

Engineering Data Sheet

0225

Process: Palm Oil Mill Waste-To-Energy Anaerobic Treatment

The market for palm oil continues to be extremely attractive even though it is now selling at about one half of its all time high. It is a staple food item and the prospects for its continued success are therefore excellent, as the product itself is a preferred food ingredient throughout the world except for the United States where its healthiness has been undermined by the US agricultural industry.

In addition to wastewaters that are high in organic strength, the palm oil production process generates copious quantities of agricultural solids as well. In order to create added value, some of the mills have installed charcoal plants for the purpose of making fuel briquettes or activated carbons. The market for both briquettes and activated carbon is now on the decline because so many countries, in addition to Malaysia, are pursuing the same value-added activities. Coal mining, for example, is now on the decline worldwide.

Rather than simply discharging these wastewaters, some 30% of the mills have installed several ponds to accomplish reduction of the organic strength. Because the ponds are unlined widespread contamination of underground aquifers has occurred. Mostly during election years there exists environmental pressure on the mills to initiate more and better air and water pollution management.

The use of anaerobic digesters, for example, has already begun. The methane rich biogas produced fuels energy hungry charcoal plants and natural gas generators to produce value-added electricity. Agricultural debris generally fires the mill's steam boiler producing significant quantities of black smoke and particulates. For the most part, however, the mills still concentrate their energies in the production of palm oil with far lesser priorities placed on environmental concerns and value-added activities. One might say this about the vast majority of businesses, as it is the principal product of any company that pays its bills and otherwise rewards its owners.

The first and only significant design question was whether to support or eliminate the charcoal plant from the mill. The three agricultural components that can be made into briquettes or activated carbon can also be anaerobically digested to make methane gas. When the costs of production are taken into consideration, an average 30 tonne/hr FFB mill can generate an annual profit of about US\$500,000 in making briquettes and/or activated carbon. If the same amount of wastes were to be

anaerobically digested and converted into electricity, the sale of US\$0.040/kWh excess electricity translates into an annual profit of about US\$1,500,000. The long-term marketplace value trend of both commodities would have to strongly favor briquettes in order to sustain the economic viability of the charcoal plant. When other factors are taken into consideration, such as the input energy required to make briquettes (or activated carbons) as well as unhealthy environment of a charcoal plant, it is an easy conclusion to eliminate the charcoal plant from the process design model.

Additionally, another byproduct, namely liquid carbon dioxide, is always simultaneously generated during anaerobic digestion. On a volumetric basis the gas percentages are about 70% methane and 30% carbon dioxide. Carbon dioxide, either liquid or solid, has a wholesale commodity marketplace value of about US\$0.06/lb with demand on the increase. For example it is used in greenhouses to promote vegetable growth, welding, food processing, and many more industries. The yearly economic value of this byproduct to the mill is about US\$1,500,000 before its modest costs of production and marketing expenses are factored in. Therefore, based on the above several analyses, the charcoal plant should be eliminated from the full system design.

Even though the POME is high organic strength, the agricultural debris represents about 6-1/2 times as much total organics, and therefore generated electricity. Thinking of the agricultural debris as a valuable resource rather than but a byproduct that can be burned, or better yet roasted into briquettes, is extremely important from a psychological standpoint. Appreciating this agricultural debris commercially properly reflects the true value of this palm oil production byproduct.

The hydraulic residence time within the OAT process anaerobic digester is less than 20 minutes. This extremely short residence time still accomplishes complete treatment thereby eliminating the necessity for acidification ponds, anaerobic ponds, and facultative ponds. The estimated total area required for entire treatment of the POME and fruit bunch debris is less than 5% of the area occupied by multi-pond technology. The conversion of all ponds to fresh water fish farming can eliminate these existing sources of groundwater contamination while creating significant added value to the mill.

The vast majority of the nutrients are retained in the liquid effluent rather than the sludge biosolids. Anaerobic treatment never removes nutrients, only organics. One

of the nutrients, namely ammonia nitrogen, is actually increased through anaerobic digestion due to the presence of organic nitrogen. Thus the anaerobic treatment process effluent contains the three components of liquid fertilizer. These are subsequently removed and concentrated through reverse osmosis treatment. The sludge biosolids as well as the liquid fertilizer concentrate can be land applied to sustain the essential nutrients required for oil palm re-growth.

All of the recommended design features are shown in attached drawing S-2021. A 30 tonne/hr plant can generate sufficient gas to fuel the boiler with the remainder used to produce about 14 MW of excess combined cycle electricity. The construction cost of the OAT waste-to-energy plant would be about US\$15,000,000. At US\$0.04/kWh, the value of the electricity translates into about US\$4,000,000 based on 300 days/year operation. The value of the other co-products of carbon dioxide, organic fertilizer (otherwise known as biosolids), and liquid fertilizer concentrate approximately doubles the profits to about US\$8,000,000/year for a 2-year ROI.

In the transmission of electricity there are always losses due to the inherent resistance in the wires. The greater the distance between the electricity generation plant and the end user, the greater the line losses. The generator, not the user, pays for these line transmission losses. It is therefore in the best interests of the generator to reduce this source of inefficiency. This can be achieved if electricity can be generated at the sites of at least some of the users along the transmission line. This is called **distributed energy** generation within the industry and is highly favored by prime electricity generators. When electricity is put back into the distribution grid the line losses are significantly reduced. The prime generator, therefore, has a significant built-in interest in purchasing the excess electricity generated by palm oil mills.

In connection with industrial park development, the availability of reliable electricity is extremely important if Malaysia or other palm oil mill countries are to effectively support new industrial development. It is rather well

known that the reliability of central plant supplied electricity is rather poor, at least this is the case within the United States. A palm oil mill can be the core industry within these parks as it can supply extremely reliable electricity for most of the year.

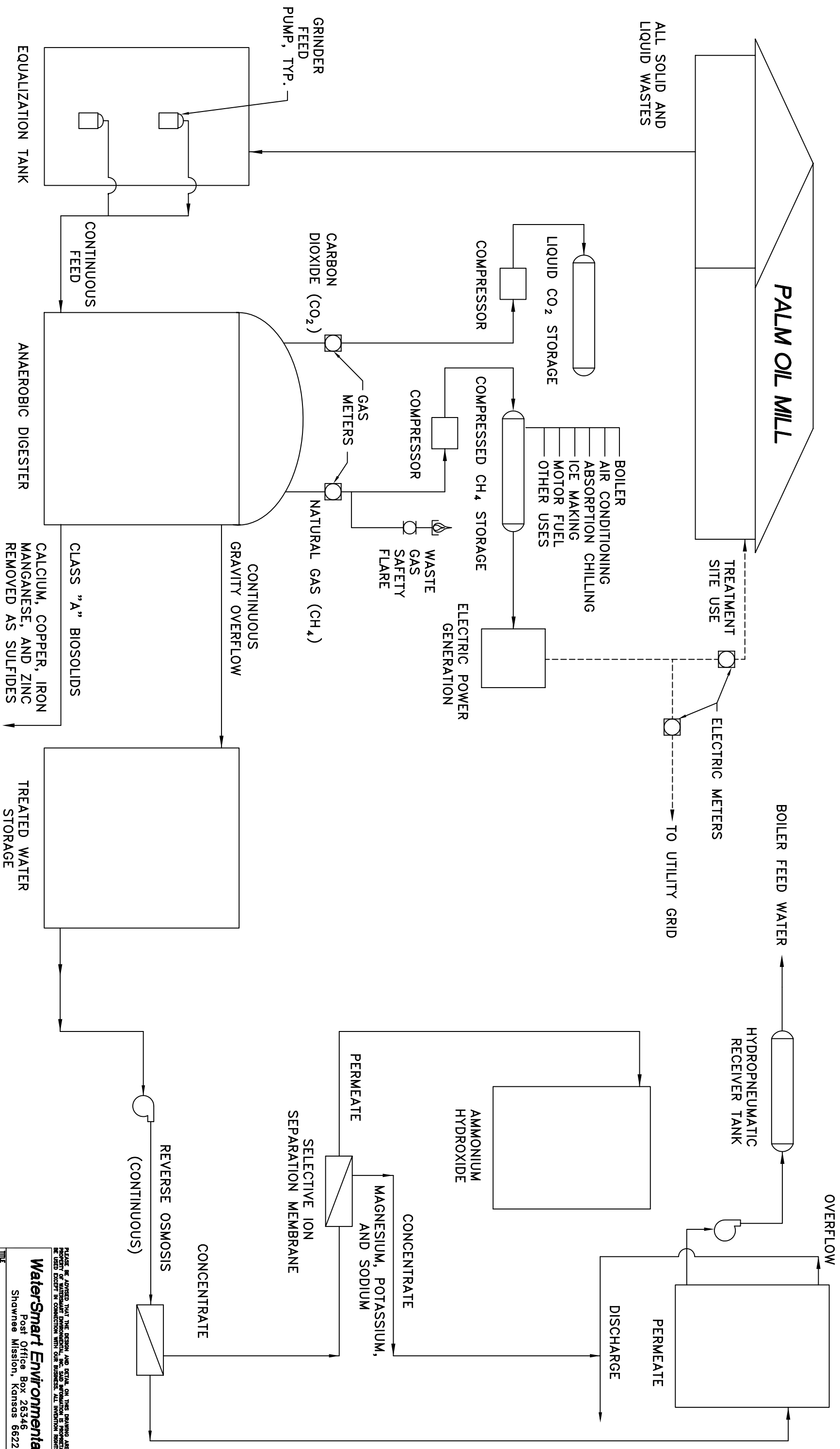
It is generally understood within the United States that the supply of electricity from anaerobic digesters is far more reliable than traditional oil or coal prime electricity generation sources. This is an additional reason to biologically digest all of the agricultural wastes as they produce significant energy. If all mills in East Malaysia had a 14MW power plant, over 4,000 MW of electricity could be produced on a distributed basis. The land development possibilities would be enormous. Virtually all of the industrial and sanitary waste treatment required could be accommodated by the mill's anaerobic digester, even wastes with heavy metals as the OAT™ process also removes these contaminants of concern.

From an environmental purview, there are no wastes with the proposed technology as every item is beneficially used. Carbon dioxide and methane gasses are both captured as commodities thereby minimizing greenhouse gas discharges. And since virtually all treatment is accomplished within closed vessels, there are no odors associated with the proposed technology. The treated effluent, if ever discharged, would easily satisfy current and future DOE palm oil mill discharge regulations.

As incentives, the mill gets boiler gas and reliable electricity at a negotiated discount as well as the business opportunity to engage in fresh fish farming while eliminating all air and water environmental pollution. The beneficial owners of the OAT™ Process waste-to-energy facility obtain the operating profits from the sale of electricity and the other co-products.

The waste-to-energy technology will be exclusively promoted on a design-build-own-operate basis rather than an equipment sale basis. This approach accelerates the introduction of the technology while also protecting its operational performance.





MATERIAL FLOW SCHEMATIC

REV.	DATE	DESCRIPTION	BY	CHK	SCALE	NONE	DRAWN	B.E.H.	INVC. NO.
	9/4/00								S-2021

DO NOT SCALE DRAWING. USE DIMENSIONS ONLY.

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 MATERIAL FLOW SCHEMATIC