776 E. Riverside Drive
Suite 150
Eagle, Idaho 83616

Dynamis Energy

Process and Technology Description

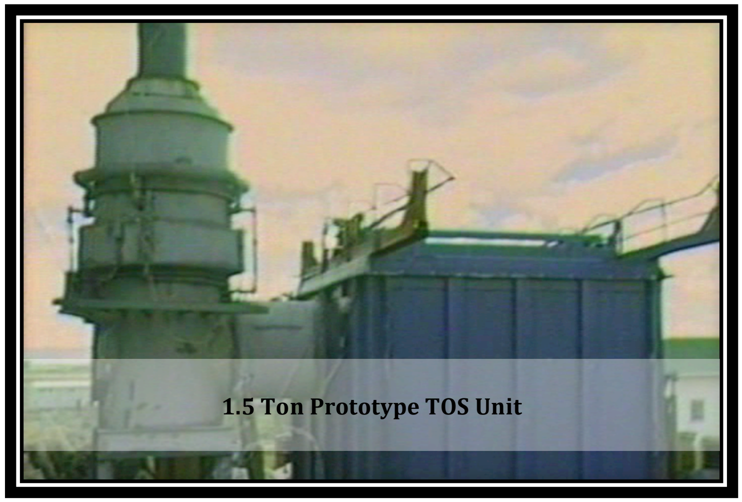
(Includes History and Gasification vs. Incineration Discussion)

Phone: 208-938-2680 Website: www.dynamisenergy.com Fax: 208-938-2684

History and Reference Information

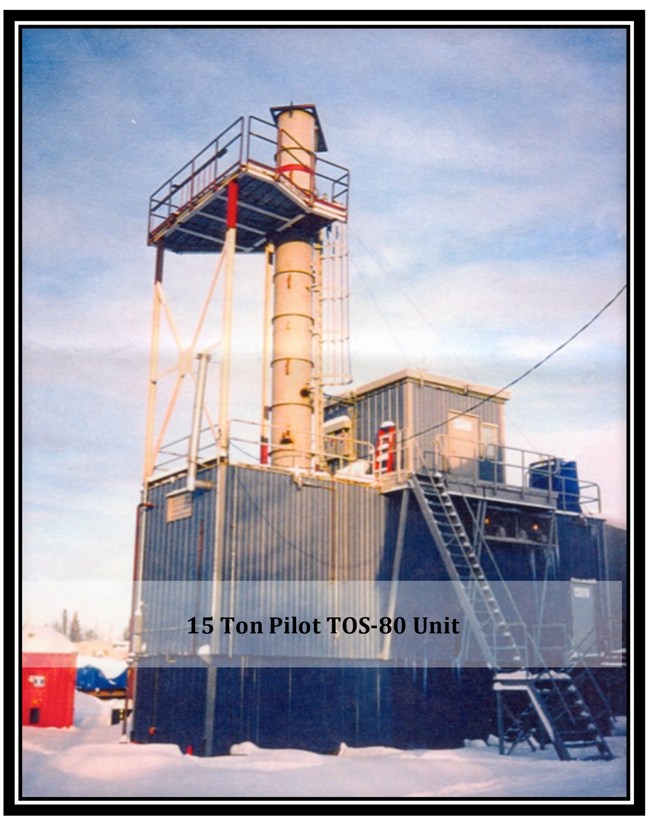
Dynamis Energy has acquired and improved a batch, two-stage thermal conversion technology for the gasification of municipal solid waste ("MSW") and other wastes in a primary chamber followed by the combustion of the produced syngas in a secondary system. Energy is recovered from the combustion products for the production of steam and electricity.

The inventors of the advanced thermal waste destruction technology have collectively been in the waste destruction industry for 50+ years. Those years have seen them design and engineer literally 100's of systems and projects from wood waste oxidation to bio mass boilers, to industrialized auto fluff solutions. The original prototype of our thermal waste destruction technology was a 1.5-ton system and was designed, developed and constructed in 1988. Trial runs were performed to witness the validity of the final Prototype System. With the success of the trial oxidation cycles, performance data and design sketches were sent to the Western Research Institute (WRI) in Laramie, Wyoming. WRI was contracted for proof of concept using their combustion modeling software program.



1.5 Ton Prototype TOS Unit

The modeling program indicated that the system design contained the right attributes for further testing and warranted moving the prototype to the testing grounds in Laramie. In all, the system operated in over 30 tests under EPA Testing Protocol for emissions and ash results. The prototype system was operated with a manual control system.



15 Ton Pilot TOS-80 Unit

In 1991 the testing programs at WRI were complete and a scale-up system was designed and constructed in Anchorage, AK. The scale-up system was named, Model TOS-80. The Primary Chamber was capable of holding 15 tons of waste materials. The TOS-80 operated over the next three years under commercial operations in the destruction of oily waste materials from the Valdez Oil Spill, medical waste and MSW operations. The 15-ton system, which had automated controls and continuous emission monitoring, was tested for the proof of scale up in comparison to the 1.5-ton system. During this time period further testing was performed utilizing different waste materials. These tests were performed under the same EPA Protocol which the prototype TOS operated under at the WRI testing labs. These tests were to demonstrate the validity of the scale-up design and the ability to operate under commercial and industrial applications. Along with WRI research personnel an additional 3rd party, AmTest Alaska was contracted to further confirm the test results and scalability of the system design. The results of all tests further confirmed the scalability of the engineering and the consistency of emission performance leaving no question as to the validity of the technology.

Upon successful completion of the Anchorage pilot plant, a fully operational plant was funded and purchased by the North Slope Borough in Barrow Alaska.

30-Ton per Day Barrow Facility

The engineering for the Barrow, AK 30 ton plant was based on the 15 ton Anchorage plant. The Barrow plant achieves 30 tons per 24-hour cycle by using two 15-ton Primary Chambers. This system was commissioned for operations in the community of Barrow, Alaska in 1996. At the request of the North Slope Borough the controls for the system were designed and constructed for manual operation. The permitting for the Barrow, AK project followed the procedures for emissions in a non-attainment zone. The plant operated under the permit as a Primary Emissions producer in its first years of operation (continuous daily reporting). After several years of documented emissions results with the Alaska DEQ, the Permit reporting standards have been lowered to a Secondary Emission producer, reporting only for upset conditions and once every quarter for confirmed emission results. The Dynamis Energy, modular design incorporates the confirmed engineering compiled for the prototype, 15-ton and 30-ton system designs. The question of scale up has been confirmed with the process of testing and the complete fully operation system working for 15 + years of service with no technological down time of service. The modular designs of today are nothing more than a series of 15-ton systems. Along with this confirmation of mechanical attributes of the technology, Dynamis has incorporated state-of-the-art automated controls in parallel with its own proprietary control system to guarantee the combustion process, emissions and ash content.

The facility treats all municipal solid waste generated by the community as well as the medical waste generated from the local hospital and medical offices. The North Slope Borough has been able to close one landfill, and uses the remaining landfill for the ash and non-combustibles.

Tipping Floor and Primary Chambers

The facility is designed with two primary chambers and a shared secondary chamber utilizing natural gas fired burners. Each primary chamber has a maximum operating capacity of 97 cubic yards, which gives the facility a practical process rating of up to 30-tons per day

Secondary Chamber and Turbulent Manifold

A 68-foot horizontal refractory lined secondary chamber incorporates a turbulent air mixing manifold and natural gas burners that complete the combustion of the off-gases (syngas) from the primary chambers. The secondary chamber exits into a vertical refractory lined stack.

How is Dynamis Technology different from Incineration?

The Dynamis Technology is based upon the principals of gasification and pyrolysis. These technologies are not incineration. Incineration is the burning of fuels in an oxygen rich environment, where the waste material combusts and produces heat and carbon dioxide, along with a variety of other pollutants. Gasification and the Dynamis technology is the conversion of feedstock's (raw material for processing) into their simplest molecules – carbon monoxide, hydrogen and methane forming a syngas which can then be used for generating electricity or other products.

Gasification and Advanced Thermal Conversion Technologies are increasingly being used to convert municipal solid waste and Biomass into valuable forms of energy. While this type of waste has been burned, or incinerated, for decades to create heat and electricity, the Dynamis technology represents significant advances over incineration. In order to understand the advantages of the Dynamis technology when compared to incineration, it's important to understand the significant differences between the two processes.

The definition of incineration is to "burn up completely; reduce to ash". Incineration uses MSW as a fuel, burning it with high volumes of air to form carbon dioxide and heat. These hot gases are then used to create steam, which is then used to generate electricity. Though the Dynamis technology also creates steam, which is then used to generate electricity, the process is much different.

The Dynamis technology converts the municipal solid waste to a usable synthesis gas, or syngas. It is the production of this syngas, which makes gasification and the Dynamis technology so different from incineration. The Dynamis technology uses the MSW not as fuel, but a feedstock for a low temperature thermal chemical conversion process. In our system, the MSW reacts with a controlled amount of oxygen, breaking down the feedstock into simple molecules and converting them into syngas. The syngas is completely combusted in our Secondary Combustion System to create a hot exhaust that is used to produce energy in the form of steam and electricity. Incineration can also create forms of energy, however the Dynamis gasification process provides energy with many environmental benefits.

One of the concerns with incineration of MSW is the formation and reformation of toxic dioxins and furans, especially from PVC-containing plastics and other materials that form dioxins and furans when they burn. These toxins end up in exhaust steams by three pathways:

- By decomposition, as smaller parts of larger molecules,
- By "re-forming" when smaller molecules combine together; and/or
- By simply passing through the incinerator without change.

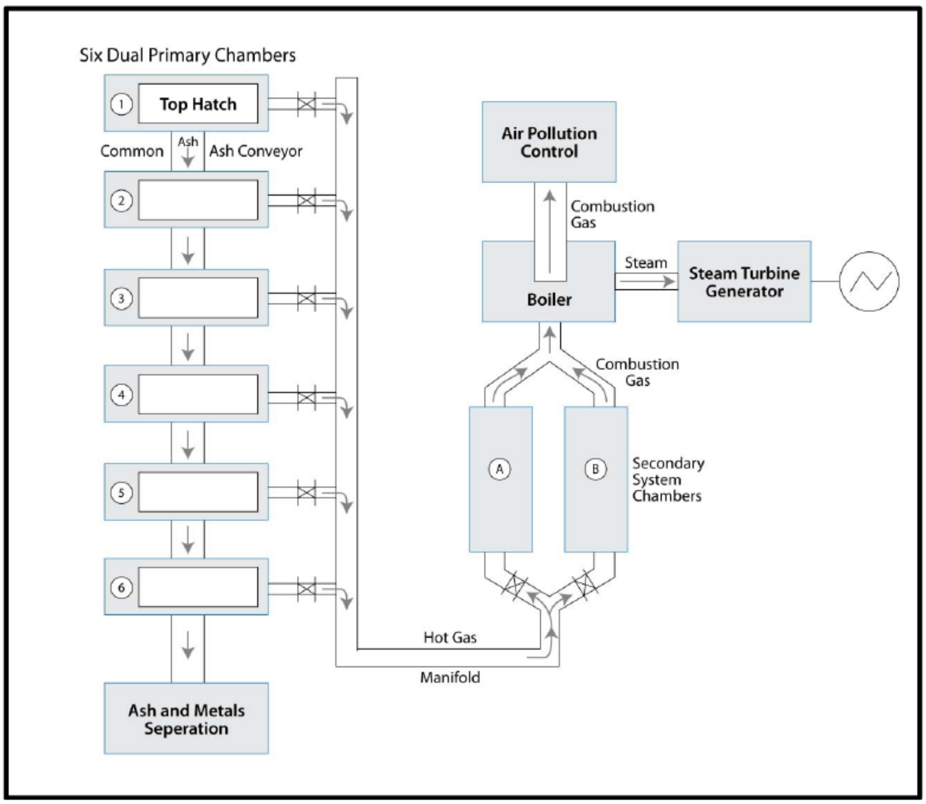
Incineration does not allow control of these processes, and all cleanup occurs after combustion.

The Dynamis technology is significantly different and cleaner than incineration:

- In the Dynamis thermal conversion process, larger molecules such as plastics are completely broken down into the components of syngas, which are then completely combusted in the Secondary Combustion System,
- Dioxins and furans need sufficient oxygen to form or re-form, and the oxygen-deficient and controlled atmosphere in our process does not provide the environment needed for dioxins and furans to form or reform,
- Dioxins can be mobilized when particulate matter (PM) is generated in the combustion process. These PM act as a carrier for dioxin to enter the vapor gas stream. The Dynamis technology produces very low PM and does not break down metals and glass, resulting in limited production of dioxin and furans and those that are produced remain in the bottom ash.
- Dioxins are denatured at temperatures about 1500° F, so any small amounts that do form, are destroyed in the secondary combustion chamber.

Typical Dynamis Energy Installation

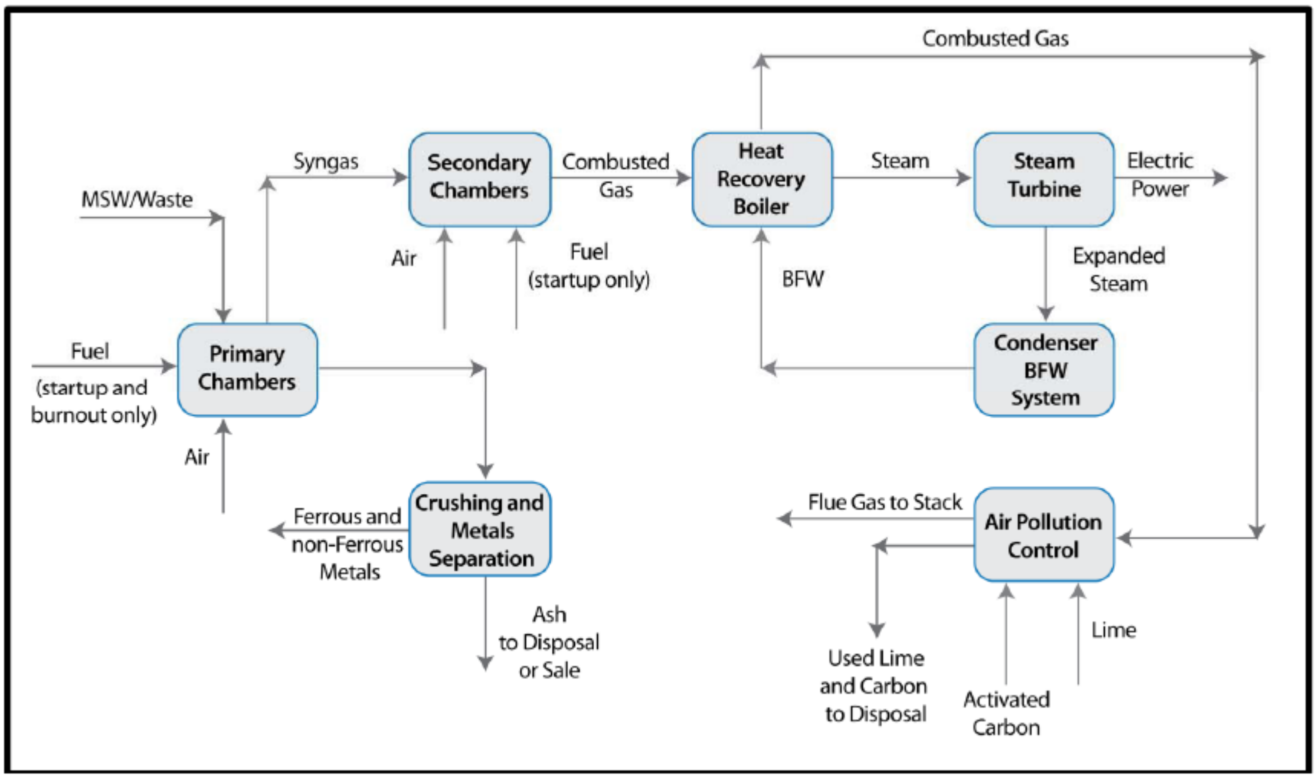
A typical installation will have several primary chambers connected to a dual-chambered secondary system through a common syngas manifold as shown below that (for convenience) shows six primary chambers and the secondary system. Dampers are located in the ductwork downstream of each primary chamber to control the flow from and to allow isolation of each primary chamber. Dampers are also located upstream of each secondary system chamber to balance the flow gas from the primary chambers between the secondary system chambers. The cycles of the primary chambers are designed to provide a uniform flow of syngas heating value and sensible heat (over a 24-hour cycle) to the secondary system and heat recovery boiler for an constant power output, or the cycles of the primary chambers can be staged to maximize the syngas flow and power output during peak value hours for electricity production with minimal syngas output to maintain temperature in the secondary system chambers during off-peak hours. If necessary, natural gas or another fuel can be substituted for syngas to maintain secondary system combustion gas exhaust and temperature output.



Typical Dynamis Installation Diagram

Waste Destruction Technology

The Dynamis Technology uses a modular concept, where the size of the proposed facility will dictate the number of primary chambers and the size of the secondary system chambers to be used. The number of primary chambers and the size of the secondary system chambers are a function of the daily-required throughput rate of MSW. The block flow diagram below shows the process.

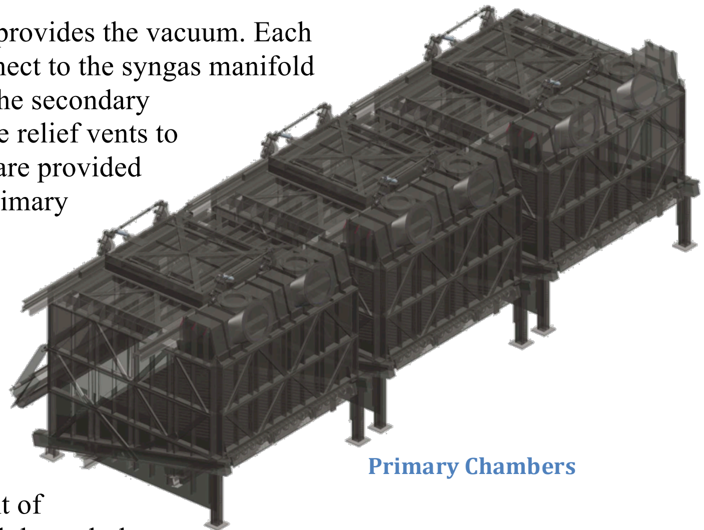


Dynamis Process-Block Flow Diagram

The MSW is moved from the tipping floor by a front-end loader or a grapple crane or a conveyor that is to be used to the primary chambers that are mirror images of each other, and are to be operated sequentially in order. The top feed hatch is opened and closed using a hydraulic motor. The primary chambers share a common ash removal conveyor. MSW is to be fed through the hatch until approximately 70 percent of the volume of the chamber is filled, forming a mound that tapers from a maximum height in the middle/centerline area of the chamber to the minimum at the outer walls. The expected weight of MSW charged is approximately 34 tons.

Each primary chamber has an ash grate that supports the load of MSW and is also used to distribute air into the MSW above the grate. The grate is angled downward from the outer wall towards the centerline. The lower end of the grate terminates at an ash door that runs the width of the chamber. The grate incorporates a vibrator to assist in the removal of unburned material (i.e., the inorganic material in the MSW and residual ash from the organics) by gravity down the grate and through the ash door when the door is open. Each primary chamber has a natural gas or multi-fuel-fired burner that is to be located in the wall opposite of the shared centerline. The burner is located slightly above the level of the top of the ash grate. The interior walls of the primary chamber are refractory lined to reduce heat loss.

After a known volume of feed has been introduced into the primary chamber, the top hatch is closed. The primary chamber operates at a slight vacuum relative to the ambient pressure; an induced draft fan downstream


Primary Chambers

of the secondary system and heat recovery boiler provides the vacuum. Each primary chamber has syngas outlet ducts that connect to the syngas manifold that directs syngas from all primary chambers to the secondary chambers. Each primary chamber has two pressure relief vents to the atmosphere or the secondary chamber, which are provided to prevent a build-up of positive pressure in the primary chamber during upset conditions. The burner is ignited to preheat and ignite the charge of MSW. The burner is to be shut off when it has been determined by the gas temperature above the bed that the gasification is self-sustaining. The control of air through the grate is to be based on the temperature of the gas above the bed of material and by the oxygen and carbon monoxide content of the gas. Approximately 30 to 40 percent of the stoichiometric oxygen requirement is provided through the grate. However, some bypassing of air through the bed of MSW occurs and because the temperature of the gas above the bed is to be kept below the auto ignition temperature of the syngas components, some oxygen is present in the syngas above the bed. The actual flow of air is modulated by the settings of dampers in the ductwork between the primary and secondary systems, and the forced draft blower that provides airflow to both the primary and secondary systems.

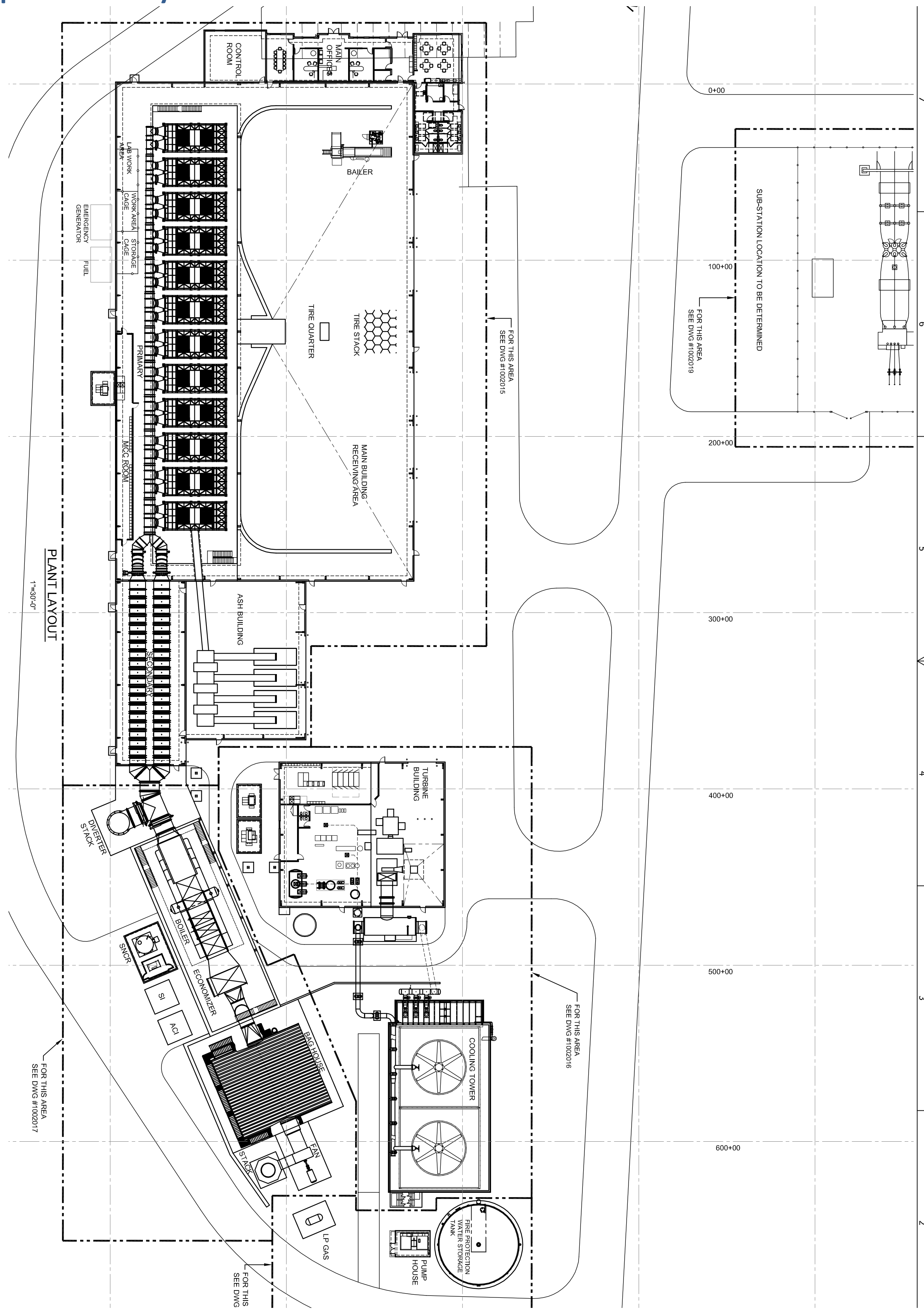
During the gasification phase of the cycle, the desired operating temperature of the gas above the material bed is approximately 850°F. After the gasification portion of the cycle is completed as determined by the level of oxygen and carbon monoxide in the syngas, the burner is to be turned back on (if required), and the air flow adjusted to burn out any remaining organic material until the desired level of carbon monoxide and oxygen in the primary chamber off gas are reached. After burn out, the airflow is increased to cool down the contents of the primary chamber.

The carbon monoxide and oxygen content of the syngas flow from a primary chamber to the secondary system is to be monitored by a flue gas combustion analyzer located downstream of the primary chamber in the syngas manifold to the secondary system. The syngas from each primary chamber is monitored separately. The sample gas sent to the analyzer is passed through a gas conditioning train to remove tar and particulate that could adversely affect the analyzer. The carbon monoxide and oxygen content of the syngas and the temperature of the syngas at the top of the primary chamber are used to control the amount of air addition to the chamber and the operation of the burner. The design of the primary chamber burners, the allowable airflow rates per unit area of grate, and MSW conversion rate have all been selected by Dynamis to produce a low-velocity flow that is intended to prevent the flow of particulate from the primary chambers into the secondary system. This is expected to minimize the potential of slagging in the secondary system chambers and deposition of slag or sticky particulate on the heat recovery boiler tubes and to avoid supplying a source for surface formation of dioxins from aromatic ring compounds in particulate.

The primary chambers are to be typically operated simultaneously and sequentially on a 24-hour cycle. After the MSW feed has been placed in the chamber and the chamber seals have been tested, the process begins. Once the gasification phase of the cycle is complete, burnout and cool down of the chamber follows.

At the end of the cool down portion of the primary chamber cycle, when the temperature sensor for the ash door indicates that the material in the primary chamber is below 250°F, the ash door is opened hydraulically, and the vibrator on the ash grate is turned on to move the ash and non-combustible material out of the primary chamber onto the ash conveyor. The ash conveyor is to be a common conveyor for all primary chambers. The ash conveyor is to transfer the ash and non-combustible material to two other conveyors in series that are to be used to feed a crusher. A screen is located before the crusher to remove oversized non-combustibles. The crusher is to reduce the size of the glass remaining in the ash. The crushed materials are to be passed by an electromagnet to remove ferrous metals and by an eddy current device to remove non-ferrous metals, each are to be conveyed to their own separate storage bin. The remaining glass and ash material are to be conveyed to third storage bin. It is Dynamis' intent to sell the ash for use in cement, concrete, road aggregate or similar products such as landfill cover.

Typical Plant Layout



The Dynamis Process

Material Handling

The incoming waste is weighed, then deposited on the tipping floor from any of the trucks currently in use that pick-up and/or transfer MSW. The only separation that is required will be large oversized pieces that won't fit into the Primary Chamber, heavy metal items like engines, and items that need special pre-processing, such as refrigerators, freezers and air conditioning units that need the Freon removed. Some hazardous waste and medical waste can also be processed. The system is designed to process waste as quickly as possible.

During delivery hours the waste is delivered faster than it can be gasified. Consequently, some of the waste is stored for processing at night and on weekends and holidays. This stored waste can be "bailed" in a specially designed bailer that will wrap the waste in airtight plastic sheeting. The wrapping process slows down the decomposition process of the waste, which maximizes its energy value within the systems, and minimizes odors during the storage process. Actual waste materials can be accepted loose, bagged, baled, or on pallets. The system can also accept a wide range of bulky items such as vehicle tires, mattresses, furniture, and construction debris.

The process begins by loading municipal solid waste (MSW), directly from garbage trucks, onto the tipping floor. Next a conveyer or grapple crane can move the MSW into the Primary Chamber.

During schedule and unscheduled shutdowns, the waste received from the municipality goes into the storage area that is designed to handle normal surges and continue accepting the waste.

The Primary Chamber

The Dynamis technology utilizes a thermal oxidation process to convert municipal solid waste (MSW) to a clean burning fuel, which differentiates itself in the industry from incineration, gasification, and pyrolysis. Dynamis Energy process is described as follows: The primary conversion process is a batch load configuration, in which MSW is loaded into multiple Primary Chambers through a hydraulically operated door at the top of the chamber and processed in sequential order to create a consistent fuel. The Primary Chambers operate at temperatures of 850°F (460°C) and below. Fossil fuel burners, which are strategically positioned within the Primary Chambers so as not to create any particulate matter, are used in the initial stage for the ignition process. Once the conversion process has reached an internal chamber temperature of 450°F (230°C), the fossil fuel burners are shut down. At the temperature of 450°F (230°C), the oxidation process within the MSW stream commences. This oxidation process requires a source of oxygen to complete the destruction cycle.

The oxygen source in the Primary Chambers is supplied through the bottom grate system, which provides and maintains an oxygen discharge rate of 2% excess or less in order to allow ample oxidation for heating to occur. Typically 30 to 40 percent of the stoichiometric air requirement is controlled in the Primary Chambers. As the oxidation process advances, the temperatures within the Primary Chambers will elevate to a maximum of 850°F (460°C) in the upper envelope of the chamber, while continuing to maintain the oxygen discharge of 2% excess or less. The MSW is converted into a highly combustible syn gas and passes along to the Secondary Combustion System (SCS).

The air-controlled environment in the Primary Chambers prevents turbulence within the solid waste stream and allows the Dynamis technology to maintain almost zero discharge of particulate matter while simultaneously converting the MSW to a super rich gas. Additionally, the placement of the fossil fuel burners at the bottom of the MSW further prevents the turbulence within the solid waste stream. This is crucial in that many trace elements such as dioxin furans, hydrochloric acids, sulfurs, etc. can attach to particulate matter as a carrier and enter the gas stream. With limited airflow, lack of turbulence and low production of particulate matter within the primary chambers, these trace elements are minimized in production and if formed, remain in the bottom ash.

Without the particulate matter as a carrier, those trace elements are maintained in the bottom ash within the Primary Chambers, while the syn gas created provides for a clean fuel rich and highly combustible gaseous stream for presentation to the SCS.

While the controlled operating temperature of the Primary Chambers is held at 800°-850°F (425°-460°C), the bottom grate temperature is maintained at 400°-450° F (200°-240°C). This distinction in temperature is significant because any heavy metals that may have been a part of the MSW stream and not detected on the tipping floor, such as hearing-aid batteries, medical supplies (i.e. any items that contain mercury, cadmium, etc.) will settle to the bottom ash. These cooler temperatures maintain a controlled environment to prevent vaporization of these trace elements to the gas stream, thus preventing discharge to the atmosphere. The ash is monitored and tested to ensure it contains negligible amounts of pollutants (well below EPA limits). Dynamis' proprietary technology includes highly accurate control of the temperature and pressure throughout the entire conversion process. The purpose of this control is to retain any pollutants in the ash, as opposed to being discharged in the syn gas. Due to the batch load design system, we are able to segregate the ash in the removal process. If any toxic ash condition exists, we can identify and remove it. Under normal operating conditions, the ash is usable in cement, road aggregate, concrete blocks and similar products. These ash products are a marketable element for concrete construction products.

The Secondary Combustion System

Once the hot gas is passed into the secondary combustion system (SCS) they are actively mixed with oxygen (taken from the ambient air). The mixture is then introduced to a flame source where it flashes (combusts). Once the system is active, the gas mixture will auto ignite without the use of an additional burner.

The purpose of the secondary system is to combust and hold in residence the syngas produced from the primary chamber's at temperatures above 1, 800°F which is considered to be sufficient to destroy both dioxins formed in the primary chamber and precursors to dioxin formation that could form dioxins (with the chlorine from the MSW) during combustion gas cooling. The temperature in the secondary system is to be controlled by the amount of air added and the flow rate of syngas from the primary chambers (the flow of gas from the primary chambers can be throttled back by controlling the air flow to them). The amount of air that is added to the secondary system is controlled by a combination of the level of combusted gas exiting the secondary system, the temperature in the secondary system chambers, and the percentage of excess air in the combusted gas stream downstream of the secondary system. The diameter and length of the secondary system chambers are dependent on the volume of waste processed, which produce fuel for the process. The secondary combustion system can be connected to multiple primary chambers each processing up to an expected 34 TPD of MSW. The diameter is to be designed for turbulent mixing and the length is to be selected to provide sufficient residence time for complete combustion of the syngas. Burners are provided along the length of the chambers to provide heat for start-up to bring the secondary system chambers up to their normal operating temperature, and to maintain the operating temperature when syngas-heating value is not sufficient or when syngas is not available. The secondary system is internally insulated with refractory to control heat loss.

Boiler/Steam Production

The heat created by the super rich gas/oxygen combustion is directed through a high temperature power boiler where water is converted into high-pressure and high temperature steam. The combustion exhaust from the secondary system is used to generate steam in a single heat recovery boiler at approximately 900 pounds per square inch gauge ("psig") pressure, at 850 degrees Fahrenheit for use in a steam turbine generator. In most installations, the boilers will be configured as a fire tube, water tube or scotch marine. All of which are high temperature, high-pressure firebox boilers of three-pass construction for highest thermal efficiency. These boilers have an extended retention time design that provides maximum volume plus increased radiant surface for supreme heat absorption without excessive chemical elements traditionally used to retain furnace heat.

Energy Production

This high-pressure steam generated from the boiler is directed through a power generation turbine creating electrical power that can be routed to the local electrical grid. Additionally, steam not needed for the turbine can be diverted away from the turbine condensed or can be diverted for other applications, like district heating, greenhouse heating or hot water production.

Flue Gas Treatment

Conventional technology is used to produce the steam and for flue gas emission control. The flue gas from the heat recovery boiler is to be treated with lime to remove sulfur dioxides and hydrochloric acid and with activated carbon to remove mercury from the flue gas. The injected activated carbon and lime, plus particulate in flue gas are collected in a baghouse. No other flue gas treatment is incorporated into the design. The Dynamis technology can control nitrogen oxide ("NOx") via staged oxidation and by controlling the combustion temperature in the secondary system. An induced draft fan downstream of the baghouse is to be used to control the pressure of the system at the primary chamber, draw syngas and flue gas through the overall system and out through a stack. Depending on the type of waste, a wet scrubbing system may also be incorporated.

Process Logic Control System

All aspects of combustion and fuel feed are monitored and controlled by state-of-the-art logic control system, which monitors and processes data at a frequency up to 1 sample per second. This is especially important with the ever-changing combustion conditions of biomass and waste fuels. The microprocessor analyses data from various inputs such as switches, thermocouples, pressure sensors, combustible gas sensors and an oxygen sensor to continually monitor exhaust and optimize air-to-fuel mixture, and automatically adjusts the process to create better efficiencies within the system.

Reclamation

In the final step, we reclaim recyclable metals and bottom ash. After a thermal oxidation cycle in the Primary Chambers, the remaining material (2- 5% of the original volume) is moved by conveyor belt where all recyclables are removed from the ash and sold. The ash is then run through a crusher where all residual glass will be crushed and made part of the ash product for use in concrete construction products, road compaction base material or sent directly to the landfill. Additionally, the residual metals removed from the ash will be commercially sold and/or recycled. Lastly, the conveyor system used to process the ash contains air ventilation enclosures, which increases the efficiency in the amount of ash processed from the system and limits the amount of dust related to that process.