

[54] **APPARATUS AND METHOD FOR THE PYROLYSIS OF SOLID WASTE MATERIAL**

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[58] Field of Search **110/8 B, 8 A, 11, 110/15, 18, 19**

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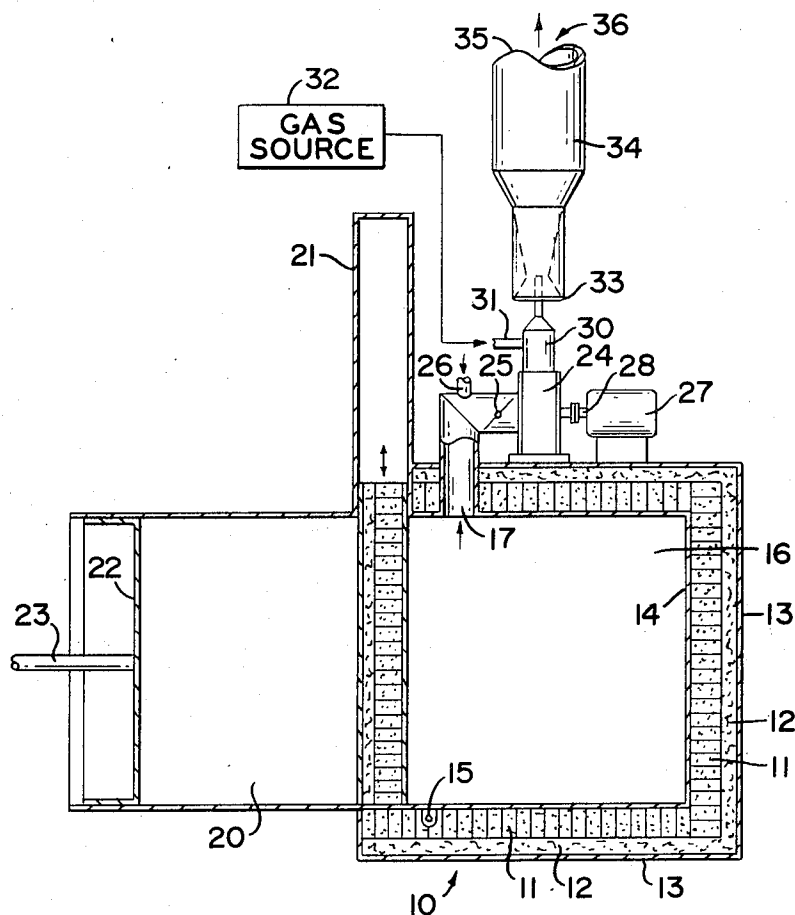
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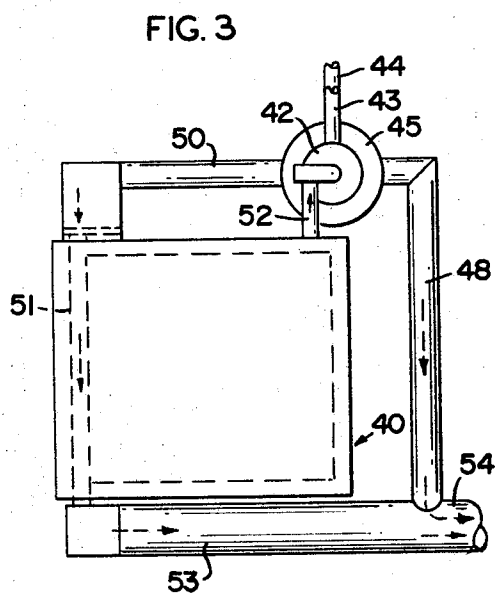
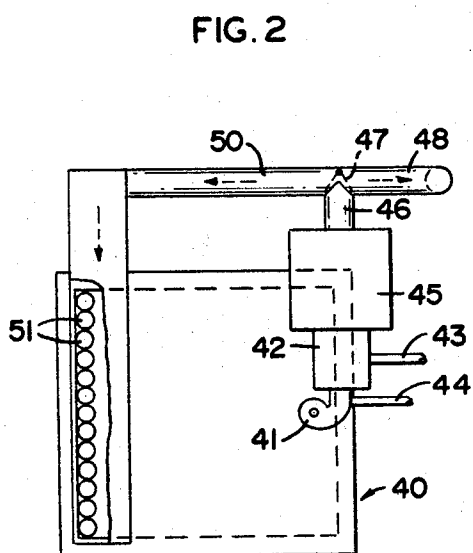
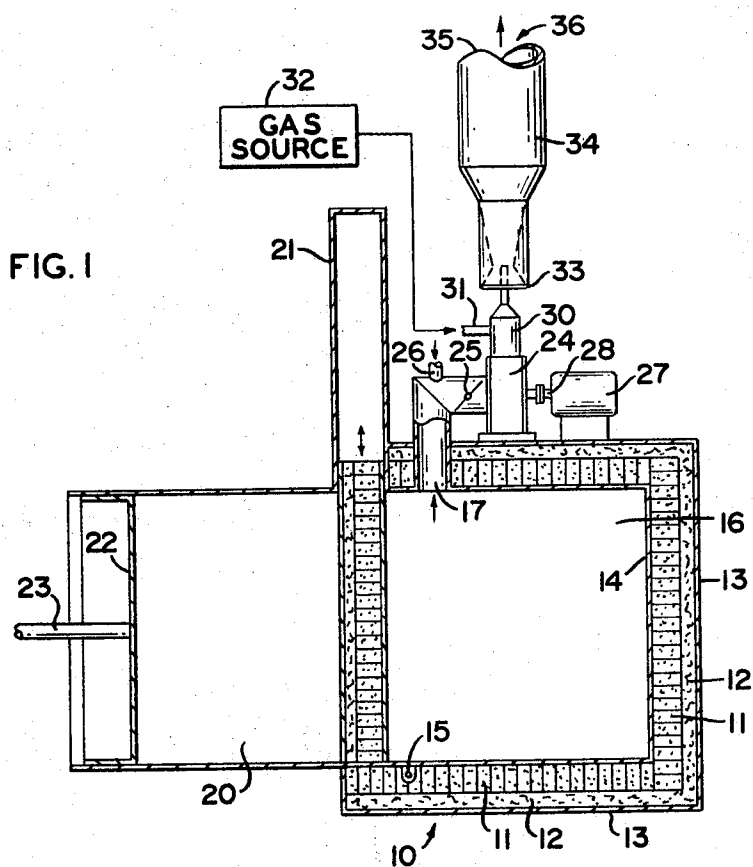
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[57] **ABSTRACT**

A method and apparatus for the disposal of solid material, utilizing a pyrolytic decomposition chamber for heating the material to its decomposition temperature in the absence of air and utilizing the vaporized material therefrom with air and a combustible gas, such as propane, in a combustion chamber for the further reduction of the vaporized material. The heat generated in the combustion chamber is utilized through a heat exchanger to transfer heat to the primary heating chamber.

9 Claims, 3 Drawing Figures





APPARATUS AND METHOD FOR THE PYROLYSIS OF SOLID WASTE MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to a treatment of solid waste utilizing pyrolysis as an intermediate step in the incineration of difficult to incinerate solid waste such as many of the plastic materials like polyethylene garments, and the like.

In the past, solid waste materials have been disposed of in a great many ways but one conventional type involves the burning of the material in incinerators where a combustion chamber has a burner therein and an inlet for charging the chamber with solid materials such as trash, of which at least a portion is combustible material that may be burned. The charging port can be of a continuous type but normally is closed by a door which is opened in order to introduce the trash material to be burned into the combustion chamber. These prior art incinerators have been unsatisfactory for many materials, such as metal cans, and the like, which do not burn and must be disposed of following incineration or separated prior to the incineration. Other materials, such as thermoplastic plastics will upon being heated become soft and sticky and difficult to dispose of in an incinerator without messing up the incinerator or in the case of certain types of plastic, will release harmful or dangerous vapors which are frequently released to the atmosphere.

In the past, pyrolytic reactions have been used in a number of chemical processes, and non-catalytic type pyrolysis may be brought about by heating the material to its decomposition temperature in the absence of air or in the absence of any other type of catalyst, and is commonly used in such chemical processes as the production of ethylene from ethane, or acetylene from butane. Other types of pyrolysis are commonly used in the catalytic cracking of petroleum. It has been suggested to utilize pyrolysis as an intermediate step in the incineration of difficult to incinerate solid wastes to convert such materials into a gaseous decomposition product and then dispose of the gases through the air. The use of pyrolysis in solid waste disposal offers many advantages which direct incineration would not provide and these include the use of low temperatures compared with the combustion temperatures involved in direct incineration along with the potential, or either recovering by-products of the further combustion of the products to produce harmless gases such as carbon dioxide and water vapor which is exhausted into the atmosphere without the pollution problems encountered by direct incineration.

To accomplish an incineration process utilizing an intermediate step of pyrolysis, a batch system is for incinerating batches of different sizes in an incinerator and is heated either directly by burners or indirectly with radiant tubes. The heating chamber is sealed to prevent oxygen infiltration and the heating of the waste material will then establish a neutral atmosphere as the process gets under way. The solid material is melted and the gaseous pyrolysis products evolved from the charge in the furnace may then be exhausted into the air or may be exhausted into a combustion chamber. The initial heating to perform the pyrolysis may require maintaining the temperature within the heating chamber within a predetermined range of heat for an efficient operation and to complete the pyrolysis without

ignition. One advantage of pyrolysis is that it provides a combustible gas therefrom which can be partially combusted for disposal in the air.

One principal advantage of the present invention is that the combustible vapor given off by the pyrolysis chamber is fed to a combustion chamber where air or oxygen is fed into the chamber for the combustion of the gas and in which a propane gas or other combustible gas is added to the chamber to increase the efficiency of the burning of the gases.

It is another object of the present invention to produce an incinerating system for gases from a pyrolysis chamber in which the heat generated by the burning of the vapor from the pyrolysis chamber, along with propane or another combustible gas added to the chamber produces heat that is utilized in a feedback arrangement with a heat exchanger to provide heat for operating the pyrolysis chamber, thus reducing the amount of energy required to operate the waste disposal system, in addition to providing a more complete combustion and decomposition of the material.

The prior art has taught various systems for incinerating plastics. Typical systems may be seen in U. S. Pat. No. 3,495,555, and 3,490,395, have methods and apparatus for incinerating thermoplastic material and which utilize a primary combustion chamber subjecting the plastic material to initial burning and thereafter to a secondary combustion chamber which includes a diffusion chamber to provide additional burning of the gases from the primary chamber. U. S. Pat. Nos. 3,589,313 and 3,540,388 describe systems for the solid waste disposal which include pyrolyzers for the disposal of certain other materials in the disposal system.

SUMMARY OF THE INVENTION

The present invention relates to disposal of solid waste materials and especially to an apparatus and method for disposing of waste materials utilizing pyrolysis to decompose the solid materials. A primary heating or pyrolytic decomposition chamber for heating solid material for vaporization thereof, is provided with a means for the loading of a chamber with the solid waste materials. The heating chamber is connected to a combustion chamber in a manner to receive the gases from the pyrolysis chamber therein for combustion of the pyrolytic gases. The combustion chamber is connected to receive air thereinto along with a gas, such as propane, to produce initial decomposition of the gas from pyrolyzer. A blower is provided for directing the gases into the combustion chamber and for maintaining a regulated vacuum in the pyrolysis chamber. A material loading system for loading the pyrolytic decomposition chamber is provided and includes a door adapted to provide a tight seal for the chamber and a pushing or compacting system for driving the material into the chamber in batches while limiting the intake of air in the chamber. One embodiment provides utilizing the heat from the combustion of the propane and from the pyrolytic decomposition in a feedback system connected to a heat exchanger located in or near the pyrolytic decomposition chamber for heating the solid waste material which either eliminates or reduces the necessity for having another heating system such as burners or radiant heating tubes in the pyrolytic decomposition chamber. A proportioning damper may be used with this latter system to control the heat being transferred through the heat exchanger system into the

pyrolytic decomposition chamber to help maintain the temperature in the chamber within a predetermined range, and for exhausting any excess heated gases to the atmosphere.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of this invention will be apparent from a study of the written description and the drawings in which

FIG. 1 is a cutaway view of a disposable system in accordance with the present invention ;

FIG. 2 is a cutaway sectional view of a second embodiment of the present invention having a feedback system for utilizing the heat from a combustion chamber; and

FIG. 3 is a top sectional view of the embodiment in accordance with FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a heating or pyrolytic decomposition chamber 10 is illustrated having fire brick 11 surrounding the chamber and being insulated with a refractory wool insulating material 12 for insulating the fire brick 11. An outer enclosure 13 may be made of stainless steel and encloses the refractory wool 12 and the insulating fire brick 11, and an interior liner 14 which may be made of stainless steel, provides the lining for the interior of the pyrolysis chamber 10. The interior liner 14 advantageously provides a high temperature surface for direct contact with the material to be decomposed which greatly increases the rate of disposal of the material. A heating element 15 which may be an electric resistance heater coil and is embedded in the insulating fire brick and is shown passing through one portion of the fire brick 11. Material that enters the pyrolysis chamber 10 enters into the high temperature chamber 16 where it is heated to a predetermined temperature and may become a liquid prior to decomposition, into a combustible gas. The chamber is sealed from the input of air or other oxygen containing gases during pyrolysis to prevent combustion from taking place in the chamber. The gas is exhausted at an exhaust pipe 17 from the chamber 16. The chamber is loaded by inserting the solid waste materials, which would typically be plastic materials, such as polyethylene, in a chamber 20 by opening the door 21 which lifts into and out of the chamber 16 for sealing the chamber 16 from the chamber 20 and then having a pusher or piston 22, which may be hydraulically or pneumatically driven, and is connected for pushing the solid waste material to be disposed of from the chamber 20 into the chamber 16 and also for compressing the solid waste material to a smaller volume. The pusher is then retracted and the door 21 is closed to seal chamber 16 against the entrance of air. Chamber 20 may also have an airtight door to minimize the air intake into the chamber 16. When the heating coils 15 are actuated, the chamber 16 is heated and the solid waste materials therein will melt forming even a smaller volume and the vaporization from the pyrolysis will begin to take place. Any air remaining in the chamber will soon be disposed of at the beginning of the pyrolysis and the remaining gases will be generated and exhausted through the exhaust pipe 17 which has suction produced thereon by blower 24 and includes a damper and vacuum control 25 for controlling the draft of the gases entering there-

through and to regulate the vacuum in the chamber 16. An air pipe 26 is connected to pipe 17 to allow air to enter the system and to maintain a constant flow of air and combustible gases from the chamber 16 through blower 24 and to control the vacuum in the chamber 16 and which is driven by an electric motor 27 through a shaft 28. The blower 24 can be any standard type of impeller driven blower, and is used to force the gas through a mixing chamber 30 which has an opening 31 in which a combustible commercially available gas is fed into the mixing chamber 30. The gas entering opening 31 may be from a propane gas source 32, or may be any gas which is combustible, without departing from the spirit and scope of the present invention. Propane, or similar gases, are used because the residue following combustion is primarily carbon dioxide and water, which keeps pollution to a minimum. The mixed gases are then fed from an inspirator type gas burner 33 which includes a pilot and flame detector, if desired, and is fed into the main combustion chamber 34 which would typically be lined with a refractory lining material 35. This chamber produces a more complete combustion of the pyrolysis gases with the air by the addition of the combustible gas at the beginning of the process, and the exhaust therefrom at 36 is primarily carbon dioxide and water which is exhausted into the atmosphere.

A significant feature of the present invention is the addition of the propane gas which produces a more complete combustion in the beginning and at the end of the pyrolysis cycle for reducing harmful pollution that might otherwise be released into the atmosphere.

Turning now to FIG. 2, a second embodiment of the present invention is illustrated having a pyrolysis chamber 40 which is the same or similar to the pyrolysis chamber 10 of FIG. 1 but which may be loaded in a different manner if desired, without departing from the spirit and scope of the invention. The gas is exhausted in a similar manner by an exhaust blower 41 into a mixing chamber 42 having an air inlet 43 and a gas inlet 44 which mixes the gas from the pyrolysis reaction with the air and with the combustible gas being fed into the combustion chamber 45 which may be similar to the system described in FIG. 1 except that the heat from the combustion in the chamber 45 is fed to an exhaust pipe 46 past a proportioning damper 47 which controls the tube temperatures and which may be automatically controlled by thermostats, if desired. The damper 47 directs a portion or all of the heated vent gases out an exhaust pipe 48 and all or a portion of the hot gases through a feedback pipe 50 which is connected to a heat exchanger 51 which transfers most of the heat from the heated gases into the pyrolysis chamber 10 and then exhausts the cooled gases. This system may be operated without additional heating elements in the pyrolysis chamber 40 by first operating the combustion chamber 45 with the air from the inlet 42 and the gas from the inlet 44 until the pyrolysis begins to take place, and until the combustion from the gases from the pyrolysis chamber begin producing sufficient heat to operate the system. Alternatively, the chamber 40 could have additional system. Alternatively, the chamber 40 could have additional heating strips or a burner therein for initiating the pyrolysis and maintaining the temperature within a predetermined range.

FIG. 3 shows a chamber 40 from another view connected by an exhaust pipe 52 into the mixing chamber

42 which is in turn connected to the combustion chamber 45. The air inlet 43 and the gas inlet 44 may also be seen in this view along with the feedback pipe 50 connected to the heat exchanger 51 which is in turn connected to an exhaust system 53 for exhausting cool gases from the heat exchanger 51. The exhaust pipe 48 which is controlled by the proportional damper 47 is also shown connected to the exhaust pipe 53 for venting all of the gases from the pipe 54 into the atmosphere. The operation of the system provides for loading the pyrolysis chamber 10 of FIG. 1 and 40 of FIGS. 2 and 3 which may be done through the chamber 20 piston 22 of FIG. 1 or by some other means if desired.

The loading of the pyrolysis chambers is followed by the sealing of the chambers from the atmosphere and the heating of the chambers for melting and vaporizing the solid waste materials sealed therein, and mixing of a combustible gas with the air and the pyrolysis vapor in a combustion chamber for burning the gases.

It will be clear to those skilled in the art at this point that a waste disposal system has been provided for disposing of solid wastes such as polyethylene or other plastics, or any other material that could be vaporized in an intermediate pyrolysis step and by the feedback of the resulting combustible gases for the heating of the pyrolyzer chamber. This invention, however, is not to be construed as limited to the particular forms disclosed herein, since these are to be regarded as illustrative rather than restrictive.

I claim:

1. An apparatus for the disposal of solid waste material including pyrolytic decomposition of the material, comprising in combination:

- a. heating chamber for the pyrolytic decomposition of at least a portion of solid materials placed in said heating chamber;
- b. a combustion chamber connected to said heating chamber for receiving gas generated during the decomposition of said solid materials in said heating chamber and for burning said gases in said combustion chamber;
- c. combustible gas input means connected to said combustion chamber for burning in said combustion chamber;
- d. air input means connected to said combustion chamber means for adding air thereto whereby a combustible gas from said combustion gas input means, air from said air input means and gas from said heating chamber burns in said combustion chamber; and
- e. exhaust means operatively connected to said combustion chamber for exhausting heat and gases from said exhaust chamber, said exhaust means being connected to said heating means and said heating means including a heat exchanger for directing heated gases from said combustion chamber for heating said heating chamber.

2. The apparatus in accordance with claim 1 in which

said heating chamber is a substantially air free pyrolytic chamber when operating to decompose solid materials therein.

3. The apparatus in accordance with claim 2 in which said heating chamber has an inlet door adapted to be opened and closed for the insertion of solid waste materials into said heating chamber.

4. The apparatus in accordance with claim 3 in which a pushing mechanism is associated with said inlet door for said heating chamber for pushing solid materials into said heating chamber from a loading chamber when said door is open.

5. The apparatus in accordance with claim 4 in which ducts are used to connect said heating chamber with said combustion chamber, and includes a blower therein for drawing the gases from said heating chamber into said combustion chamber.

6. The apparatus in accordance with claim 5 in which the combustible gas input means includes a propane gas source for directing propane gas into said combustion chamber.

7. An apparatus for the pyrolytic decomposition of solid waste materials comprising in combination

- a. a pyrolytic decomposition chamber for the decomposition of solid waste by the heating of the solid waste to predetermined temperature levels;
- b. a combustion chamber connected to said decomposition chamber for burning gases produced by the pyrolytic decomposition in said decomposition chamber;
- c. air input means connected to said combustion chamber for feeding air thereto;
- d. combustible gas input means connected to said combustion chamber for feeding a combustible gas thereto;
- e. feedback means connected to said combustion chamber for feeding back the heated gases being exhausted by said chamber; and
- f. heat exchanger means located adjacent said pyrolytic decomposition chamber and connected to said feedback means for passing said heated gases therethrough for heating said pyrolytic decomposition chamber, exhaust means connected to said heat exchanger for exhausting said gases passing through said heat exchanger.

8. The apparatus in accordance with claim 7 in which said feedback means includes a proportioning damper means for directing the gases being exhausted by said combustion chamber to said heat exchanger in accordance with the heat requirements of said pyrolytic decomposition chamber.

9. The apparatus in accordance with claim 8 including a blower means connected between said pyrolytic decomposition chamber and said combustion chamber for drawing gases from said pyrolytic decomposition chamber, and air from the atmosphere into said combustion chamber.

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