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NOTICE OF ENTITLEMENT

We, ENVIROTRUST TECHNOLOGIES INC. of 10 Toronto Street, Toronto, Ontario, Canada M5C 2B7 being the applicant and nominated person in respect of Application No. 27841/92, state the following:-

The person nominated for the grant of the patent: has entitlement from the actual inventor Dr Erik Schmidt

by virtue of the following:

The said inventor assigned his rights in the invention to ENVIROTRUST TECHNOLOGIES INC.

The person nominated for the grant of the patent: has entitlement from the applicant of the application listed in the declaration under Article 8 of the PCT.

The basic application listed in the declaration made under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

ENVIROTRUST TECHNOLOGIES INC.
By his Patent Attorneys
CULLEN & CO.

RONALD A. HALIDAY

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(71) Applicant(s)
ENVIROTRUST TECHNOLOGIES INC.

(72) Inventor(s)
ERICK SCHMIDT

(74) Attorney or Agent
CULLEN & CO , GPO Box 1074, BRISBANE QLD 4001

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(57) Claim

Abstract

1. A method of processing waste material containing pathogenic microorganisms comprising:

granulating said waste material;

treating said granulated waste material by heating at a temperature of ~~about~~ 160 to about 200°C at a pressure of ~~about~~ 90 to about 226 psi in an atmosphere comprising solute at a concentration which differs from that known to occur in the pathogenic microorganisms, the atmosphere being generated from a liquid salt solution comprising solvent and solute, for a period of time sufficient to substantially reduce or totally eliminate the amount of pathogenic microorganisms in said material; and

separating said treated waste material from any liquid phase that may be present.

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(71) Applicant: ENVIROTRUST TECHNOLOGIES INC. [CA/CA]; 10 Toronto Street, Toronto, Ontario M5C 2B7 (CA).

(72) Inventor: SCHMIDT, Erick ; 12345-121 Street, Edmonton, Alberta T5G 2Z4 (US).

(74) Agent: ERRATT, Judy, A.; Gowling, Strathy & Henderson, 160 Elgin Street, Ottawa, Ontario K1N 8S3 (CA).

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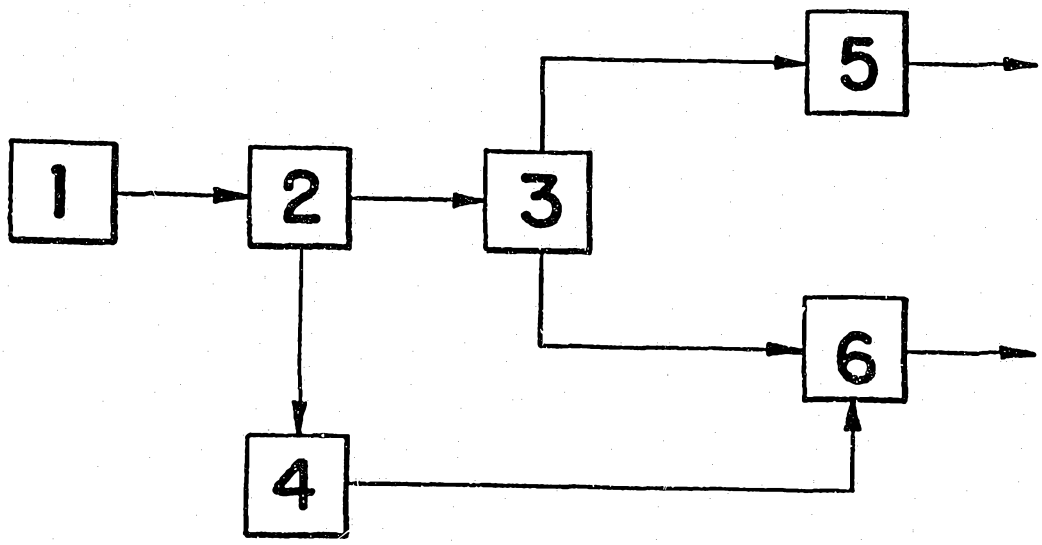

(57) Abstract

Waste materials containing pathogenic microorganisms may be processed by a method comprising granulating the waste material; treating the granulated waste material by heating at a temperature of about 160 to about 200 °C at a pressure of about 90 to about 226 psi in an atmosphere of the steam from a non-isotonic salt solution. The treatment is conducted for a period of time sufficient to substantially reduce the amount of pathogenic microorganisms present in the waste material. After treatment, the material is separated into useful solid and liquid phases.

METHODS FOR TREATING INFECTIOUS WASTES

Field of the Invention

The present invention is directed to methods for the treatment of biomedical and other infectious wastes. More specifically, the present invention is directed to methods for processing wastes containing pathogenic microorganisms to substantially reduce or eliminate the amount of pathogens present therein and to generate safer, industrially useful products.

Background of the Invention

Various methods for treating or processing waste containing infectious material, i.e., waste containing various pathogenic microorganisms, are known in the art, and various technologies have been tested in attempts to effectively sterilize such wastes. However, the known, conventional processes have inherent disadvantages which limit their use.

The currently most widely used method of sterilizing or treating infectious wastes utilize thermal degradation as the primary treatment mechanism. The elevated temperatures used in these processes are generally achieved through dry air, steam or flame in order to sterilize infectious microorganisms by partial molecular degradation at lower temperatures or total molecular destruction at high temperatures.

An example of this type of method is the autoclave, which uses a combination of vacuum and pressurized steam to treat clinical products, such as instruments and containers, as well as to decontaminate post-patient care materials prior to disposal. The limitations of such sterilization systems include the possible escape of aerosolized and liquid borne pathogens through the drain and exhaust ports of the system; the incomplete sterilization of materials containing pathogens resistant to the temperatures used; possible inadequate steam penetration to the center of the waste load; and the continuing requirement of storing, transporting and disposing the treated material, generally utilizing further incineration or landfills. Thus, this technology creates a secondary environmental problem relating to the disposal of the treated waste and is not designed to create any useful by-products from the treated materials.

Another conventional process utilizing thermal technology is incineration, which is presently the most commonly used infectious waste treatment method in the world. However, this technology is now coming under severe environmental criticism, and is subject to strict regulatory standards. In many instances, incineration is being banned entirely because of the likelihood that hazardous products are generated thereby. Thus, new guidelines regarding incineration involve higher standards relating to emissions, such as hydrogen chloride and carbon monoxide, and new requirements relating to dioxins and furans produced from burning complex plastic materials, such as polyesters. In order to comply with these standards, conventional incineration technology must be re-designed significantly, making these treatment methods economically unfeasible. The problems resulting from potential toxic emissions from incineration processes are an additional limitation to the traditional problems of intermediate storage and transport associated with this process, as well as the disposal of the residual ash in landfills.

A third conventional method of treating infectious waste which employs thermal technology comprises heating the waste in large scale microwave systems. Microwave systems are particularly effective for

sterilizing water-based tissue and materials which allow the absorption of microwave frequencies. However, microwave systems have been found to be ineffective for achieving thermal sterilization of dry matter. Moreover, microwave methods do not penetrate materials shielded by metallic enclosures, such as needles, syringes, etc. Such processes are also expensive for large volume treatment and produce disinfected waste which requires further disposal, with its accompanying costs and problems.

Waste treatment processes employing the use of chemicals are also known and used in the art. In general, there are two major chemical methodologies utilized in waste treatment systems, utilizing both gas and liquid mechanisms. An example of a gaseous system comprises contacting the waste load with an appropriate amount of a gaseous chemical agent such as ethylene oxide, formaldehyde, peracetic acid and beta-propyl acetone in an appropriate treatment vessel, such as an atmospheric chamber. Ethylene oxide gas is widely used in the sterilization of thermolabile materials, which would otherwise be damaged by exposure to heat and moisture. However, these treatment processes have fallen into disfavor since the chemicals used are considered to be probable human carcinogens and require extreme care and containment during use. These materials also remain

hazardous after treatment and require special detoxification procedures so that their concentration in the treatment area meets safety standards.

Waste treatment methodology employing liquid chemicals comprises the use of chlorine which is a very strong oxidizing agent and reacts in water to form hypochlorite ions. An example of a treatment methodology employing liquid chlorine comprises granulating the waste material and then subjecting the granulated particles to a chlorine spray or bath treatment. The chlorine treatment disinfects the granulated waste material by oxidizing the pathogens. However, such systems have limitations relating to the drying and final disposal of the chlorinated disinfected wastes, the safe disposal of the residual chlorinated treatment solution and the comprehensiveness of the exposure and subsequent inactivation of all pathogens embedded in the waste mass.

More recent, emerging infectious waste treatment processes employ advanced technologies originating from the fields of electronics and physics. Such processes achieve the destruction of infectious microorganisms within the waste by bombarding the waste load with electron beams or electromagnetic radiation. Examples of

such methodology presently in use employ gamma radiation, electron beam radiation and ultraviolet radiation to destroy the pathogens present in the waste load.

For example, gamma irradiation systems utilize powerful radiation originating from radioactive sources such as Cobalt-60 and Cesium-137. Such systems are primarily used for the sterilization of medical supplies and food. However, recent high power gamma irradiation systems have been designed to treat large volumes of infectious waste materials in continuous conveyorized facilities. The disadvantages of such systems include the obvious hazards to personnel which require extra safety measures, such as shielding of the radiation units, which ultimately decreases the cost efficiency of these methods. Moreover, the effectiveness of such processes are dependent on the continual adjustment of exposure durations in order to accommodate for the continuous decay of the radioactive material. A more serious problem of these systems relates to the disposal of the spent radiation sources and the treated waste due to the existence of trace radioactivity therein.

Another treatment comprises subjecting the waste material to electron beam radiation utilizing electron energies exceeding 10^7 electron volts. Commercial linear accelerators are used extensively for the small scale

sterilization of surgical bandages and other disposable medical products. However, the use of electron beam energy for the sterilization and treatment of infectious waste material requires a large scale installation with attendant problems relating to costs and occupational safety procedures. For example, the possibility of workers absorbing low level secondary x-ray radiation remains and the disposal of the treated waste requires full secondary storage, transport and final disposition. Moreover, while this method is generally effective in destroying existent pathogens, the penetration efficiency of the electron beam energies diminishes with distance, density and the presence of metallic shielding in the waste material caused by needles, syringes, etc., thus limiting the guarantee of total disinfection of the treated material.

A third type of radiation technology now being used to treat infectious waste material utilizes ultraviolet radiation. However, it has been found that in general, ultraviolet wavelengths are effective only for the surface treatment of the waste materials and therefore, are not appropriate for the processing of infectious waste materials requiring subsurface

penetration to accomplish sterilization. This characteristic limits the use of ultraviolet radiation for treating large volume mixed infectious waste.

Processes for eliminating or reducing the concentration of pathogens within waste materials to produce fertilizer materials are known in the art. For example, U.S. Patent No. 3,953,191 discloses a process for ridding cotton gin waste of detrimental pathogens and weed seeds to produce a fertilizer. This process comprises chopping or grinding the gin waste and steaming the material by the temperature of 215°F and at constant pressure of 30 psig. U.S. Patent No. 4,743,287 discloses a method of treating waste organic materials to produce a humic acid base fertilizer formulation which comprises granulating the material and then reacting the granulated material with water, acid and a base. A temperature of about 110 to 280°F and a pressure of up to 30 psi is maintained in the reaction vessel. Also, U.S. Patent No. 5,021,077 discloses a method of preparing natural nitrogenous particles useful as plant food by granulating waste material and then heating the material at a temperature of about 50 to 100°C. However, this patent discloses that heating at temperatures higher than 100°C disadvantageously causes the denaturing of proteins in the

material. In contrast to the present method, none of these processes are directed to the treatment of infectious waste.

Accordingly, there is a need for a method for treating infectious waste material to substantially reduce or eliminate the concentration of pathogens therein, which is safe, effective, economical and which produces useful products.

Summary of the Invention

The present invention has as its objective to provide a method for effectively treating infectious waste material to substantially reduce the concentration of pathogens therein and which results in the provision of useful products. According to the present invention, waste material containing pathogenic microorganisms is processed by a method comprising: granulating the waste material; treating the granulated waste material by heating at a temperature of about 160 to about 200°C, at a pressure of about 90 to about 226 psi in a non-isotonic atmosphere. The granulated waste material is treated for a period of time sufficient to substantially reduce or eliminate the concentration of pathogenic microorganisms in the waste material. After treatment, the treated material is separated into solid and liquid phases. The

present invention also encompasses useful liquid fertilizers and industrial composite materials which are products of the present method.

Brief Description of the Drawings

Fig. 1 shows the main steps of the process according to the present invention in diagramatic form.

Detailed Description of the Invention

The present invention is directed to a method for processing and disinfecting waste containing pathogenic microorganisms. More specifically, the present invention is directed to a method for treating infectious waste materials which contain pathogens, such as those found in hospitals, veterinary facilities, and the like, so as to substantially reduce or totally eliminate the amount of pathogenic microorganisms present therein. By "substantially reduce" it is meant that the concentration of the pathogens is reduced to non-detectable levels using conventional assay methods. In many cases, the pathogens are entirely eliminated from the waste. The thus treated material may then be further processed into useful materials, such as liquid fertilizers, industrially useful composite feedstock material, etc.

The pathogenic microorganisms treatable with the present method appear to be unlimited and include all known human pathogenic microorganisms, generally including viruses, bacteria, fungi, protozoa, etc. Specific examples of pathogens which may be treated with the present method include, but are not limited to: Brucellosis spp., Campylobacter spp., Clostridium spp., diphtheria, Haemophilus spp., Listeria spp., Meningococcus spp., Bordetella spp., Pneumococcus spp., Salmonella spp., Shigella spp., E. Coli spp., Yersinia spp., hepatitis A virus, hepatitis B virus, hepatitis C virus, hepatitis D virus, human immunodeficiency virus (HIV), measles virus, mumps virus, rubella virus, varicella-zoster virus, cytomegalovirus, Epstein-Barr virus, herpes simplex virus type 1, herpes simplex virus type 2, human herpes virus type 6.

Although not wishing to be limited to any particular theory, it is believed that the present method substantially reduces or totally eliminates the pathogenic microorganisms present in the waste material through the specific combination of temperature, pressure and atmosphere used. That is, it is believed that the treatment of the waste material at high temperatures and pressures in the presence of a non-isotonic atmosphere denatures the pathogenic microorganisms by altering their

molecular structure so that their outer protective covering is either broken open or altered through osmotic shock and/or biochemical reaction. This acts to either functionally disintegrate the microorganisms and/or structurally alter the genetic information within the microorganisms, so that further multiplication of the pathogens cannot occur. Thus, the original pathogenic entities are broken down to discrete chemical elements, consequently losing their infectious character.

The process for treating infectious waste according to the present invention can best be described with reference to Fig. 1. The main steps of the present process comprises granulating the waste material 1; treating the granulated waste material by heating at a temperature of 160-200°C at a pressure of about 90-226 psi in a non-isotonic atmosphere 2; and separating the treated material into solid and liquid phases 3.

In accordance with the present method, the waste material is first mechanically prepared for treatment by granulating the material into particles having a particle size which will facilitate treatment of all of the material with the non-isotonic atmosphere. This is represented by step 1. The particles should be granulated to an extent sufficient to raise the effective surface area of the material to an appropriate degree to allow for

the effective processing of all portions of the material. However, generally, the waste material should be granulated into particles having a particle size of about 0.0625 to about 0.25 inches and preferably about 0.0625 to about 0.125 inches.

The granulation step may be carried out by any suitable device known and used in the art which will granulate the material into appropriate sizes. An example of such a device is a Ball and Jewell granulator manufactured by Sterling, Inc. of Milwaukee, WI. An example of a particularly preferred granulator device useful in the present process consists of knives mounted on rotors which shear the material against knives mounted on the interior walls of a cutting chamber. The size of the particles may be controlled by passing the granulated material through an appropriate base screen upon granulation. The waste material should be granulated for a time period sufficient to process the waste material into fragments and particles of the desired size.

After the granulation step, the granulated waste material is treated by heating at elevated temperatures under high pressures in a non-isotonic atmosphere for a suitable period of time. Such treatment of the granulated waste material may be conducted in a suitable pressure vessel. Appropriate pressure vessels should be prepared

in accordance with ASME standards based upon their size and the amount of pressure to be reached in the process. This is represented by step 2 in Fig. 1. Specifically, the granulated waste material is heated at a temperature of about 160 to about 200°C at a pressure of about 90 to about 226 psi in a non-isotonic atmosphere. This treatment is continued for a period of time sufficient to substantially reduce or totally eliminate the amount of pathogenic microorganisms present in the material to non-detectable levels as determined by conventional assay technology, such as the Infectious Unit Assay method.

The treatment of the granulated waste material includes subjecting the material to temperatures which are sufficiently high to inactivate or destroy pathogenic microorganisms present therein. Generally, it has been found that heating the material at a temperature of about 160 to about 200°C will accomplish this objective. Heating the waste material at this temperature is also advantageous as it is below levels at which dioxins and other toxic chemicals may be produced from the waste. Preferably, the material is heated at a temperature of about 170 to about 180°C. The heat can be supplied to the reaction chamber by any appropriate means evident to one skilled in the art. However, an example of an appropriate

heat generating device is a heater band such as that manufactured by Fast Heat Element Manufacturing Co., Inc. of Elmhurst, IL.

The treatment of the waste material in accordance with the present method must take place at a pressure which is elevated to a sufficient degree to ensure the destruction of the outer covering of pathogens present in the material. Generally, it has been found that treating the waste material at a pressure of about 90 to about 226 psi will accomplish the stated objective. Preferably the waste material should be treated at a pressure of about 115 to about 146 psi.

In accordance with the present process, the treatment of the granulated waste material at the temperatures and pressures stated above takes place in a non-isotonic atmosphere. That is, the atmosphere in which the waste is treated has a solute concentration which differs from that knoiwn to occur within the microorganisms in the waste. This makes the pressure on one side of the cell membrane different from that on the other side creating a pressure differential across the cell membrane. The non-isotonicity of the atmosphere further aids in destroying or altering the protective outer covering of pathogenic microorganisms present in the waste. To accomplish this result, the atmosphere may be

either hypertonic or hypotonic with respect to the organisms being treated, but in any event must be non-isotonic with respect thereto.

The atmosphere must be non-isotonic with reference to the microorganisms being treated. The tonicity of the atmosphere is believed to be an important factor in the destruction or alteration of the integrity and infectious nature of the pathogenic microorganisms which require a zero pressure differential across the cell wall membrane to maintain their integrity.

The non-isotonic atmosphere may be generated in any suitable manner evident to one skilled in the art based upon the present disclosure and is not limited. However, it is preferable that the non-isotonic atmosphere comprise the steam from a non-isotonic salt solution. When employing the steam from a non-isotonic salt solution, the atmosphere may be generated, e.g., by loading a hypertonic salt/water solution onto the base of the treatment vessel prior to heating. Once heating is begun within the vessel, the salt/water solution will evaporate causing steam from the salt solution to form. The steam will also be hypertonic, thus providing a non-isotonic atmosphere (i.e., specifically hypertonic) within the reaction vessel.

An alternative method of generating the non-isotonic atmosphere in accordance with the present method utilizes an external high pressure steam generator loaded with a non-isotonic salt solution attached to the treatment vessel. Examples of appropriate steam generators useful in the present method are, e.g., those manufactured by Foster-Wheeler, Inc. of Perryville, NJ. The steam generator injects the treatment vessel with preheated steam arising from the non-isotonic salt solution thus providing the necessary atmosphere. This alternative has advantages in that the steam may be injected at appropriate pressures and temperatures to aid in achieving and maintaining the desired pressures and temperatures within the vessel as discussed above.

The non-isotonic salt solution which is used to form the non-isotonic atmosphere within the treatment vessel in accordance with the above methods may be prepared from any salt which can provide an atmosphere, which is non-isotonic with respect to the pathogenic microorganisms present in the waste. For example, potassium chloride may be used to form the non-isotonic atmosphere. Other salts which are also believed to be effective as a component of the non-isotonic salt solution to produce the non-isotonic atmosphere include the chloride, sulfate, phosphate, nitrate and carbonate salts

of potassium, sodium, ammonium, magnesium and calcium. However, it is preferred that potassium chloride, or another salt having plant nutrient properties be used.

The non-isotonic salt solution should contain about 20 to about 30 weight % and preferably, about 25 weight % of the salt. Solutions should be provided which will provide an atmosphere having about 1 to about 7% and preferably about 5%, of the salt. The non-isotonic salt solution may be prepared by any standard procedure which will be evident to one skilled in the art.

In order to insure maximum penetration of the granulated waste material by the non-isotonic atmosphere, it is preferred that the infectious waste material be constantly agitated during the entire treatment period. The agitation of the material may be effected by any appropriate mechanical device evident to one skilled in the art from the present disclosure and is not limited. Examples of appropriate agitation devices are those manufactured by Vibration Products Inc. of Wyoming, RI.

The granulated material is treated for a period of time sufficient to substantially reduce (i.e., non-detectable levels) or totally eliminate the pathogenic microorganisms within the material. The duration of treatment may vary dependent upon the make-up of the material being treated, particularly the amount of

pathogens contained therein and the amount of material being treated. Appropriate treatment durations for specific samples will be evident to one skilled in the art from the present disclosure. However, it is believed that generally, treatment for a time period of about 20 to about 60 minutes, and preferably about 30 minutes, would be sufficient to disinfect a 500 lb. or greater load of waste material and achieve the objectives of the present method.

At the end of the treatment period, the treatment vessel is depressurized. At this time, any accumulated liquids in the treatment vessel may be pumped into a holding tank while the main treatment chamber is opened to allow for the removal of the disinfected, treated waste material. This is represented by step 4 in Fig. 1. These accumulated liquids may be retained for mixture with additional liquids arising from the material due to the further treatment discussed below or may be directly processed as a liquid fertilizer or a component thereof.

As the treatment vessel is depressurized, steam may be generated from the treated material and the treatment system. In order to capture and utilize this steam, a condenser may be attached to the treatment vessel at an appropriate location. The condenser acts to convert

the steam to liquid which may then be pumped into the holding tank discussed above and mixed with other liquids arising from the process. As the condensed steam generally contains at least the salt used to form the non-isotonic atmosphere, it is useful in the liquid fertilizer formed by the present method.

The treated waste material is then further processed to effect the separation of the material into solid and liquid phases. This is represented by step 3 in Fig. 1. This separation may be carried out by various suitable devices as will be evident to one skilled in the art from the present disclosure. For example, conventional centrifuge devices may be used to effectively separate the treated material into solid and liquid phases. Examples of appropriate centrifuges are those manufactured by Bird Machine of South Walpole, MA. This treatment separates the treated material into a solid phase comprising the disinfected solid waste material and a liquid phase generally comprising condensation from the salt-steam atmosphere and an aqueous phase from the waste material comprising highly concentrated organic, inorganic and mineral elements.

The liquid phase may then be removed and combined with the accumulated liquid from the treatment vessel previously removed and discussed above. The

combination of the residual liquids may be performed in an appropriate vessel, such as a blender, as will be recognized to one skilled in the art. This is represented by step 6 in Fig. 1. The resulting liquid blend contains a number of valuable plant nutrients, such as the electrolytic component from the non-isotonic atmosphere and/or any residual non-isotonic salt solution and therefore, is useful for direct application to the soil as a liquid fertilizer. The liquid fertilizer thus produced may be used directly in concentrations correlated to a specific fertilizer analysis, or may be blended with other commercial water soluble chemical fertilizers to achieve a target NPK combination liquid fertilizer.

The remaining solid phase may then be safely discarded or further processed. If the material is to be discarded, it can be done so safely without further treatment. The treated solid phase is environmentally safe and non-toxic and thus, may be discarded with conventional waste.

If the solid phase is to be used as an industrially functional composite feedstock product, it may first be dehydrated in order to remove any remaining moisture present therein. The dehydration is represented as step 5 in Fig. 1. Generally, the material should be dehydrated to a moisture content of no more than 10%,

although the final moisture content will vary with the ultimate use of the material. The solid phase may be dehydrated in conventional dehydrators or extruders as would be evident to one skilled in the art from the present disclosure. If the solid material is to be dehydrated, it is generally appropriate to attach a scrubber to the dehydration unit in order to remove any odorous organic materials contained therein.

Once dehydrated, the solid material may then be utilized as industrial composite feedstock and processed into any of various articles of manufacture by known extrusion techniques. This solid phase will generally contain variable percentages of polymeric materials, paper, glass, etc., dependent upon the profile of the original waste being treated. Preferably, the dehydrated solid phase material is treated in accordance with Applicant's methods for preparing composite materials which is the subject matter of copending U.S. Patent Application Serial No. 07/727,176.

Infectious or biomedical waste materials which may be processed with the present method are generally any waste material containing pathogenic microorganisms, such as wastes originating from medical, veterinarian, laboratory and transportation sources which are classified by regulatory bodies as "infectious". The waste material

containing pathogenic microorganisms may include mixtures of all types of common waste including plastics, paper, metal, glass, etc. Examples of the type of material contained in the waste created by the present process include plastic and composite paper packaging; plastic and glass tubes; syringes and utensils; aluminum packaging components; hypodermic needles; paper stationery; fabric materials; bedding textiles and fibers; absorbency products (such as diapers and sanitary napkins); disposable paper; composite drapery; bandages; rubber gloves, tubes and other polymeric materials; surplus medical liquids and organic tissue; residual metal fragments from packaging; waste from diagnostic and surgical procedures and cultures; stocks of infectious agents, etc. Generally, the only materials which are presently believed to be unsuitable for treatment with the present method are radioactive and toxic chemicals whose admixture to the waste material to be treated would result in product materials exceeding regulatory safety standards.

The waste material may be treated directly with the present method without the need for presorting. Thus, the present method can be used to treat materials which are specifically packaged in accordance with regulatory guidelines, such as in the form of prescribed coded boxes

and plastic pouches, without separation of the packaging from its contents. This provides a unique advantage over conventional methods of treating infectious waste-containing material.

Although the apparatus used to carry out the present process may vary and different appropriate configurations thereof will be evident to one skilled in the art from the present disclosure, it is preferred that the granulator device and treatment vessel be maintained within the same sealed system. That is, the granulator device is preferably maintained inside a sealed vessel designed to insulate the infectious material and associated airborne particles so that no contamination of the external environment can occur. To accomplish this objective, the sealed granulator device should be designed as a subsystem of the total treatment system. Thus, following granulation, the sized particles are transferred to the treatment stage within the same vessel. The entire vessel may thus remain sealed and pressurized during granulation and treatment to ensure disinfection prior to opening the system to reload subsequent batches of waste material therein.

The present invention will now be illustrated with reference to the following specific non-limiting examples.

Examples

The following examples illustrate the method of the present invention and its efficacy in substantially reducing or totally eliminating the amount of pathogenic microorganisms present in infectious waste material. Each of the examples used the following apparatus.

An apparatus was provided which comprised, as a reaction chamber, a custom pressure vessel designed in accordance with ASME requirements, specifically ASME Boilers and Pressure Vessels Code Section VIII, and which was tested to a maximum pressure of 1200 psi. The reaction chamber was prepared from a stainless steel cylinder having a 1/2 inch thick wall and a 3.5 inch internal diameter. The cylinder was 10 inches high.

The reaction chamber further comprised a lid which was also prepared from 1/2 inch stainless steel. The lid was attached to the body of the reaction chamber with eight pressure bolts. A tetrafluoroethylene (TFE) O-ring served as a pressure seal between the lid and the chamber. A heater band manufactured by Fast Heat Element Manufacturing Co., Inc. of Elmhurst, IL was attached to the base of the pressure vessel and electrical power was continuously supplied to the heater band.

A pressure gauge was mounted on the lid to allow the continuous monitoring of the pressure within the chamber. A thermocouple was mounted on the lid of the chamber and served as a means of monitoring the temperature within the chamber and also as a controller for the electrical power required to maintain a constant temperature within the chamber. A pressure relief valve was also provided on the lid of the chamber to guard against the accidental over-pressuring of the reaction chamber.

The reaction chamber further comprised a loading basket to hold the test samples. The basket was made from stainless steel screen having a mesh opening of 1/16 inch. The basket had a diameter of 3.5 inches and was 4 inches in height. The basket was attached to a steel ring allowing it to be maintained at the top of the chamber.

Example 1

Example 1 illustrates the efficacy of the present method in inactivating certain representative bacteria, specifically Bacillus Stearothermophilus and Mycobacteria tuberculosis. These pathogens were chosen due to their high resistance to most conventional decontamination and sterilization procedures. Moreover,

it is believed that conditions known to inactivate or destroy these pathogens should also inactivate or render inoccuous virtually all other known pathogens.

Samples B1 to B6 employed a test procedure required by the Canadian Standards (CAN 3-Z314.3-M79) as a sterility test for all steam sterilization processes. According to this procedure, a standard concentration of Bacillus stearothermophilus is contained in nutrient media-based solution in sealed glass or plastic containers. These standard samples contain approximately 1.2×10^5 c.f.u./ml of bacillus. The test vials containing the bacillis were manufactured by Medical Laboratory Systems, 3M Co., MN. Following incubation at 370°C for 72 hours, the color change of the nutrient media based solution from purple to any other color indicates the inactivation of the bacilli present in the invention.

In Samples M1 to M6, Myrobacteria was cultured to a concentration of >1000 col./ml in Middlebrook media solution. The cultured solutions were placed in glass Bijou bottles and treated with the present process. After treatment, the samples were tested for the presence of Mycobacteria by a culture test as set forth in the Manual of Clinical Microbiology, Ballows A. et al., American

Society of Microbiology, Chapter 34 (1991). All samples (B1 to B6 and M1 to M6) were treated in the manner set forth below.

The reaction chamber was first thoroughly cleaned and rinsed with deionized water. The vials containing the pathogens (i.e., Samples B1-B6 and M1-M6) were then placed separately in the treatment apparatus described above. The vials were placed in either the loading basket or on the bottom of the reaction chamber as indicated in Tables I and II. Then, 50cc of a 25% potassium chloride solution in water was poured onto the bottom of the reaction chamber. The chamber was then heated to a temperature of 160°C and the pressure within the chamber was maintained at 90 psi. This treatment was conducted for 20 minutes. After 20 minutes, the chamber and its contents were allowed to cool to room temperature and the chamber was depressurized. After treatment, Samples B1-B6 were observed for color change and then were incubated at 37°C for 72 hours and observed for color change again. After treatment, Samples M1 to M6 were incubated at 37°C for 21 days. Cultures of each sample were taken after the 21 day period and the concentration of Mycobateria was determined. The results are set forth in Tables I and II below.

Table I

Sample	B1	B2	B3	B4	B5	B6
Container Type	Glass	Glass	Plastic	Plastic	Glass	Glass
Initial Color and Turbidity	Clear Purple	Clear Purple	Clear Purple	Clear Purple	Clear Purple	Clear Purple
Location in Chamber	Basket	Bottom	Basket	Bottom	Basket	Bottom
Color and Turbidity After Treatment	Clear Brown	Hazy Brown	Clear Brown	Hazy Brown	Clear Brown	Hazy Brown
Color and Turbidity After Incubation for 72 hours at 37°C	Clear Brown	Hazy Brown	Clear Brown	Hazy Brown	Clear Brown	Hazy Brown

Table II

Sample	Control	M1	M2	M3	Control	M4	M5	M6
Location in Chamber	Basket	Basket	Basket	Basket	Bottom	Bottom	Bottom	Bottom
Initial Concentration (colonies/ml)	0	>1000	>1000	>1000	0	>1000	>1000	>1000
Concentration After Treatment	0	0	0	0	0	0	0	0

From the results set forth in Tables I and II, it can be seen that treatment of the samples containing both the Bacillus and those containing the Mycobacterium with the present method resulted in the destruction of the pathogens to non-detectable levels. The effectiveness of the present method is clearly evident for the Bacillus and both Mycobacteria species.

Example 2

Example 2 sets forth an actual working example of the present process. The reaction chamber of the treatment apparatus was first thoroughly cleaned and rinsed with deionized water. Then, 50cc of a 25% potassium chloride solution in deionized water was poured onto the bottom of the reaction chamber.

The base material specified in each of samples P1 to P9 set forth in Table III was pre-granulated to a particle size of 0.25 inches in a Ball and Jewel granulator manufactured by Sterling Inc. of Milkwaukee, WI. Standard stock solutions of Polio Virus in phosphate buffer saline solution were analyzed in order to determine the concentration (in plaque forming units per milliliter) of Polio Virus present in the solutions. The granulated base material was then innoculated with an amount of the Polio Virus solution appropriate to provide the

concentration (pre-treatment) as indicated in Table III. Excess liquid was drained from the granulated base material and the wet, innoculated base material was then placed in the reaction chamber. The material was placed either in the loading basket or on the bottom of the chamber as indicated.

The reaction chamber was then sealed and heated to a temperature of 160°C and maintained at a pressure of 90 psi. During the entire treatment period, the temperature was maintained within 1°C and the pressure was maintained within 1 psi. The examples were treated in this manner for 20 minutes.

At the end of 20 minutes, the chamber and the material were allowed to cool to room temperature and the vessel was depressurized. Once cooled, existent residual liquid and the treated solid material were removed from the reaction chamber and separated. The solid material was then washed in a minimal amount of phosphate buffer solution. The washed solution was then combined with the residual liquid earlier removed.

The combined liquid from each sample was then tested by the standard Infectious Unit Assay procedure which is a standard test for viruses of this type. The full procedure is set forth in detail in the Manual of

Basic Virological Techniques, G.C. Rovozo and C.M. Burke, Prentice-Hall, pp. 64-93 (1973). The results are set forth in Table III.

Table III

Sample	P1*	P2	P3	P4	P5	P6	P7	P8	P9
Initial Conc. PFU/ml	10^7	10^6	10^8	10^8	10^9	10^9	10^8	10^8	10^7
Base Material		20g Mixture of Metal/ Plastic/ Paper**	10g Mixture of Newspaper and Fiber	10g Mixture of Newspaper and Fiber	10g Mixture of Newspaper and Fiber	20g Cloth	20g Cloth	Syringes	Syringe
Measureable Concentration of Virus After Addition to Base Material	10^7	10^5	10^6	10^5	10^8	10^7	10^7	10^8	10^7
Concentration of Virus in Residual Liquid After Treatment	0	0	0	0	0	0	0	0	0
Concentration of Virus in Solids After Treatment	-	0	0	0	0	0	0	0	0

*Sample P1 was the control. **Tetrapak® Packaging.

As can be seen from the results set forth in Table III, treatment of the granulated waste material innoculated with the Polio Virus results in the destruction of the virus at least to non-detectable levels.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

CLAIMS

1. A method of processing waste material containing pathogenic microorganisms comprising:

granulating said waste material;

treating said granulated waste material by heating at a temperature of ~~about~~ 160 to about 200°C at a pressure of ~~about~~ 90 to about 226 psi in an atmosphere comprising solute at a concentration which differs from that known to occur in the pathogenic microorganisms, the atmosphere being generated from a liquid salt solution comprising solvent and solute, for a period of time sufficient to substantially reduce or totally eliminate the amount of pathogenic microorganisms in said material; and

separating said treated waste material from any liquid phase that may be present.

2. A method as in claim 1 wherein said atmosphere is generated from a liquid salt solution which is non-isotonic with respect to the pathogenic microorganisms.

3. A method as in claim 1, wherein said waste material is granulated into particles having a particle size of ~~about~~ 0.0625 to about 0.25 inches.

4. A method as in claim 3, wherein said waste material is granulated into particles having a particle size of ~~about~~ 0.0625 to about 0.125 inches.

5. A method as in claim 1, wherein said granulated waste material is heated at a temperature of ~~about~~ 170 to about 180°C.

6. A method as in claim 1, wherein said granulated waste material is treated at a pressure of ~~about~~ 115 to about 146 psi.

7. A method as in claim 1, wherein said material is treated for a time period of ~~about~~ 20 to about 60 minutes.

8. A method as in claim 7, wherein said material is heated for a period of ~~about~~ 30 minutes.

9. A method as in claim 2, wherein said liquid salt solution comprises a salt selected from the group consisting of chloride, sulfate, phosphate, nitrate and carbonate salts of potassium, sodium, ammonium, magnesium and calcium.

10. A method as in claim 9, wherein said salt is potassium chloride.

11. A method as in claim 2, wherein said liquid salt solution has a salt concentration of ~~about~~ 20 to about 30 weight %.

12. A method as in claim 11, wherein said liquid salt solution has a salt concentration of ~~about~~ 25 weight %.

13. A method as in claim 1, wherein said atmosphere has a solute concentration of ~~about~~ 1 to about 7%.

14. A method as in claim 13, wherein said atmosphere has a solute concentration of ~~about~~ 5%.

15. A method as in claim 1, wherein said separation of said treated material comprises centrifugation.

16. A method as in claim 1, further comprising dehydrating the separated treated waste.

17. A method as in claim 1, wherein said treated waste material is useful as an industrial composite feedstock material and said liquid phase is useful as a liquid fertilizer.

18. A method as in claim 1 wherein the liquid salt solution is an aqueous solution.

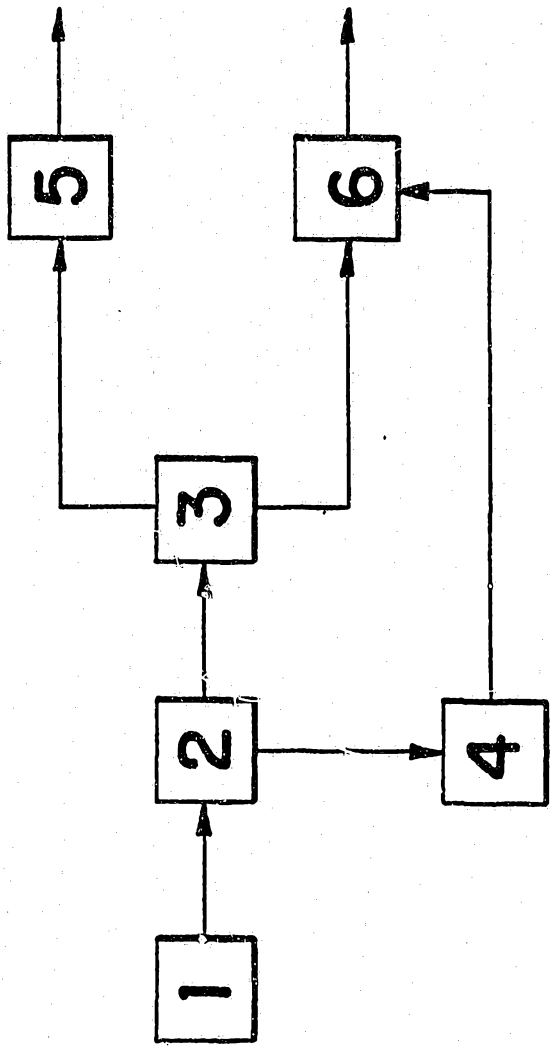

FIG. 1

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 92/00468.

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: A 61 L 11/00, C 05 F 7/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	A 61 L; C 05 F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US, A, 3953191 (BENNY M. BARTON) 27 April 1976, see column 1, line 59 - column 3, line 61	1,3-8
A		2,9-19
P,A	EP, A2, 0510277 (WINFIELD INDUSTRIES) 28 October 1992, see column 8, line 19 - line 30	17-19
A	US, A, 3976465 (JAMES M. O'DONNELL) 24 August 1976, see the whole document	1-19

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8th January 1993	20. 01. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Kerstin Boije Janson

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4743287 (ELMO C. ROBINSON) 10 May 1988, see the whole document --	1-19
A	US, A, 5021077 (WILLIAM P. MOORE) 4 June 1991, see the whole document --	1-19

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/CA 92/00468

SA 65727

This annex lists the patent fam. / members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 02/12/92
The European Patent office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 3953191	27/04/76	NONE		
EP-A2- 0510277	28/10/92	NONE		
US-A- 3976465	24/08/76	BE-A-	791085	01/03/73
		CH-A-	593878	15/12/77
		DE-A-C-	2254583	17/05/73
		FR-A-B-	2159331	22/06/73
		US-A-	3942970	09/03/76
		US-A-	4081366	28/03/78
US-A- 4743287	10/05/88	NONE		
US-A- 5021077	04/06/91	AU-B-	626510	30/07/92
		AU-D-	6922291	11/07/91
		EP-A-	0440339	07/08/91
		US-A-	4997469	05/03/91
		US-A-	5021247	04/06/91