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Global Waste Energy Conversion Company Pyrolysis Technology Review

FINAL REPORT

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1.0 EXECUTIVE SUMMARY

Global Waste Energy Conversion Company ("GWECC") engaged Sigma Energy Solutions, Inc. ("Sigma") to perform a technical review/evaluation of the pyrolysis technology employed by GWECC. Specifically, Sigma was requested to opine on the economic viability of the technology when scaled to large capacity plants firing 600 tons per day of municipal solid waste ("MSW"), and to identify any significant technical issues or risks associated that would negatively impact the successful construction, operation, and maintenance of such plants.

Sigma's review and this summary report is based on information provided by GWECC's technology partners as well as information gathered by Sigma engineers during a recent three day visit to a pilot plant employing the pyrolysis technology. During the site visit, two Sigma engineers witnessed tests conducted with samples of MSW, tires, and a blend of MSW and tires. The results of the tests are discussed in Section 4 of this report.

In addition, Sigma reviewed the detailed design documents at the test facility and engaged in detailed discussions of the pyrolysis technology with engineer Dr. Latif Mahjoob, CEO of ACTI and developer of the technology. Further, Sigma reviewed the list of successful projects currently in operation that are using the proposed pyrolysis technology and discussed the design and operation of these projects with the GWECC engineer.

Pyrolysis is defined as the degradation of carbon based materials through the use of an indirect, external source of heat, typically at temperatures of 750 to 1,650ºF, in the absence, or almost complete absence of free oxygen. This process thermally decomposes and releases the volatile portions of the organic materials, resulting in synthetic gases (syngas) composed primarily of hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2) and methane (CH_4). After the syngas is cleaned, it can be used in gas turbines, internal combustion engines or boilers to produce heat or generate electricity. Oil and char material that can be processed into activated carbon are also by products of this process. Pyrolysis is a viable thermal conversion technology and several companies around USA and Canada have developed such alternative thermal conversion facilities. Japan, Germany and other European nations have considerable commercial experience with the pyrolysis technology.

Some examples of large pyrolysis plants are listed below. The technology and equipment employed in these facilities is similar to the technology that will be used in the GWECC facilities. GWECC claims that this technology and design has additional advantages over the pyrolysis systems used in these facilities.

- A pyrolysis facility in Hamm, Germany is processing 100,000 tons per year (or 300 tons per day) of MSW and is operating satisfactorily since 2001.
- A pyrolysis facility in Burgau, Germany processing 30,000 tons per year (or approximately 100 tons per day) of MSW since 1982.
- Several pyrolysis facilities are operating in Japan, the largest being 330 tons per day in Chiba, Japan operating since 1999.
- Reklaim Facility in Boardman, Oregon, USA is processing approximately 2 million scrap tires annually (about 60 tons per day) utilizing tire pyrolysis technology since 2008.
- A 100 metric tons per day pyrolysis plant processing dry residual wood is operating in Renfrew, Ontario, Canada since 2005.
- A pyrolysis plant capable of processing 400 bone dry tons of biomass is planned to be built in High Level, Alberta, Canada.

Based on the analysis presented in this report, Sigma confirms that the prpoposed pyrolysis design using auger driven feedstock conveying system is technically sound and is similar to other auger devices in the power industry. Further, Sigma does not dispute the following advantages that GWECC claims this design has over other pyrolysis systems:

a) The use of double air lock valves in the fuel supply and ash removal systems minimizes the leakage of air into the process. Conversely, in the case of feedstock processing in rotary kilns there is a risk of air leakage into the process, which adversely affects the pyrolytic process.

b) The use of an auger (screw conveyor) to positively convey the feedstock to the indirectly heated reactor at a controlled and pre determined speed allows additional control over the production of syngas and oil

The results of the pilot tests witnessed by Sigma engineers were analyzed and verified by Sigma and the main observations are presented below.

- The test conducted with MSW produced syngas and oil. The syngas can generate 667 kWh/ton of the MSW. This value is within the range of efficiency accepted in MSW fired pyrolytic plants, which is 650 to 900 kWh/ton depending on the heating value of the feedstock. For a 600 ton per day MSW plant, the gross electrical power output would be approximately 16.7 MW.

- The test with tires was conducted as follows:

  Tire with wires was shredded into small sizes per the demonstration unit standard and was fed into the pyrolytic unit. After the completion of the process, the ash was collected in the ash bin. The ash contained metal from the tire separated from other material and was easily recoverable.

  The results of the test with tire were analyzed by Sigma as follows:

  The projected production of oil from tire pyrolysis is estimated to be 1,666 bbls per day in a 600 tons per day plant. Syngas produced is not appreciable but can supplement the energy use in the pyrolysis plant.

- Test conducted with 50% MSW and 50% tire produced syngas and oil. Syngas produced can generate 747 kWh/ton of the tire excluding the oil. This value is considered reasonable for pyrolytic process using the blend of MSW and tire feedstock. For a 600 tons per day plant the gross electrical power output would be approximately 18.7 MW and the oil production would be approximately 571 bbls per day.

Sigma reviewed the pyrolysis technology proposed by GWECC and held a detailed discussion of the technology with the engineer and developer of the technology. Sigma also reviewed the design drawings prepared for a 120 tons per day tire pyrolysis plant for use in Malaysia. The design drawings are complete and internally consistent. Based on Sigma's review, if the proposed plant in Malaysia is constructed per the drawings and in compliance with good industry practice the proposed tire pyrolysis plant should operate satisfactorily. In addition, Sigma understands that ACTI has five (5) pyrolysis plants on order including an order for 150 tons per day MSW pyrolysis plant to be located in Oneida, Green Bay, Wisconsin. ACTI has supplied twelve (12) pyrolysis plants in USA and worldwide with multiple feedstocks ranging in size from 6 to 24 tons per day, which Sigma understands are operating satisfactorily.

Sigma reviewed the design documents for the proposed plant in Malaysia, witnessed the tests at the pilot plant, conducted detailed discussions of the technology with the chief engineer, reviewed the list of successful projects and projects on order using the pyrolysis technology. The demonstration pyrolysis unit performed satisfactorily during the tests witnessed by Sigma engineers. Based on the review and satisfactory results from the tests Sigma opines that the pyrolysis technology is mechanically sound and should have a high probability of performing satisfactorily when scaled up to two (2) lines of 150 tons per day or four (4) lines of 150 tons per day facility feeding MSW or shredded tires.

Sigma is not opining on the overall design of a 150 tons per day facility as we have not reviewed the balance of plant (feedstock processing, conveying and supplying to the plant, cooling water system design, etc.).

This opinion is also based on Sigma's experience with performing due diligence work on several large advanced thermal recycling (waste to energy) plants in USA and Europe and knowledge of facilities utilizing the principle of pyrolysis worldwide (principally in Japan and Germany) and on researching of recent publications on the subject. It should be recognized that there are likely to be some technical challenges particularly during construction and initial operation because of the relatively short construction and operating history (in North America) of large scale plants over 100 tons per day consuming waste as feedstock. However, these challenges are judged to be manageable. Further, lessons learned from operating plants using the proposed pyrolysis technology and other pyrolysis plants operating in Japan and Germany and a tire pyrolysis plant in USA. can be applied to help overcome challenges encountered during initial operation.

Sigma suggests that a detailed feedstock availability and supply study be conducted to insure that adequate supply of feedstock will be available for the planned plant for a period of 20 years in order to operate the plant economically.

Sigma also suggests that a more detailed study be made of the balance of plant design of such a large facility including feedstock handling and supply facilities, and overall design, construction and O&M costs of such a facility.

2.0 OBJECTIVE AND SCOPE OF THE REVIEW

2.1 Objective

The objectives of Sigma's review are to evaluate the current technical status of the proposed pyrolysis technology using MSW, tires and a blend of tires and MSW, and to provide an opinion on any technical issues that may affect the satisfactory operation in large scale applications of the technology.

2.2 Scope

Sigma's scope was to review the following information provided by the Client:

- Overview: ACTI Advanced Thermal Distillation Technology
  R.W. Beck's report dated September 23, 2008
- Summary Table, Air Toxics Emissions Testing

Two (2) Sigma engineers to conduct a visit to the technology supplier for a visual inspection and demonstration of the technology and conduct a detailed discussion on the merits of the technology.

Based on the site visit and review of technical material collected from the technology supplier prepare a report providing Sigma's opinion on the viability of the technology for power generation applications and the scalability of the pilot plant to large capacity applications.

2.3 Methodology

The technology review process consisted of:

a) An initial review of the documents received from GWECC
b) Site visit by two (2) Sigma engineers to witness the pilot plant tests
c) Discussions with Dr. Latif Mahjoob and review of design documents for large scale plants
d) A review of technical data obtained from the demonstration plant
e) Development of mass balances and heat balances to determine kWhr per ton of feedstock based on the results of the tests.

The demonstration facility was visited by Sigma senior engineers C.B.Sampathkumar and Minh Le on November 9, 2010 to November 11, 2010 to witness the tests and gather data.

Persons met during the visit:

Dr. Latif Mahjoob, Founder and CEO of ACTI
Mr. Jahan Moghadam, COO, GWECC
Mr. John Stroud, Chief Strategy Officer, GWECC

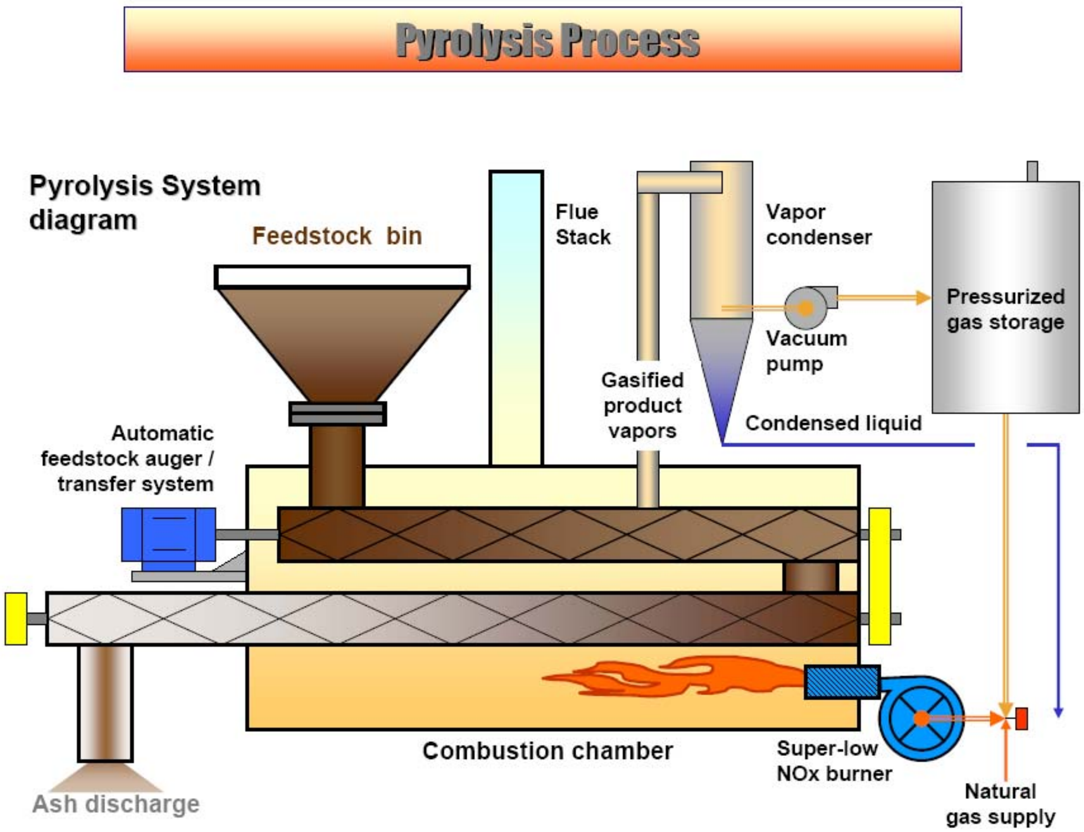
Sigma performed some additional research of the pyrolysis technology and the status of plants using the principle of pyrolysis all over the world and their experience with the technology.

2.4 Assumptions and Limitations

In performing the evaluation, Sigma relied on information provided by GWECC, technical discussions with the engineering personnel at the site and witnessing of the tests conducted with the pilot plant. The information provided appears to be reasonable, and Sigma assumes this information to be true and accurate. Sigma did not review any costs associated with the scale up of this technology.

3.0 REVIEW OF THERMAL DISTILLATION TECHNOLOGY

3.1 Process Description



The pyrolysis demonstration unit at the site is a skid mounted, self contained unit designed to convert waste into hydrocarbon fuels suitable for clean combustion and generation of electrical power. The unit consists of gas heated retort with internal transport augers, gas cleaning and condensing components, gas and liquid pumps, cooling tower, and a storage tank. The following components are the major parts of the pyrolytic system:

- The Furnace
- The Auger
- The Retort
- The Burner
- The Particle Wash System
- The Condenser
- The Gas Blower
- Storage tank
- The Cooling Tower

3.1.1 The Furnace:

An insulated box which contains the waste to energy retort. The retort is isolated from the furnace environment so the gases can not leak in to the retort from the furnace. The furnace is equipped with a burner firing natural gas. The heat from the burner travels through two passes to heat the retort. The flue gas temperature is normally 150 to 200 ^{o}F above the retort operating temperature. The furnace is designed to allow the retort to easily expand and contract during the operation.

3.1.2 The Retort:

The retort is a sealed stainless steel vessel containing the two transport augers. The feedstock is manually fed to the retort via a double blade air sealed valve. This valve is installed to minimize the passage of air into the retort. The feedstock is fed into the retort when the top blade opens and allows the material to enter the valve. Once the top blade has closed the bottom blade opens to feed the material into the retort. This valve is synchronized with an auger feed into the valve. As the material travels through the retort it gasifies. The gases are collected under a slight negative pressure and sent out of the retort. As the gasification sequence of the material ends the carbon ash exits the retort through a similar double blade valve thus maintaining the slight vacuum during the discharge of this residue.

In the case of tire it is shredded and fed into the supply bin feeding the retort. After the pyrolysis process the ash exits the retort into an ash bin. The metal from the tire is separated from the ash and is easily recovered.

3.1.3 The Augers:

The retort is equipped with high temperature stainless steel augers which move the material from the inlet, through the retort, and finally to the discharge point. These augers travel at a pre-set speed determined by the operator. However, the speed of the augers can be changed at the Operator Control Panel to suit the material processed.

3.1.4 The Burner:

The burner is manufactured by American Combustion Technologies, Inc. and is a low emission and very efficient burner. This burner can operate at very low levels of excess oxygen if required and can meet the Southern California emission requirements.

The furnace is equipped with a gas burner that is normally fueled with either natural gas or waste gas. The burner is supplied with a flame safeguard control and can be modulated to a higher firing rate on demand. A temperature control installed on the retort allows the burner to start and to modulate. Once the burner is turned on, it modulates to a firing position where it heats the retort to the pre-set temperature. When the temperature demand is satisfied the burner modulates back to its lower firing rate. If the temperature exceeds its pre-set upper limit the burner automatically shuts down. During the operation in many cases the material conversion process becomes exothermic and even though the burner has shut down the retort temperature [will remain high] may continue to rise. If the retort temperature falls below the lower set point the burner will automatically start and raise the temperature back to the upper set point.

3.1.5 The Particle Wash System:

When the pyrolytic system is in processing mode, gases travel from the unit to the Particle Wash System (PWS). The PWS is provided with a liquid pump.

The Particle Wash System must contain either light oil or water (10 to 15 gallons) depending on the nature of the process. The Wash Pump energizes as the unit starts to operate and re-circulates the washing media. This washing process takes place in a venture and any heavy particles such as tar or wax can be removed from the gas and will be retained within the Particle Wash System. A glass level indicator is supplied with the Particle Wash System. The unit must be drained from time to time to keep the level low enough for the gas to travel through. Once the gas has been cleaned through the venture it travels through the demister and liquid particles are stripped from the gas.

3.1.6 The Condenser:

A condenser is installed at the end of the PWS to make sure the lighter condensable gases liquefy through this condenser. The light liquid collects in the tank installed at the bottom of the condenser and the non condensable gases travel through a demister separating the last liquid particles before the gas reaches the gas blowers.

3.1.7 The Gas Blower:

A Gas Blower is supplied to remove the gases from the system while maintain the slight negative pressure within the system. It is a Roots-type positive displacement blower. The blower is controlled through the use of a pressure transducer installed on the retort. This transducer senses the rate of gasification. As the gasification process gas flow changes, the retort pressure rises or falls and sends a signal to the blower speed control to compensate. In this way the operating retort vacuum is maintained at a pre-set level. This insures the quality and uniformity of the by-products.

3.1.8 Intermediate Storage Tank:

The final gas product travels to an intermediate gas storage tank. This is a small tank and cannot be used as a permanent gas storage tank. This tank must be emptied continuously otherwise it will cause back-pressure on the system.

3.1.9 The Cooling Tower:

A cooling tower is supplied to cool and re-circulate cooling water to the condenser.

3.2 System Operation

The pyrolysis system operation follows:

The burner in the furnace is started and a flame is established monitoring three important items. 1. Furnace temperature, 2. Retort temperature, and 3. Retort pressure. The retort pressure is kept at a slight negative level in inches of water column mainly between -0.5 to -2.00 "H2O". This helps to raise the retort temperature faster and insure a safe operation. The retort temperature normally varies between 650 ° F to 1600 ° F. For pyrolyzing MSW the retort temperature is maintained between 1100 ° F to 1200 ° F. The residence time for this material is also important. For MSW the residence time is one hour and the material is kept in the retort for one hour. As the burner operates it will increase the temperature of the pyrolytic unit until a temperature of 800 ° F is reached. At this point material can be fed to the retort via the air-locked valves initiating the pyrolytic process. Once the pre-set retort temperature is reached the burner will automatically shut down. The burner will not re-energize until another pre-set burner starting temperature is reached in the ideal pre-set operating temperature. As the material begins to gasify, the gases will build a pressure which is higher than the pre-set negative retort pressure, the pressure transducer senses this change and sends a signal to the gas blower and the blower is programmed to response to this demand to bring the pressure down to the pre-set level. The gases are drawn constantly from the retort and washed out of dust, dirt and maybe some pollutants such as some sulfur compounds. Once the gas is washed, in the next two stages of operation it is important that all condensed liquids are separated from the gas using a condenser and water separators before it reaches the gas blower(s). The gas blower sends this gas to an intermediate tank at a low pressure from which it is drawn and kept in a higher pressure tank (up to 200 psig).

The condenser is cooled using a cooling tower, which re-circulates the water as a cooling media to the condenser and the gas washing heat exchanger.

Once the pyrolytic media is completely finished, the unit has to run for a least another hour in order to gasify the material that was just introduced to the unit. It is important that the furnace temperature is monitored to make sure the flame temperature does not increase beyond 2000°F. Although the retort is manufactured using high temperature alloys, it is important that too high temperatures are avoided at all time. This will insure a long retort life.

3.3 Technical viability and scalability of the pyrolytic process

Sigma reviewed the pyrolysis technology used by GWECC and had a detailed discussion of the technology with the engineer who was associated with developing the pyrolysis process. Sigma also reviewed the design drawings prepared for a 120 tons per day tire pyrolysis plant for use in Malaysia. Sigma reviewed technical publications on the pyrolytic process and information on commercially operating large pyrolytic plants in Japan, Germany, Canada and USA as listed below:

- The pyrolysis facility in Hamm, Germany is processing 100,000 tons per year (or 300 tons per day) of MSW and is operating satisfactorily since 2001.
- Burgau pyrolysis facility in Burgau, Germany processing 30,000 tons per year (or approximately 100 tons per day) of MSW since 1982.
- Several pyrolysis facilities are operating in Japan, the largest being 330 tons per day in Chiba, Japan operating since 1999.
- Reklaim Facility in Boardman, Oregon, USA is processing approximately 2 million scrap tire annually (about 60 tons per day) utilizing tire pyrolysis technology since 2008.
- A 100 tonnes per day pyrolysis plant processing dry residual wood is operating in Renfrew, Ontario, Canada.
- A pyrolysis plant capable of processing 400 bone dry tons of biomass is planned to be built in High Level, Alberta, Canada.

Based on the review Sigma provides its opinion as follows:

- The pyrolytic process as demonstrated in the tests witnessed by the Sigma engineers utilizes a similar indirect heating mechanism as the operating plants listed above, is mechanically sound and produces syngas and oil from MSW and tires.
- As described in Section 3.1, the process utilizes indirectly heated retort with internal transport augers. The transport augers provide positive movement of the feedstock at a predetermined speed to suit the different characteristics of the feedstock. The air lock valves provided at the feedstock inlet and ash outlet insures that no air is leaked into the reactor. In the case of other types of pyrolysis equipment where kilns are used to indirectly heat the feedstock there is a risk of air leaking into the kiln affecting the process. This design feature of this pyrolysis system is

considered a competitive advantage in producing optimum quantity of syngas and oil from the feedstock.

- ACTI has supplied twelve (12) pyrolysis plants in USA and worldwide with multiple feedstock ranging in size from 6 to 24 tons per day, which are operating satisfactorily. A list of these plants and new plants on order including a 150 tons per day MSW pyrolysis plant to be located in Green Bay, Wisconsin is provided in Exhibit A.

- Sigma opines that the design developed by ACTI for the 120 tons per day pyrolysis plant in Malaysia is of professional quality. If further engineering of this design, procurement of good quality equipment, construction and commissioning are executed per good engineering practice, it is reasonable to expect that a 2X150 or 4x150 tons per day plant utilizing the pyrolysis technology will have a high probability to perform satisfactorily. Technical challenges will be encountered during construction and initial operation of the plant because of the relatively new pyrolysis process and short operating history of such plants using waste as feedstock in U.S.A, but these challenges are judged to be manageable. Lessons learned from operating plants worldwide, in Japan and Germany and a tire pyrolysis plant in U.S.A. can be applied to overcome challenges encountered during initial operation.

- Sigma learns from the discussions with Dr. Latif that low NOx ACTI burners, which will satisfy Southern Coast Air Quality Management Division (SCAQMD) emissions limits will be used in the scaled up plant. If the plant satisfies SCAQMD emission limits it is expected that it will comply with the emission limits currently in effect at any other state in USA.

- Scalability of the following systems is not expected to be an issue because these systems are in commercial use operating satisfactorily in regular large waste to energy plants in USA and all over the world:

    - MSW receiving, processing and supply to the plant. The proven MSW processing system can be used in the scaled up pyrolysis plant

  - The supporting systems like condenser cooling and cooling tower design are the same as regularly used in large power plants

  - Because of the low emissions in the pyrolysis process, it is not expected that elaborate pollution control equipment similar to large scale waste to energy (WTE) plants will be needed.

- The only consideration in the scale up of the pyrolysis plant, in our opinion, is the auger transport system in the retort of the reactor chamber. Here again, the screw conveying systems for large volumes of material like coal and hot bottom and flyash are performing satisfactorily in large power plants and WTE plants in USA and worldwide. Therefore, because of the successful experience with screw conveying systems in large power plants, adapting the auger conveying system for the scaled up pyrolysis plant should not pose a major challenge.

- It is considered prudent to plan initially to construct 2x150 tons per day plant with provision to duplicate the design for a total of 4x150 tons per day (600 TPD) throughput.

3.4 Opinion on the economic viability of the technology in a large scale plant

Sigma has not been provided with pertinent information to opine on the economic viability of a large scale, say 100,000 or 200,000 tons per annum MSW throughput pyrolysis plant. In order to opine on the economic viability we need to be provided with the following factors:

- Capital Cost - cost can only be obtained by sending budget specifications to vendors.

- Annual O&M

- Revenues from sale of electricity

- Revenues from sale of recyclables

- Tipping Fees

- The developer has to perform a financial proforma for 20 years and provide to Sigma. Then Sigma can review and opine on the proforma.

3.5 Opinion on cost to complete, schedule to complete, and operating performance risks

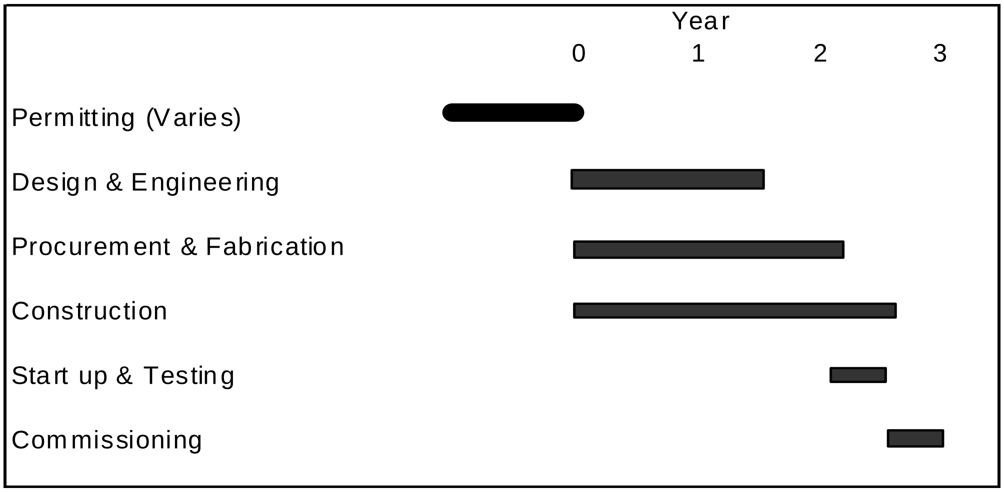
Cost to complete will vary region by region depending on costs for labor, land, licensing and permitting and fluctuations in equipment costs from different equipment suppliers.

An accurate capital cost estimate can only be obtained after completion of a fairly detailed completed design of the overall plant, and actual equipment quotes from reputable vendors. Even then, it will be prudent to allow a contingency.

3.6 Schedule

Based on Sigma's experience with advanced thermal recycling (waste to energy) plants in USA and Europe, the permitting process for waste energy plants like pyrolysis power plants firing MSW and tires can be a prolonged process, in addition to the time taken to fend off local community opposition. Therefore, it is Sigma's suggestion that a duration of at least one (1) to two (2) years should be allocated for completing the permitting process.

A typical schedule based on the schedule for large waste to energy plant is shown below



3.7 Operating Performance Risks:

The discussion with the GWECC engineer indicates that because of the nature of the pyrolysis process and the use of low NOx burner for indirectly heating the retort the emissions from the plant will comply with the SCAQMD emission limits. Since the plant is expected to be compliant with SCAQMD emission limits, the current limits of other states in USA are expected to be met.

Assuring the supply of adequate quantity of MSW with reasonable heating value, for 20 years is very important in maintaining the design performance of the plant.

If conditions at the site vary from the design conditions and the out put suffers, then installing additional module can be considered to maintain the required output.

The design of MSW receiving, storing, preparing and supplying to the reactor is tried and proven in various large WTE plants in USA and Europe. Therefore, problems with this system is not expected to occur if good quality equipment from reputable manufacturers are procured, operated and maintained per industry practice.

During the initial operation of the scaled up plant during the first two years, the operator is likely to face challenges in operating the plant. The solution to the problems encountered should be arrived at by working closely with the technology developer.

3.8 Critical Flaw Analysis

Since the auger tubes are subjected to high temperatures of up to 1700ºF, the material of the reactor chamber and the equipment inside the reactor chamber including the auger and tubes must be selected suitably to operate in this high temperature atmosphere. Sigma learned that all the equipment inside the chamber are made of elevated temperature stainless steel, which will withstand the high temperature.

Scale up of the auger tubes to higher capacity will require larger diameter and longer tubes. Therefore, the design of the tubes and augers will require sound engineering design to counter problems with thermal expansion and warping of the larger and longer tubes and augers. Also, the design of the chamber that contains the retort should be appropriately designed for the high temperatures expected during operation. Sigma believes, based on the discussions with the engineer these design considerations have been satisfactorily addressed in the design already developed for the Malaysian 120 tons per day plant.

In summary, the design and equipment used in the pyrolysis plant are in operation in other processes in the power plant industry and are not likely to cause problems in the design phase or in the operating phase, if accepted industry practices are followed.

4.0 DISCUSSION OF THE TESTS

The demonstration tests were performed on both MSW and Tires. The demonstration unit capacity is 50 pounds per hour. Prior to each test, the feed stocks were scaled and stored in containers. The syngas produced was stored in a pressure vessel. The pressure in the vessel is maintained in the range of 40 to 80 psig by using the flare. The measurement of the liquids (oil and water) and the char were taken at the end of each test. A sample of the syngas was taken from each of the tests and GWECC sent the gas samples to a local laboratory to perform the gas analysis by chromatography.

4.1 MSW Test Results:

Sigma received the MSW test results from GWECC and the test results are shown in the Table No.1 in Exhibit B-1. The MSW test results show a gas yield of 54.11 weight percent of the MSW feedstock, 28.32 weight percent as moisture, and 17.57 weight percent as carbon (Ash). The high heating value of the syngas is 521.78 Btu/lb and low heating value of the syngas is 473.3 Btu/lb.

The produced syngas can be used to generate electricity and the gross power output is estimated to be 667 kWhr per ton of MSW based on the test results of the syngas heating value and syngas yield weight percent of MSW. This efficiency is within the range of 650 to 900 kWhr per ton experienced in MSW pyrolytic plants. It is important to note that the efficiency (kWhr/ton) is dependent on the heating value of the MSW feedstock, which ranges widely. For a 600 ton per day plant, the gross electrical power output is projected to be approximately 16.7 MW. See Figure No.1 in the Exhibit B-4 for the MSW energy balance.

4.2 Tire Test Results

A representative test results for tires provided by Dr. Latif are shown in Exhibit B-3, which indicated oil yield of 46 weight percent of the tires, 8 weight percent as gas, 40 weight percent as carbon (Ash), and 6 weight percent as metal. The gas and oil analyses are shown in Table 3-1 and the carbon black analysis in Table 3-2 of Exhibit B-3. The syngas produced can be used as supplemental fuel in the burner. For 600 tons per day plant, the estimated oil production is 70,000 gallons or 1,666 bbls of oil per day and the metal recovered is 36 tons per day.

4.3 50% MSW and 50% Tires Test Results

The 50% MSW and 50% Tire test results are shown in the Table No.2 in the Exhibit B-2. The test results show a gas yield of 38.12 weight percent of the feedstock, 16.63 weight percent as oil, 18.00 weight percent as moisture, and 27.25 weight percent as carbon (Ash). The high heating value of the syngas is 731.9 Btu/lb and low heating value of the syngas is 660.35 Btu/lb.

The syngas produced can be used to generate electricity and the gross power output is estimated to be 747 kWhr per ton of 50% MSW and 50% Tires. This efficiency is considered reasonable for pyrolytic process using the blend of MSW and tire feedstock. For a 600 ton per day plant, the gross electrical power output is approximately 18.7 MW. See Figure No.2 in the Exhibit B-5 for the 50% MSW and 50% Tires Test Results energy balance.

The estimated oil production is 24,000 gallons or 571 bbls of oil per day

5.0 REVIEW OF DOCUMENTS PROVIDED BY GWECC

Sigma reviewed the following documents provided by GWECC:

1. Overview: ACTI Advanced Thermal Distillation Technology

2. Report Prepared by R.W. Beck on the Review of American Combustion Tech. Inc.'s Indirect Gasification Process for the Production of Liquid Fuels

1. ACTI Advanced Thermal Distillation Technology

   This document provided a general description of the design of the ACTI pyrolysis process and data on air emissions indicating that the emissions using ACTI technology are considerably lower than the U.S.E.P.A Limits. These low emissions are achieved by the use of ACTI low NOx burners to indirectly heat the retort in the reactor chamber.

   Sigma has no comments on this document.

2. R.W. Beck's Report on the Review of American Combustion Tech. Inc.'s Indirect Gasification Process.

   This report prepared in 2008 provides opinion on the coal gasification using ACTI technology.
   Sigma reviewed the report strictly for information. R.W.Beck ("RWB") reviewed the suitability of the auger driven ACTI technology for coal gasification. RWB opined that the technology was mechanically sound, but was not able to opine on the scalability for lack of additional information at that time.

   Sigma's review of the technology is to evaluate its suitability for MSW and tire pyrolysis. Since 2008 GWECC has gained experience in the design of MSW and tire pyrolysis plants in large capacities up to 150 tons per day. Sigma was provided with GWECC's current information on large scale MSW and tire pyrolysis design, their successful projects and large capacity projects on order. Sigma used the current information provided to opine on the technology and scalability as explained in this report.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Sigma reviewed the technology and design for a pyrolysis plant processing MSW and Sigma's evaluation and opinion are provided in this report and summarized below.

1. Pyrolysis is a viable thermal conversion technology and several companies in the USA and Canada have constructed pyrolysis thermal conversion facilities. In addition, a considerable commercial track record has been developed from plants operating in Japan, Germany and other European nations.

2. ACTI has supplied pyrolysis plants in the USA and worldwide that consume multiple feedstock, and ranging in size from 6 to 24 tons per day. Sigma understands that these plants are operating satisfactorily and recommends that further investigations be conducted on the operating history of these facilities.

3. ACTI has a complete professional design for a 120 tons per day tire pyrolysis plant to be installed in Thailand. Sigma reviewed the drawings available at the site but did not review in detail the complete design of the overall plant. In addition, Sigma was informed that ACTI has received an order for a 150 tons per day MSW pyrolysis plant to be located in Oneida, Green Bay, Wisconsin.

4. The pyrolytic process as demonstrated in the tests witnessed by the Sigma engineers utilizes a similar indirect heating mechanism as the previously listed plants in operation, mechanically sound and produces syngas and oil from MSW and tires. As described in Section 3.1, the process utilizes indirectly heated retort with internal transport augers. The transport augers provide positive movement of the feedstock at a predetermined speed to suit the different characteristics of the feedstock. The air lock valves provided at the feedstock inlet and ash outlet insures that no air is leaked into the reactor. In the case of other types of pyrolysis equipment where kilns are used to indirectly heat the feedstock there is a risk of air leaking into the kiln affecting the process.

   This design feature of the proposed pyrolysis is considered a competitive advantage in producing optimum quantity of syngas and oil from the feedstock.

5. Based on Sigma's review of the technology and plant design documents, Sigma's experience conducting technical due diligence on several large advanced thermal

(waste to energy) plants in the USA and Europe, and Sigma's knowledge of facilities utilizing the principle of pyrolysis worldwide (principally in Japan and Germany), Sigma opines that the proposed pyrolysis technology is mechanically sound, performed satisfactorily during the demonstration witnessed by Sigma engineers and has a high probability of performing satisfactorily when scaled up to two (2) lines or four (4) lines of 150 tons per day facility feeding MSW or shredded tires.

6. Sigma expects that there will be technical challenges during construction and initial operation of a large scale plant (over 100 tons per day) using the technology, because there has been limited implementation of the technology in large scale plants in the USA and local contractors and operators have limited experience in executing such facilities. Further, there is a relatively short operating history in the USA of using waste as feedstock in pyrolysis plants. It is Sigma's opinion that these challenges will be manageable and that lessons learned from operating plants worldwide, in Japan and Germany and a tire pyrolysis plant in the USA can be applied to overcome challenges encountered during initial operation.

7. Sigma suggests that initially 2x150 TPD plant be constructed allowing space and other provisions to add a duplicate 2x150 TPD unit such that eventually a 600 TPD plant can be installed at the same site.

8. Sigma suggests that a detailed feedstock availability and supply study be conducted to insure that adequate supply of feedstock will be available for the planned plant for a period of 20 years in order to operate the plant economically.

EXHIBIT A

Exhibit A

Experience list of successful projects:

Projects already completed and operating:

1. Cow manure gasification to produce electricity 2004 California USA
2. Laundry waste to electricity pilot plan built in 2005 New Bedford, MA USA
3. Plastic gasification System in Milan, Italy.
4. MSW to electricity plant installed in Knoxville, TN running for 2 yrs
5. Tire recycling System in Tacoma, Washington USA
6. Medical Waste Recycling, China
7. Human Sludge (Bio solid) waste to liquid fuel system. Running for 18 months already.
8. Coal to gas and electricity, China.
9. Garbage to electricity South Korea.
10. Medical waste, California
11. 200 tons/day tire recycling system in Dalian, China
12. 100 tons/day tire recycling system in Nun Kung, Taiwan

Projects On order:

1. Ultra-Poly 24 tons/day plastic pyrolysis
2. China, 24 tons/day coal Pyrolysis
3. 120 tons per day tire pyrolysis plant in Thailand
4. 150 tons/day MSW Pyrolysis plant, Oneida, Green Bay, Wisconsin
5. 24 tons/day Coal Pyrolysis, Australia
6. 100 lbs/hr pilot unit for Aruba

EXHIBIT B

EXHIBIT B-1

Table No.1: MSW Gasification Test Results

Actual mass balance after the pyrolytic process:

Moisture	28.32	%
Carbon (Ash)	17.57	%
Volatile	54.11	%
Sulfur	0.24	PPM

Data File ID: **132 lbs MSW** **Analyst:** **lab**

Analysis Date: 11/9/2010

Component	Norm Mole %	(a) HHV	(b) LHV	(c) SG	Xi* HHV Btu/SCF	Xi*LHV Btu/SCF	Xi *SG
Hydrogen	**35.2312**	**325**	**275**	**0.06928**	**114.5014**	**96.8858**	**0.0244082**
CO	**22.4321**	**321**	**321**	**0.9686**	**72.00704**	**72.007041**	**0.2172773**
Methane	21.3212	1012.3	911.5	0.5539	215.83451	194.342738	0.11809813
Ethane	**0.7987**	1773.8	1622.4	1.0382	14.167341	12.9581088	0.0082921
Propane	**0**	2522	2320.3	1.5226	0	0	0
i-Butane	3.2011	3259.5	3007.3	2.0068	104.33985	96.2666803	0.06423967
n-Butane	0	3269.9	3017.8	2.0068	0	0	0
i-Pentane	0	4010.2	3707.6	2.491	0	0	0
n-Pentane	0	4018	3715.5	2.491	0	0	0
C6+	0	5194.5	4421.3	3.2522	0	0	0
Oxygen	0.2837	0	0	1.1048	0	0	0.00313432
Nitrogen	6.7892	0	0	0.9672	0	0	0.06566514
CO2	9.9428	0	0	1.5196	0	0	0.15109079
Ethylene	0	1613.8	1513.2	0.974	0	0	0
Total	**100**				**520.8501**	**472.46037**	**0.6522056**

(d) Compressibility Factor (Z) for mixed gases

Total Inorganics:	**17.0157**
A = (Total SG)(0.0101)	**0.008317**
B = (Total Ing) (0.007)	**0.0011911**
Z = 1.00369 -A + B	**0.9965641**

(e) Adjusting Values (14.73 psia, 60° F, Gross, Dry, real volume basis)

High Heating Value	**521.787674**	**BTU/real cubic foot**
Low Heating Value	**473.310797**	**BTU/real cubic foot**
Specific Gravitiy	**0.65337962**	
Gas density	**0.04998354**	**lb/ft^3**
HHV	**10439.1899**	**BTU/lb**
Gas volume	**20.0065858**	**ft^3/lb**

EXHIBIT B-2

Table No.2 : 50 % MSW 50 % tires Test Results

Actual mass balance after the pyrolytic process:

Oil	16.63	%
Moisture	18.00	%
Carbon (Ash)	27.25	%
Volatile	38.12	%
Sulfur	102	PPM

Data File ID: **132 lbs MSW** **Analyst:** **lab**

Analysis Date: 11/9/2010

Component	Norm Mole %	(a) HHV	(b) LHV	(c) SG	Xi* HHV Btu/SCF	Xi*LHV Btu/SCF	Xi *SG
Hydrogen	**28.3979**	**325**	**275**	**0.06928**	**92.29318**	**78.094225**	**0.0196741**
CO	**3.7222**	**321**	**321**	**0.9686**	**11.94826**	**11.948262**	**0.0360532**
Methane	42.5931	1012.3	911.5	0.5539	431.16995	388.236107	0.23592318
Ethane	**3.5892**	1773.8	1622.4	1.0382	63.66523	58.2311808	0.03726307
Propane	**0.0715**	2522	2320.3	1.5226	1.80323	1.6590145	0.00108866
i-Butane	1.3678	3259.5	3007.3	2.0068	44.583441	41.1338494	0.02744901
n-Butane	0	3269.9	3017.8	2.0068	0	0	0
i-Pentane	0	4010.2	3707.6	2.491	0	0	0
n-Pentane	0.0204	4018	3715.5	2.491	0.819672	0.757962	0.00050816
C6+	0	5194.5	4421.3	3.2522	0	0	0
Oxygen	0.1401	0	0	1.1048	0	0	0.00154782
Nitrogen	6.2454	0	0	0.9672	0	0	0.06040551
CO2	8.5467	0	0	1.5196	0	0	0.12987565
Ethylene	5.3057	1613.8	1513.2	0.974	85.623387	80.2858524	0.05167752
Total	**100**				**731.9063**	**660.34645**	**0.6014659**

(d) Compressibility Factor (Z) for mixed gases

Total Inorganics:	**14.9322**
A = (Total SG)(0.0101)	**0.008317**
B = (Total Ing) (0.007)	**0.00104525**
Z = 1.00369 -A + B	**0.99641825**

(e) Adjusting Values (14.73 psia, 60° F, Gross, Dry, real volume basis)

High Heating Value	**733.223779**	**BTU/real cubic foot**
Low Heating Value	**661.535076**	**BTU/real cubic foot**
Specific Gravitiy	**0.60254853**	
Gas density	**0.04609496**	**lb/ft^3**
HHV	**15906.8094**	**BTU/lb**
Gas volume	**21.6943447**	**ft^3/lb**

EXHIBIT B-3
TABLE 3-1
Oil Analysis

Tire Pyrolysis Product Properties Analysis

Pyrolysis Product Distribution: `

Pyro Gas..	8.00	%
Pyro Oil..	46.00	%
Carbon Black...	40.00	%
Steel and Fiber..	6.00	%
Total........	100.00	%

Pyro-Gas in Pyro-Gas Oil.......................................	14.81	%
Pyro-Oil in Pyro-Gas Oil.....................................	85.19	%

Analysis of Oil and Gas

Gas analysis

Compound	mole%	MW(g/mole)		Wt%	Cp	
H2...........................	14.60	2.00	29.20	0.97	3.49	3.40
CO2........................	7.84	44.00	344.96	11.50	0.26	2.96
C2H4......................	8.07	28.00	225.96	7.53	0.62	4.63
C2H6......................	7.62	30.00	228.60	7.62	0.72	5.50
CH4........................	31.17	16.00	498.72	16.62	0.80	13.36
CO..........................	3.59	28.00	100.52	3.35	0.26	0.88
C3+, as C4H10........	27.11	58.00	1572.38	52.41	0.70	36.67
Total.......................	100.00		3000.34	100.00		67.39

Average Cpmean of Pyro-Gas..............................	0.6739	Kcal/Kg.C
Average molecular weight of pyro gas..................	30.00	Kg/Kgmole

Physical Properties of Pyro-Oil

Compound	wt%	Bp C	liq. density (g/cc)				Cpmean (Kcal/Kg.C)		DHvap Kcal/Kg		Mole. wt (g/mole)	Mole Fraction	Average Mole. wt	bp<250 Mol. Frac	bp<250 Avg.Mw	bp<180 Mol Frac	bp<180 Avg. MW	
C5H12 (n-Pentane)..................	1.75	36.30	0.630	1.1025	0.0232	0.0146	0.6940	1.21	91.407	159.96	72.15	0.0278	2.01	0.03	1.83	0.0328	2.37	
C6H14 (n-Hexane)..................	3.25	69.00	0.659	2.1418	0.0432	0.0284	0.6906	2.24	88.505	287.64	86.18	0.0432	3.73	0.05	3.90	0.0511	4.40	
C7H16 (n-Heptane).................	7.25	98.40	0.684	4.9590	0.0963	0.0659	0.6880	4.99	89.105	646.01	100.21	0.0830	8.31	0.09	8.71	0.0980	9.82	
C6H6 (Benzene)......................	9.50	80.10	0.879	8.3505	0.1262	0.1109	0.5750	5.46	103.570	983.92	78.11	0.1394	10.89	0.15	11.41	0.1647	12.86	
C7H8 (Toulene).......................	9.50	110.80	0.866	8.2270	0.1262	0.1093	0.5067	4.81	98.550	936.23	92.14	0.1182	10.89	0.12	11.41	0.1396	12.86	
C8H10 (Ethyl Benzene)...........	7.50	136.20	0.867	6.5025	0.0996	0.0864	0.5326	3.99	97.790	733.43	106.17	0.0810	8.60	0.08	9.01	0.0956	10.15	
C8H10.(Xylene).......................	8.00	144.00	0.881	7.0480	0.1062	0.0936	1.1940	9.55	95.400	763.20	106.17	0.0864	9.17	0.09	9.61	0.1020	10.83	
C8H8 (Styrene)........................	10.50	146.00	0.903	9.4815	0.1394	0.1259	0.5005	5.26	92.506	971.31	104.15	0.1156	12.04	0.12	12.61	0.1365	14.22	
C9H20 (Nonane).....................	2.00	150.50	0.718	1.4360	0.0266	0.0191	0.6842	1.37	81.530	163.06	128.26	0.0179	2.29	0.02	2.40	0.0211	2.71	
C10H22 (Decane)...................	2.75	174.00	0.730	2.0075	0.0365	0.0267	0.6825	1.88	72.666	199.83	142.29	0.0222	3.15	0.02	3.30	0.0262	3.72	
C10H16 (Limonene)	13.30	177.00	0.842	11.1986	0.1766	0.1487	0.7141	9.50	77.268	1027.66	136.00	0.1121	15.25	0.12	15.98	0.1324	18.01	
C11H24 (Undecane)...............	4.00	194.50	0.741	2.9640	0.1619	0.1200	0.7201	2.88	73.453	293.81	156.31	0.0293	4.59	0.03	4.81			4.59
C10H8 (Naphthelene).............	1.00	217.90	1.145	1.1450	0.0405	0.0464	0.4644	0.46	133.141	133.14	128.17	0.0089	1.15	0.01	1.20			1.15
C11H10 (Methyl Naphthelene)	3.00	244.60	1.025	3.0750	0.1215	0.1245	0.4897	1.47	133.141	399.42	142.20	0.0242	3.44	0.03	3.60			3.44
C12H26 (Dodecane)...............	3.00	214.50	0.751	2.2530	0.1215	0.0912	0.6807	2.04	69.612	208.84	170.34	0.0202	3.44	0.02	3.60			3.44
C13H28 (Tridecane)...............	4.00	234.00	0.757	3.0280	0.1619	0.1226	0.6798	2.72	70.464	281.86	184.37	0.0249	4.59	0.03	4.81			4.59
C14H10 (Anthracene).............	2.70	342.00	1.250	3.3750	0.1093	0.1366	0.6601	1.78	85.669	231.31	196.38	0.0158	3.10					3.10
Wax, as C19....................	7.00	330.00	0.777	5.4390	0.2834	0.2202	0.6766	4.74	61.436	430.05	268.53	0.0299	8.03					8.03
Total.................................	100.00			83.73		0.83		66.36		8850.67		1.00	114.66	1.00	108.22	1.00	101.95	184.86

wt% of heavy Oil (Bp > 180 C)..	24.70	%	0.85
wt% of Light oil (Bp < 180 C)............................	75.30	%	0.95
Average Cpmean of Pyro-Oil....................................	0.6636	Kcal/Kg.C	
Average heat of vaporization of Pyro-Oil............	88.51	Kcal/Kg	
Average molecular weight of pyro-Oil...............	114.66	g/mole	
Average liquid density of total Pyro-Oil..........................	0.8373	g/cc	
Average liquid density of light Oil...................................	0.8294	g/cc	
Average liquid density of heavy Oil..	0.8615	g/cc	

Total Pyro-Product molecular weight

Pyro gas wt%...	14.81	%

EXHIBIT B-3

TABLE 3-1

CHEMICAL PHYSICAL PROPERTIES OF OIL GAS BY-PRODUCTS

Oil Analysis

Pyro Oil wt%..	85.19	%
Pyro gas avg. molecular weight........................	30.00	g/mole
100 g product pyro-oil moles.............................	0.74	
100 g product pyro-gas moles.............................	0.49	
100 g product total moles....................................	1.24	
Pyro gas mole fraction..	0.40	
Pyro Oil mole fraction...	0.60	
Total product avg mole weight..........................	80.86	g/mole
wt% of pyro-oil with bp < 180 C..........................	75.30	%
wt% of pyro-oil with bp > 180 C..........................	24.70	%
wt% of Pyro-oil with bp > 250 C..........................	9.70	%
wt% of Pyro-Oil with bp < 150 C..........................	59.25	%
B.P < 250 C Pyro-Product molecular weight		
Pyro gas wt%...	23.08	%
Pyro Oil wt%..	76.92	%
Pyro gas avg. molecular weight........................	30.00	g/mole
B.P < 250 C Pyro-Oil molecular wt............................	108.22	g/mole
100 g product pyro-oil moles.............................	0.71	
100 g product pyro-gas moles.............................	0.77	
100 g product total moles....................................	1.48	
Pyro gas mole fraction..	0.52	
Pyro Oil mole fraction...	0.48	
BP < 250C Pyro-Product avg mole weight..........................	67.57	g/mole
B.P < 180 C Pyro-Product molecular weight		
Pyro gas wt%...	35.86	%
Pyro Oil wt%..	64.14	%
Pyro gas avg. molecular weight........................	30.00	g/mole
B.P < 180 C Pyro-Oil molecular wt............................	101.95	g/mole
100 g product pyro-oil moles.............................	0.63	
100 g product pyro-gas moles.............................	1.20	
100 g product total moles....................................	1.82	
Pyro gas mole fraction..	0.66	
Pyro Oil mole fraction...	0.34	
BP < 180 C Pyro-Product avg mole weight..........................	54.82	g/mole

TABLE 3-2

SUBJECT: Evaluation of pyrolysis carbon black.
Formulation and evaluation of pyrolysis carbon black is per ASTM D3191, D2084, D 4626

FORMULAS: ASTM D3191

	A	B
SBR 1500	100.0	100.0
ZINC OXIDE	3.0	3.0
STEARIC ACID	1.0	1.0
SULFUR	1.75	1.75
ACCELERATOR TBBS	1.0	1.0
PYROLYSIS BLACK	50.0	-
N762-BLACK	-	50.0

RHEOMETER DATA, ASTM D 2084
Tech Pro rheo Tech ODR
320ºF, 3º arc, 30 min. chart speed, 100 inch lbs., 100 cpm

	A	B
Maximum Torque, MH, lbf·inch	66.6	73.0
Minimum Torque, ML, lbf·inch	12.3	12.8
Cure Time Tc50. minutes	13.7	12.1
Cure time Tc 90, minutes	23.2	19.5
Scorch Time, Ts2, minutes	5.2	5.5

MOONEY SCORCH, ASTM D 1646
Alpha Technologies MV-2000 Viscometer
CML @ 121ºC (250ºF), time to 5 point rise

	A	B
Scorch Time, t_5, minutes	>(30.00)	>(30.00)
ML Viscosity	45.00	46.80

CURING INFORMATION, ASTM D 3182

	A	B
1 slab cured at 293º F, minutes	50	50

ORIGINAL PHYSICAL PROPERTIES, ASTM D 412, 2240
Die C dumbbells tested at 20 in/min.

	A	B
Shore A Durometer, points	59	60
Tensile Strength, psi Median	1778	3044
Ultimate Elongation, % Median	595	556
100% Modulus, psi	245	272
200% Modulus, psi	479	692
300% Modulus, psi	745	1325
400% Modulus, psi	1044	2030
500% Modulus, psi	1434	2624

EXHIBIT B-4

FIGURE NO.1: MSW Energy Balance

Feedstock 50000 lb/hr

Type (MSW, Tires, Blend)

MSW	600	Ton per day
Tires		Ton per day
Blended		Ton per day

Reactor Chamber

Condenser

Syn Gas 27055.0 lb/hr

High Heating Value	522	Btu/scf
Low Heating Value	473	Btu/scf
	9,469	Btu/lb
Component	Volume %	
Hydrogen, H2	35.2312%	
Carbon Monoxide, CO	22.4321%	
Carbon Dioxide, CO2	9.9428%	
Methane, CH4	21.3212%	
Ethane	0.7987%	
Isobutane	3.2011%	
Isopentane	0.0000%	
N-Pentane	0.0000%	
C6	0.0000%	
Oxygen	0.2837%	
Nitrogen	6.7892%	
Total	100.0000%	
Gas Density	0.04998	lb/scf

Burner

Syngas 54,925,000 Btu/hr

(80% boiler efficiency)

Char 8785.0 lb/hr

Liquid 14160.0 lb/hr

Energy Used for Pyrolysis Process

43,940,000 Btu/hr

Power consumed by Pyrolysis Process

2,942 KW

(15 % of the output)

Syn Gas 27055 lb/hr

High Heating Value	521.787674	Btu/scf
Low Heating Value	472.4	Btu/scf
	9,469	Btu/lb
Component	Volume %	
Hydrogen, H2	35.2312%	
Carbon Monoxide, CO	22.4321%	
Carbon Dioxide, CO2	9.9428%	
Methane, CH4	21.3212%	
Ethane	0.7987%	
Isobutane	3.2011%	
Isopentane	0.0000%	
N-Pentane	0.0000%	
C6	0.0000%	
Oxygen	0.2837%	
Nitrogen	6.7892%	
Total	100.0000%	
Gas Density	0.04998354	lb/scf

Remaining Energy

201,267,811 Btu/hr

Power Generation

Mechanical Output	Gross Output	KWH/TON
70,443,734 Btu/hr	16,672 KW	667

Power Output

19,614 KW

Power Generation Efficiency	35%
Generator Efficiency	95%

EXHIBIT B-5

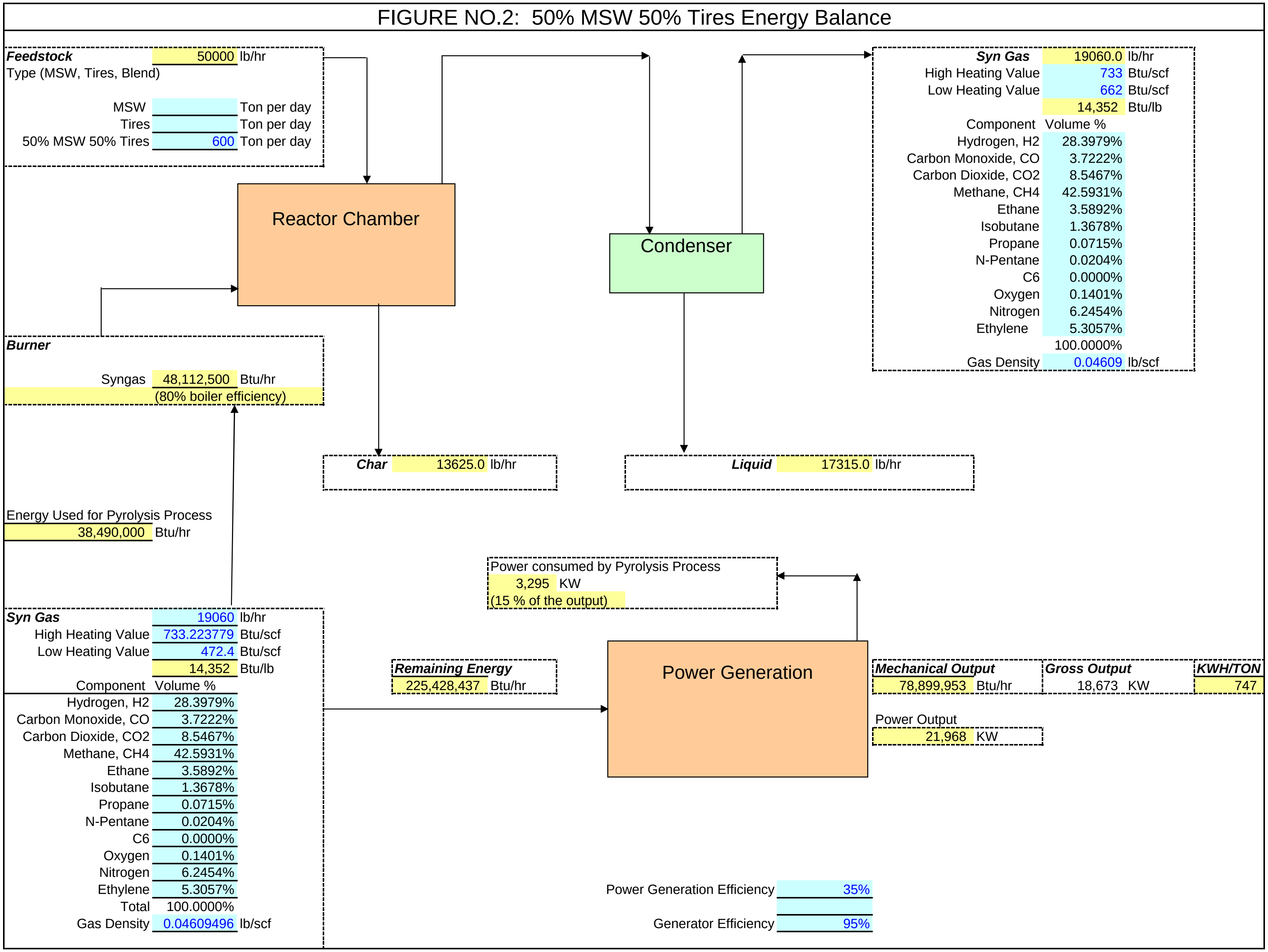


FIGURE NO.2: 50% MSW 50% Tires Energy Balance
Feedstock 50000 lb/hr
Type (MSW, Tires, Blend)
MSW Ton per day
Tires Ton per day
50% MSW 50% Tires 600 Ton per day
Reactor Chamber
Condenser
Syn Gas 19060.0 lb/hr
High Heating Value 733 Btu/scf
Low Heating Value 662 Btu/scf
14,352 Btu/lb
Component Volume %
Hydrogen, H2 28.3979%
Carbon Monoxide, CO 3.7222%
Carbon Dioxide, CO2 8.5467%
Methane, CH4 42.5931%
Ethane 3.5892%
Isobutane 1.3678%
Propane 0.0715%
N-Pentane 0.0204%
C6 0.0000%
Oxygen 0.1401%
Nitrogen 6.2454%
Ethylene 5.3057%
100.0000%
Gas Density 0.04609 lb/scf
Burner
Syngas 48,112,500 Btu/hr
(80% boiler efficiency)
Char 13625.0 lb/hr
Liquid 17315.0 lb/hr
Energy Used for Pyrolysis Process
38,490,000 Btu/hr
Power consumed by Pyrolysis Process
3,295 KW
(15 % of the output)
Syn Gas 19060 lb/hr
High Heating Value 733.223779 Btu/scf
Low Heating Value 472.4 Btu/scf
14,352 Btu/lb
Component Volume %
Hydrogen, H2 28.3979%
Carbon Monoxide, CO 3.7222%
Carbon Dioxide, CO2 8.5467%
Methane, CH4 42.5931%
Ethane 3.5892%
Isobutane 1.3678%
Propane 0.0715%
N-Pentane 0.0204%
C6 0.0000%
Oxygen 0.1401%
Nitrogen 6.2454%
Ethylene 5.3057%
Total 100.0000%
Gas Density 0.04609496 lb/scf
Remaining Energy
225,428,437 Btu/hr
Power Generation
Mechanical Output
78,899,953 Btu/hr
Gross Output
18,673 KW
KWH/TON
747
Power Output
21,968 KW
Power Generation Efficiency 35%
Generator Efficiency 95%