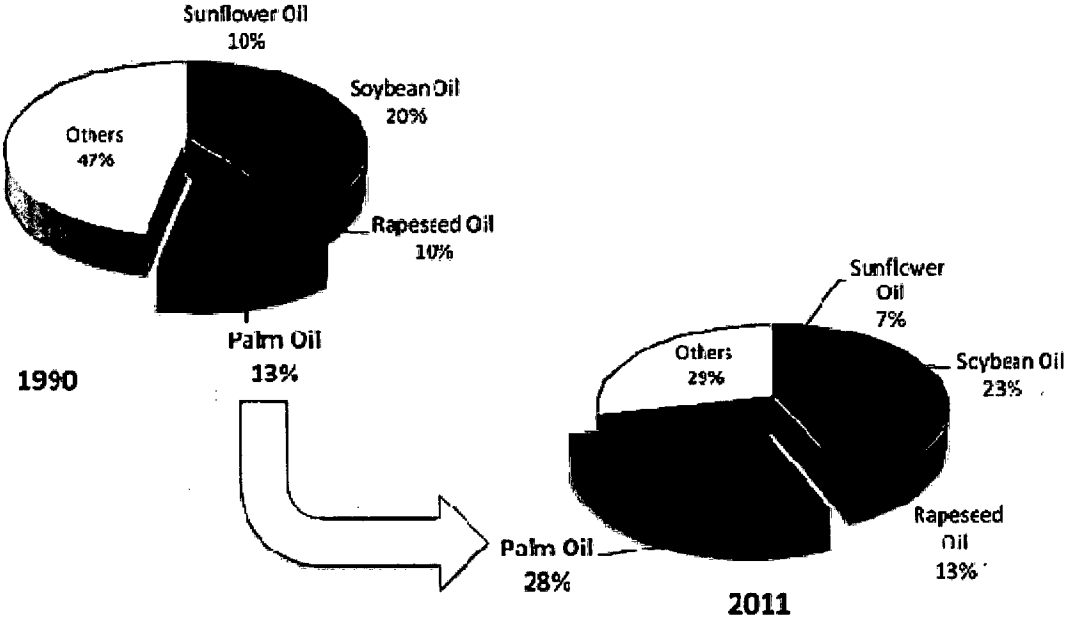


Fig. 1.1 World oil and fat production in 1990 and 2011 [13,15].

POME is the liquid waste generated from the oil extraction process from FFB in palm oil mills [19] . This effluent is a thick brownish liquid with high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) [20]. Furthermore, its high solids concentration and acidity causes it to be unsuitable for direct discharge to watercourses. For each tonne of crude palm oil

(CPO) produced, it is estimated that (5–7.5)tonnes of water is used and more than 50% of water ends up as POME [21]. This implies that about 2.5–3.75 tonnes of POME will be generated per tonne of CPO production. This huge quantity of POME will pollute the watercourses nearby the palm oil mills without proper waste management implemented in palm oil mills [22]. This problem has become more apparent as the number of palm oil mills in Malaysia continued to increase rapidly from 334 mills in 1999 to 426 mills in 2011 as shown in Fig.(1.2) [23][24].

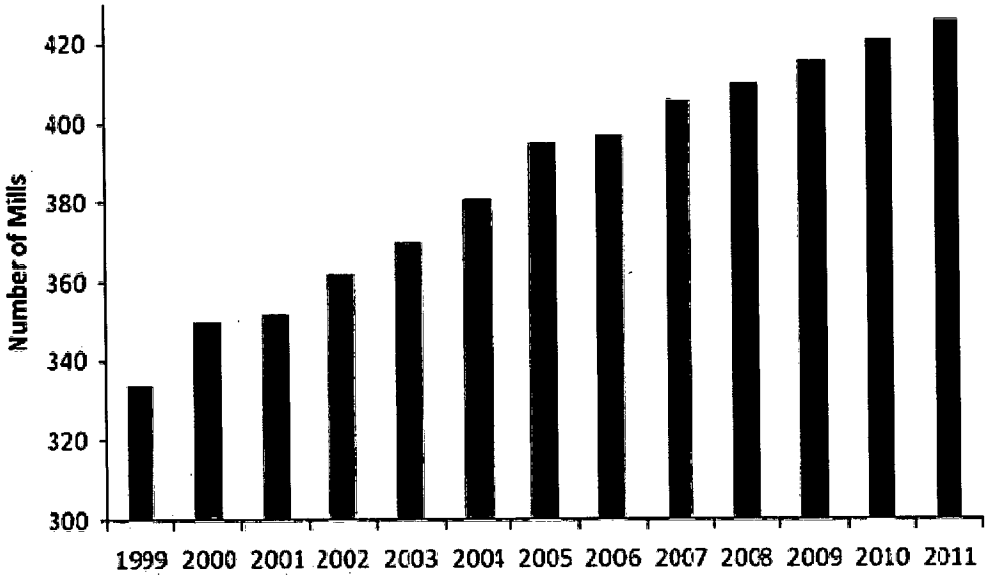


Fig.(1.2). Number of operating palm oil mills in Malaysia from 1999 to 2011 [23,24].

In order to control the industrial pollution in the country, regulatory control over discharges from palm oil mills is instituted through Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977 promulgated under the Environmental Quality Act, 1974 and enforced by the Department of Environmental (DOE). The palm oil mills are required to adhere to prescribed regulations, which includes laws governing the discharge of mill effluent into water courses and land [21]. On top of that, the requirement of BOD level of industrial effluent to be discharged to watercourse has been tightened recently by DOE where the prevailing national regulation of 100 mg/L BOD has now been reduced to 20 mg/L for mills in certain environmentally sensitive areas especially in Sabah and Sarawak [25]. Therefore, a reliable and effective treatment process has to be adopted by palm oil mill in order to achieve this stringent standard requirement on effluent discharge consistently.

However, the high organic contents in POME on the other hand have crafted POME to be a good source to generate methane gas via anaerobic digestion. Moreover, POME contains biodegradable constituents with a BOD/COD ratio of 0.5 and this implies that POME can be treated easily using biological means [26]. The most conventional method employed for POME treatment in Malaysia is ponding system whereby more than 85% of the mills have adopted this method due to low operating cost [27]. This system comprises of de-oiling tank, acidification ponds, anaerobic ponds and facultative or aerobic ponds and the number of ponds will be dependent on the capacity of the palm oil mill [18].

Although ponding system is widely used throughout the country, this treatment method is not encouraged due to lacking of operational control and long retention time for degradation [28,29].

Moreover, the biogas produced during the anaerobic decomposition of POME is not recovered for utilization but was allowed to dissipate into the atmosphere [30] . reported that an average of 54.4% and 1.5 L/min/m^2 of CH_4 composition and biogas flow rate, respectively, was emitted from anaerobic pond under normal operation condition. In fact, this POME derived biogas which contains mostly methane could be used as an additional source of energy in palm oil mill. In ponding system, this valuable energy source is not only being wasted but also causing detrimental effect to environment due to the high potential of methane gas to cause global warming (with a global warming potential of 25 as compared to CO_2) [31] .

1.2 PRODUCT OVERVIEW:

Anaerobic digestion (AD) is a bacterial process that is carried out in the absence of oxygen at a certain temperature, and is the most common treatment of domestic sewage in septic tanks. One major feature of anaerobic digestion is the production of biogas wherein the most useful component being methane, which can be used in generators for electricity production and/or in boilers for heating purposes.

Palm Oil waste requires sound and efficient waste water management system to avoid the environmental hazards. Environmental laws and regulations prohibit the discharge of any waste directly into the atmosphere. Palm oil waste is highly polluting wastewater that pollutes the environment if discharged directly due to its high chemical oxygen demand (COD) and biochemical oxygen demand (BOD) concentrations. Direct discharge of sewage or sludge wastewater causes serious environmental pollution due to its high chemical oxygen demand (COD), biochemical oxygen demand (BOD) and total suspended solids (TSS). Traditional ways for sewage or sludge treatment are expensive and are not environmental friendly. Hence, there exists a need to provide for a cost effective and a better solution for treating waste water.

H_2O TREAT SDN BHD provides an improved membrane anaerobic system (MAS) comprising ultrasonic transducers.

H_2O TREAT SDN BHD provides a cost effective and environment friendly solution by producing methane gas which can be used and a source of renewable energy. The present invention is an alternative and cost effective method for treating very toxic waste water and sewage sludge.

Our product an improved membrane anaerobic system (MAS) comprising ultrasonic transducers which provides the following advantages:

- environmentally friendly
- economically feasible
- technically feasible
- biologically degradable

The present invention attempts to provide an inexpensive solution to the problems of prior art.

The invention is an improved membrane anaerobic system (MAS) with an improved reactor as an alternate, cost effective method for treating sewage sludge .

1.3 MARKET OVERVIEW :

Around the world, pollution of the air and water from municipal, industrial and agricultural operations continues to grow. Governments and industries are constantly on the lookout for technologies that will allow for more efficient and cost-effective waste treatment. One technology that can successfully treat the organic fraction of wastes is anaerobic digestion (AD). When used in a fully-engineered system, AD not only provides pollution prevention, but also allows for energy, compost and nutrient recovery. Thus, AD can convert a disposal problem into a profit centre. As the technology continues to mature, AD is becoming a key method for both waste reduction and recovery of a renewable fuel and other valuable co-products.

World-wide, there are now more than 125 AD plants operating and a further 35 under construction using municipal solid waste (MSW) or organic industrial waste as their principal feedstock. The total annual installed capacity is more than five million tonnes. This has the potential to generate 600 MW of electricity. A considerable number of AD plants are also being planned.

The use of AD for treating sewage sludge is well established and the use of AD for treating industrial wastewaters is increasing rapidly, to the point where there are now more than 1300 vendor-supplied systems in operation or under construction throughout the world. Over 30 types of industries have been identified with having wastewaters amenable for AD treatment, including processors of beverages, chemicals, food, meat, milk, pulp and paper, and pharmaceuticals, among others. Many of these industries use AD as a pre-treatment step to lower sludge disposal costs, control odours, and to reduce the costs of final treatment at a municipal waste water treatment facility.

1.4 RESOURCE AND RAW MATERIAL :

Our efforts to supply quality products has been widely acclaimed by our customers worldwide.

Our products are high in efficiency and safe in use. The quality is a paramount importance to us. All the products supplied by us are well tested on quality control labs to retain the material property for a longer interval of time.

We strive to impart maximum satisfaction to the customers through high quality products, customer oriented services, competitive pricing and business regularity. Such efforts bring rich dividend for the company.

Figure (1.3) illustrate the embodiments of the invention. It is membrane anaerobic system to treat palm oil effluent which is an ecofriendly and cost effective way to treat the hazardous waste by production of methane gas.

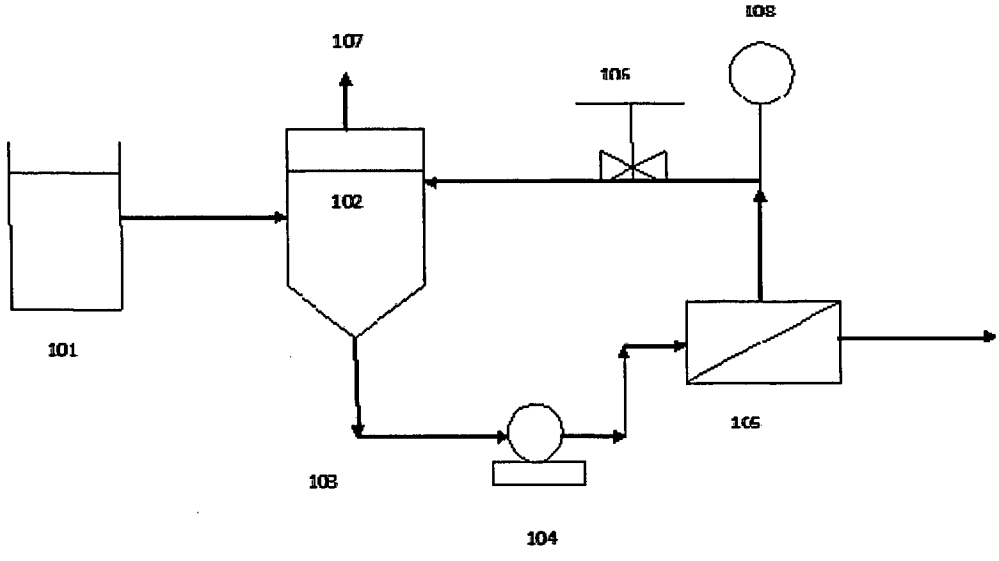


Fig.(1.3) The schematic of the entire UMAS

As the company is involved in system design and production, we do not have a specific raw materials per-se as all the components required could readily be out sourced from the specialised market within the country

Accordingly, feed tank (101), anaerobic reactor(102), centrifugal pumps(104), membrane UF Module(105), Valves(106), Gas Collector(107), Pressure gauges(108), and a system of pipes are the components needed to produce a unit of our system.

Although these parts are widely availible, as a security measures and to meet our specification and precisions, we intend to enter into a contracts with various companies to produce and supply the required components for our system.

It is our plan to maintain an array of suppliers so that we do not provide a chance of monopoly by depending on a single suppliers.

We have recognised here in Malaysia, companies like J&M TECHNOLOGY (M) SDN.BHD. and WIN-FUNG FIBREGLASS SDN BHD are sufficiently equiped to handle the design and production of our PVC Reactor tank, Which form the most technical component of our system.

1.5 SPECIFICATION OF OUR SYSTEM :

Material : Fiberglass (1st choice) , PE /PP tank .

Volume : 200 Litre volume (transparent tank)

Application : Wastewater

CHAPTER 2

MARKET ANALYSIS

2.1 INERNATIONAL INDUSTRY DESCRIPTION:

The need to responsibly dispose of mounting volumes of waste and the requirement to procure sustainable, secure energy supplies are two of the most important issues facing governments and industries around the globe. The production of energy from a number of waste streams (i.e., municipal and domestic sewage, industrial wastewater, landfills, livestock manure, and agricultural residues) is a process that addresses both of these challenges [32].

In the current waste-to-energy market, anaerobic digestion offers the most sustainable conversion process. Because the technology can be tailored to suit waste streams of all volumes, systems may be sized for use in households, commercial enterprises, utilities, and industry.

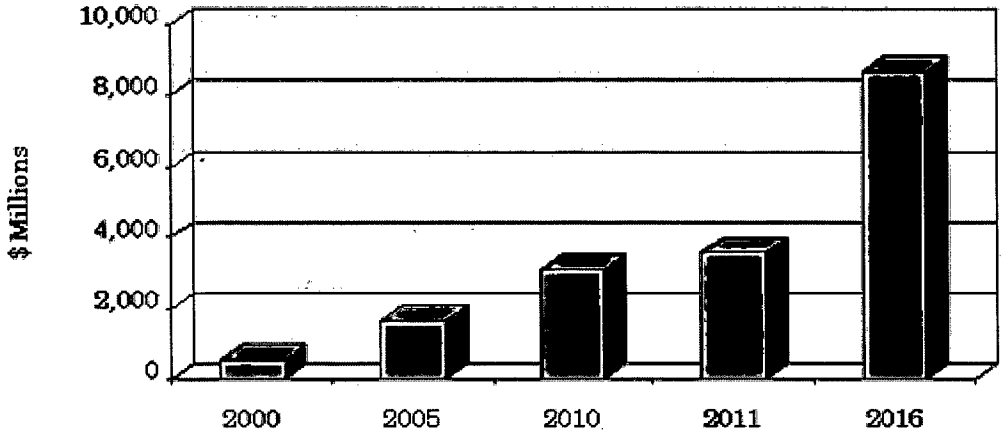
Renewable and sustainable energy generation will be the fastest-growing energy sector over the next two decades. From 2010 to 2016, the market is projected to rise from $124 billion in 2010 to $217 billion in 2016. Price volatility, supply concerns, and the environmental aspects of fossil fuels are expected to accelerate the pace of all non-fossil fuel development.

The global market for Biogas plant equipments was worth $3 billion in 2010. By 2016, it is estimated at nearly $8.6 billion and rising at a 5-year compound annual growth rate (CAGR) of 19.4% [32].

In the U.S. Energy Information Administration's (EIA) 2010 global energy outlook, total world consumption of marketed energy is predicted to increase by 49%, or 1.4% per year to 2035.

The market for renewable energy grows in excess of 30% per year. In recent years, the world market for biogas plants and AD equipment has increased at a rate of 20% to 30% annually, depending on the country.

SUMMARY FIGURE (2.1)
VALUE OF THE GLOBAL MARKET FOR BIOGAS PLANT EQUIPMENT FOR WASTEWATER- AND BIOSOLIDS-DERIVED ENERGY, 2000-2016
$ MILLIONS



Source: BCC Researc

The European market for equipment for anaerobic digestion (AD) biogas production and landfill gas-to-energy (LFG) collection is estimated at USD 2.4 billion in 2011 and projected to rise at CAGR of 15.8% to USD 5 billion by 2016. At present, Germany accounts for almost half of Europe's biogas-powered electricity generation. Its market value is expected at USD 1.3 billion this year and is seen to grow at CAGR of 17.3% to USD 3 billion in 2016.

The North American market value for biogas production equipment is estimated at USD 510 million in 2011 and predicted to increase at CAGR 17.7% to some USD 1.2 billion by 2016. The US market is valued at USD 352 million in 2011 and seen growing at CAGR of 19.1% to USD 845 million by 2016 [32].

2.2 TARGET MARKET INFORMATION :

In Malaysia, with a land area of about 14 million hectares, there are more than 1.2 million hectares in oil palm cultivation. Presently, there are 210 palm oil mills which are capable of processing a total of 6743 tons of fresh fruit bunches (FFB) per hour. There are another 47 mills under planning or construction which could process another 1134 tons of FFB/hr. In 1983, Malaysia produced 3.01 million tons of crude palm oil, making it the world's largest palm oil producer with more than 60% of the world's total output.

Over the last decade, the palm oil industry has become one of the largest revenue earners and has contributed much toward Malaysia's development and improved standard of living. However, the palm oil mills also have generated enormous amounts of highly polluting effluent, which amounted to more than 7.5 million M^3 in 1983. It has been singled out as the chief contributor to Malaysia's environmental pollution.

The palm oil mills traditionally have discharged their effluents into rivers leading to the seas. They relied solely on nature to absorb large quantities of waste products. With the rapid expansion of the industry and the public's increased awareness of environmental pollution, the industry is obliged both socially and aesthetically to treat its effluent before it is discharged. The Government also has responded by enacting the environmental laws in 1976 to control the pollution caused by the palm oil industry. The laws require the palm oil mill effluent (POME) to be treated to a required standard before it can be discharged.

Malaysia has over 1,000 palm oil plantations and POME waste is significant. However the government is pushing for the conversion of this waste into power and recently introduced a renewable energy feed-in tariff to encourage this [33].

2.3 COMPETITORS ANALYSIS:

Although it is a little bit difficult for a small companies to compete in this market due to the scope and size needed to meet customer requirement. But We strive to impart maximum satisfaction to the customers through high quality products, customer oriented services, competitive pricing and business regularity. Such efforts bring rich dividend for the company.

Environmental Engineering Services is dominated by large corporation such as Biotec International Asia Sdn Bhd and SP MULTITECH Sdn Bhd.

2.3.1 Biotec International Asia Sdn Bhd :

Biotec International is an appendage of a Belgian based engineering company and is involved in the provision of integrated organic matter management services for tropical regions.

In Malaysia, the company works mostly with palm oil mills, rubber mills, pig farms, poultry farms, cassava (starch) mills, cattle farms and the oleo-chemical industry for the conversion of waste into usable energy.

Products and services:

Consultancy activities, which include:

- Wastewater treatment facilities assessment.

  Feasibility studies for biogas, composting and ferti-irrigation projects.

2.3.2 SP MULTITECH Sdn Bhd :

SP MULTITECH Sdn Bhd was incorporated in Malaysia on September 1996 to provide wide range of Environmental Engineering Services like Design & Built of Sewage Treatment

Plant, Waste Treatment Plants, Leachate Treatment Plants and Control & Automation of Treatment Plants.

SP MULTITECH Sdn Bhd provides wide range of maintenance services for Mechanical & Electrical Engineering, Security System, Sewage Treatment Plant and Property Development.

2.4 COMPETITIVE ADVANTAGES :

Our product is able to compete strongly in the market because it owns specifications make it the best in the market compared with conventional methods.
Conventional Activated Sludge Method (ASM) and AD (Anaerobic Digestion) Process .

process	Effluent quality	Maintenance	High concentration Sludge	Energy Consumption	Small Footprint
ASM	Not good	Not good	Poor	Good	Poor
AD	Good	Good	Excellent	Excellent	Excellent

Table(2.1) (ASM) compared with (AD)

Prior art provides that anaerobic digestion has been widely used for sewage sludge treatment with large emphasis being placed on capturing the released methane gas. The methane gas is released as a product of the biodegradation treatment method. There are various disadvantageous of conventional methods in treating sewage sludge from both from the economic as well as environmental perspective.