MINI BATCH WASTE TREATMENT SYSTEM

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Abstract

An apparatus and method for treating small amounts of organic waste materials that may contain some inorganic materials in an ecologically friendly manner is disclosed. The apparatus includes a heating system and an offgas processing system, which converts the waste to benign solids and non-hazardous gases.

Mini Batch Waste Treatment System

![Diagram of Mini Batch Waste Treatment System]
MINI BATCH WASTE TREATMENT SYSTEM

BACKGROUND

[0001] This invention relates to the thermal destruction of waste materials, and, more particularly to a method and apparatus for the treatment of waste material in small quantities and/or materials that are disposal sensitive. The process involves pyrolysis, gasification of organic matter, combustion of product gasses, and sterilization of minor metallic components in the waste stream.

[0002] Small batches of medical waste as generated from Doctors offices are typically disposed of by old-fashioned incinerators or a delivery service is utilized to collect this waste material for disposal in a large facility. When Doctors offices are located in a remote area or when companies are dealing with sensitive materials, the logistics of a delivery service ceases to be a viable option. One Step incineration has long been antagonistic to the environment and a point for public concern.

[0003] Small incinerators are particularly antagonistic to the environment because they are based upon old technologies, were built during the period of approximately 1960 to 1990, and did not adequately address the release of materials into the air. During low temperatures, products of incomplete combustion and the reformation of potentially hazardous organic materials, such as dioxin and furan, are much more likely to be formed. Because batch-feeding methods rely on the energy available in the waste itself, the problems are particularly pronounced during the start-up operation. It is important to achieve high temperatures because the destruction of some organic waste components commonly found in medical and other waste streams requires them. Only a few incinerator designs can adequately reach these temperatures and they typically require the addition of fossil fuels to supplement the combustion process. Wet organic materials only work to exacerbate the inefficiencies of the combustion process because the combustion gas temperature is lowered. In addition, carbon carryover is a particular issue with many of these gasification/combustion systems that needs to be rectified in an environmentally safe manner.

[0004] In recent years, public and regulatory attention has focussed on the problems associated with the disposal of medical waste generated by hospitals, clinics, medical offices and research facilities. Numerous new technologies have emerged which have been offered as solutions to these problems. Most of these new technologies employ disinfection and/or sterilization methods to reduce or eliminate the infectious portion of the waste so that it may be placed in a landfill after treatment. What the current regulations fail to address is the fugitive emissions generated by these processes. The EPA will at some point issue guidance to tighten these current emissions regulatory loopholes.

[0005] Small quantity generators that are located in remote areas or are sensitive to the security surrounding the disposal of material find it not economically feasible or not desirable to engage a courier service to transport their materials. In such cases, the generator is only left with the incineration or one of the newer less adequate treatment technologies.

SUMMARY

[0006] Gasification and incineration are not new. This system uses a combination of equipment, sensors, heat, and an oxygen system to control the amount of C, CO, CO2, H2O, and O2 in the various stages of the process to achieve complete reduction of the waste stream to inert gases and water. The present invention has been made in view of the above-explained inadequacies of the known waste treating apparatuses and methods. It has an objective to provide a waste processing system and a method for processing small batches of waste material while complying with all applicable air and water emission standards. The system can process a variety of waste streams such as medical waste, chemical wastes, animal carcasses, drugs, and other organic and inorganic waste streams.

[0007] It is an objective of the invention to provide a waste processing system which is capable of preheating and then maintaining a constant high product gas temperature in the waste treatment process so as to destroy all complex organic material and process the off-gas to minimize the reformation of complex organic compounds.

[0008] An objective will be to drive the gasification and combustion processes through a predetermined process path with minor adjustments being made to maximize system performance. Thus, the process has complete control over the rate at which gasification and oxidation are accomplished.

[0009] Another objective is to size the system so that it can be located at the waste generation source or it can be easily transportable from location to location. It will take up the space of several filing cabinets and can be loaded in the back of a pickup truck for site to site relocation thus being able to easily take a waste disposal system to the generator for materials processing.

[0010] Additional objectives and advantages of the inventions will be learned from the detailed description of a preferred embodiment of the invention which follows, and the accompanying drawings, or may be learned by practice of the invention.

[0011] To achieve the foregoing objectives of the invention, as embodied and broadly described herein, the apparatus for treating waste in accordance with a preferred embodiment of the invention starts with a waste-processing chamber. Waste is heated in the chamber so as to convert the organic portion of the waste substantially to a gas comprising hydrogen, long chain hydrocarbons, and carbon monoxide. An oxidant is added to convert the remaining carbon particulate into a carbon monoxide gas. As the waste temperature is raised to form a gas in order to exit the processing chamber, the water is vaporized followed by hydrocarbon vaporization. Temperatures may reach up to a maximum of 1400 degrees F. If complete sterilization of remaining inorganics is required. The exit temperature of this chamber is flexible and does not necessarily have to go to 1400 degree F. given that the gas heating oxidation system is used to polish the product gas and ensure the temperature is reached. Due to the batch operation and slow controlled heat-up, gasification carbon carry-over is virtually eliminated by the controlled flow of off-gas and the proper addition of oxygen and the maintenance of the secondary chamber temperature.

[0012] To prevent the formation of complex organic compounds from off-gas reformations, the waste processing system in accordance with the invention raises and maintains the temperature of the off-gas above about 1400 degree
F. until it is cooled rapidly to a temperature below about 400 degree F. The hydrogen and carbon monoxide off-gas is converted to a non-hazardous and a non-combustible gas of substantially carbon dioxide and water vapor. This process is a thermal process of conversion driven by both chemical reaction energy and process input energy. A burner flame is not utilized to facilitate combustion. This is driven by the temperature maintenance of the gas heating oxidation system and the oxidant controls. During the cooling of the off-gas, if any particulate does remain, an additional portion is separated from the cooled gas. Acidic gases, if present in the cooled off-gas, are neutralized and a portion of any remaining particulate is separated out to form a product gas which is comprised substantially of water and carbon dioxide. The scrubber creates a negative pressure throughout the system because the process chamber and high temperature chamber are sealed to inhibit the entrance of unwanted oxidants. This allows for process control by the control system using predetermined control parameters.

[0013] A control system is utilized to monitor the process and make adjustments as required to maintain operation of the system with specific intent to minimize carbon and oxygen carryover and maximize water and carbon dioxide formation. A man and machine interface control is utilized to guide the operator through the operational sequences of the system and enter specific security control sequencing codes if required by the operator of the system. Sensor adjusted algorithms are utilized to control the process and force the waste gasification down predetermined path within established parameters.

[0014] A combustion process must have heat, fuel and oxygen. This equipment and process uses a given amount of fuel as input by the operator in the batch feed system, which is limited by the size of the process chamber. The system controls the amount of heat and oxygen input to the system thus controlling the rate of the combustion process. Controlling the combustion process with these factors controls the timing, the amount of heat generated, and the rate of combustion gas formation. The process can be stopped at any time simply by turning off the two control factors of heat and oxygen control.

[0015] The field of pyrolysis, gasification, and incineration is quite crowded with many patents. This system is unique in that it combines system mobility, an environmental dioxin and furan solution, carbon generation curtailment, carbon carry-over reduction, and a unique pyrolysis/combustion rate controllable process to safely dispose of environmentally harmful waste streams.

BRIEF DESCRIPTION OF THE SYSTEM

[0016] In the accompanying drawing:

[0017] FIG. 1 is a schematic diagram of an apparatus for treating waste in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION

Preferred Embodiment

[0018] With reference to FIG. 1, the waste processing system of the invention will be described hereinbelow in detail. There are five major subsystems that comprise the waste processing system. They are the process chamber, the gas heating oxidation system, the gas scrubbing system, the oxygen system and the control system.

[0019] This system is ideally suited for small batch type operations. The operator opens the door to the process chamber, piece #1, and places the waste for disposal into the chamber and closes the door. The chamber door locks to secure the door during operation. Scales isolate the atmospheric environment from the process chamber environment. There are electric heating coils inside the refractory lined and insulated chamber to provide the energy for pyrolysis or gasification. A replaceable sleeve, piece #2, is utilized to protect the chamber and the electrical heating elements during organic gasification. Thermocouples are utilized to monitor temperatures and provide information to the control system. As energy is applied to the chamber, the organic portion of the waste is heated; it becomes increasingly unstable until it eventually dissociates into its elemental components mainly long chain hydrocarbons, carbon and hydrogen. Oxygen and halogens are also liberated if present in the waste. Dissociation rates of the different materials vary primarily driven by the type of material, amount of material and thermal energy applied to the material. Water will be driven out of the system first and this will be followed by hydrocarbon gases, which will leave carbon particulate and metals in the process chamber. After the hydrocarbons are freed, an oxidant is added to the chamber to convert the hot carbon to a carbon monoxide gas. Excess oxygen may be added to the process to increase the amount of be generated in the process chamber by converting a portion of the carbonmonoxide to carbondioxide. Once the carbon has been converted to carbon monoxide, inorganic materials if present remain in the chamber for retrieval after the total process cycle time has been completed. Gas from the process chamber will vary in temperature from ambient to in excess of 800 degrees F.

[0020] The second subsystem, piece #3, is the gas heating oxidation system. This unit is a refractory lined, tortuous path, insulated, electrically heated, combustion processing system. Because this is a batch process materials are dissociated through a wide range of temperatures in the initial process chamber. This gas heating system takes the temperature, what ever it may be, and heats it to a constant temperature in excess of 1400 degree F. Since heating of gaseous hydrocarbons will further separate the hydrogen elements from the carbon elements, the gas heater is designed to accommodate gaseous materials as well as a limited amount of carbon black type materials. An oxidant is added to the subsystem in a controlled amount to convert the carbon and carbon monoxide to carbon dioxide and convert hydrogen to water with minimal amount of excess oxidant carryover.

[0021] Upon exit from the gas heating system the hot gas enters the gas treatment system, piece #4, that has the means to quickly cool the gas to a temperature of less than 400 degrees F. and for separating entrained particulate from the cooled gas. In the quencher, the gas is rapidly cooled with a water spray to prevent the formation of complex organic compounds. Recirculating water is jet sprayed in a path co-linear with the gas path to simultaneously quench the gas, remove additional particulate, if at all present, from the gas, and create a flow of gas from the process chamber. After the gas is cooled, it is drawn from the system by an exhaust fan,
piece #5, or it is indirectly drawn out of the system by the quench spray. The chlorinated organic materials, often found in medical and other organic wastes, decompose and in the hydrogen rich gas, reform as hydrogen chloride. This compound is neutralized in the gas treatment system by reacting with a basic neutralizing agent to form salts, as the gas travels through the system. If the waste stream does not include a potential acid-forming agent, the basic neutralizing agent will not be required. The quench water is reused and also sent to the sewer to inhibit the build-up of salts in the water. This means is preferably a wet gas scrubber, however it can utilize a property sized dry quencher/scrubber system.

[0022] Piece #6 is an oxygen system implemented to supply the oxidant to the process chamber and/or gas heating oxidation chamber. The oxidant may be in the form of oxygen, water, or other highly oxygen rich material.

[0023] The final subsystem of the waste processing system, piece #7, is the control system. The actual control code shall remain a confidential and proprietary design; however, it shall be based upon the inputs and outputs to the various thermocouples, solenoids, control valves, and other instrumentation installed in the system. An algorithm is utilized to force the waste destruction down a predetermined gasification and combustion path with minor adjustments being accomplished by the data received from process instrumentation. System shall operate at about the stoichiometric amount of oxygen required to achieve complete combustion of all gasses. This is based on pressures, flows, heat, compositions, gas quality In the form of pressure sensors, flow meters, thermocouples, and detection instrumentation that reads the status of the off-gas and adjusts the oxygen and heat that provides minor adjustments and safety interlocks to effect the complete combustion of the gaseous stream.

[0024] The above-described waste processing system in accordance with the preferred embodiment of the invention overcomes a number of disadvantages of the known waste treating systems with respect to the complete and safe processing of medical and other waste materials. More particularly, the waste processing system is able to process a wide variety of hazardous and non-hazardous, inorganic and organic, medical waste components, containing varying amounts of moisture, and simultaneously comply with applicable air and water emission standards. The process chamber and gas heater maintain a constant high temperature output to produce an end product gas containing minimal hazardous organic molecules. Residues in the process chamber have been subject to high temperatures to completely sterilize the materials. The apparatus solves a security or sensitivity concern because it can be placed under the direct control of the owner and at the owner's secured or sensitive site location so as to restrict total access to the waste treatment system. Since it is easily transportable, it can be placed at a remote located Doctor's office, clinic, or police department to eliminate courier needs and security concerns. This system solves the carbon carryover issue with correct amount of oxygen addition, solves the hazardous emissions issue with the correct application of heat and cooling, solves excess oxygen generation by requiring only the proper amount to effect complete combustion and allows for complete control, even stoppage if desired, of the gasification and combustion process through the adjustment of the added heat and oxidant to the process. Further, the apparatus and method of the present invention are not limited to the safe disposal of hospital, medical and related toxic and hazardous waste but are also effective for use in the safe disposal of chemical toxins and the like.

[0025] It is understood by those skilled in the art that the waste processing apparatus in accordance with the invention is suitable for treating waste materials other than medical waste. For example, the waste may be paper waste, water waste, chemical waste, drug materials and the like. For such type wastes, the apparatus may be modified to eliminate or add various components to the system which herein is described as the preferred method for treating small batches of medical waste type materials.

[0026] The foregoing description of the preferred embodiment of the invention has been presented to illustrate the principles of the invention and not to limit the invention to the particular embodiment illustrated. It is intended that the scope of the invention be defined by all of the embodiments encompass within the following claims, and their equivalents.

What is claimed is:
1. An apparatus for treating medical, hazardous, and non-hazardous wastes consisting of inorganic and organic components, comprising:
A heated processing chamber with replaceable lining;
A high temperature oxidation chamber to convert organic gaseous and solid components to inert gases;
Means of removing gas from previous chambers as an off-gas;
2. The apparatus of claim 1, whereas thermal insulation of chambers is added for effective dissociation and prevention of complex organic reformation;
3. The apparatus of claim 1, whereas oxidant is injected into the process chambers for carbon conversion to carbon monoxide and carbon dioxide;
4. The apparatus of claim 1, whereas there is a means to monitor the amount of carbon in the off-gas through use of process instrumentation.
5. The apparatus of claim 1 that provides a means responsive to monitoring and controlling the amount of oxidant injection.
6. The apparatus of claim 1, whereas the off-gas is rapidly quenched to prevent undesirable organic reformation and limit the amount of carbon particulate.
7. The apparatus of claim 1, wherein oxygen is generated to control flow into and out of the processing chamber and the high temperature chamber.
8. The apparatus of claim 1, wherein sensors control the timing and rate of oxygen injection to achieve complete oxidation without significant excess oxygen carryover.
9. The apparatus of claim 1, whereas there is an adjustable algorithm to control gasification and control process thus impacting gas flow.
10. The apparatus of claim 1, wherein the off-gas and oxidant are turbulently mixed to achieve complete reaction.
11. The apparatus of claim 1, wherein the process is monitored and controlled to assure equipment and process stability.
12. A method for treating medical, hazardous, and non-hazardous wastes consisting of inorganic and organic components, comprising the steps of:
Providing a waste processing chamber for waste loading
Heating the processing chamber to remove all organic materials
Heating off-gas to a high temperature for complete oxidation in a controlled environment to prevent reformation of complex organic compounds.
Oxygen injection to effect complete conversion of carbon and hydrogen into inert gas and water.
Rapid off-gas cooling to prevent reformation of complex organic compounds

13. Method of claim 12 wherein carbon content is monitored in the off-gas with use of process monitoring sensors.

14. The method of claim 12 wherein oxidant is generated and injected into each of the processing chambers through a controlled valve arrangement.
15. Method of claim 12 further comprising the steps of mixing the off-gas and oxidant in a turbulent area for an amount of time effective to achieve conversion of the organic materials into inert gasses such as carbon dioxide and water.
16. The method of claim 12 wherein a vacuum pressure is maintained in the chambers.
17. Method of claim 12 wherein temperature, flow, pressure, and carbon sensors are utilized to control gas generation rates, compositions, and chemical conditions.