A device is disclosed for decomposing particulate agricultural waste products such as peanut hulls. The device comprises an elongate cylinder having first end wall means at one end thereof and second end wall means at the opposite end thereof whereby to define a chamber. Inlet means are provided for forcibly introducing the particulate waste product and combustion supporting gas tangentially into the chamber adjacent the first end wall means and axially toward the second end wall means to form an outer helical flow layer adjacent the inner surface of the cylinder which reacts with the second end wall means to reverse axial direction and form a second helical flow layer within the confines of the outer layer. Exhaust conduit means extend through the first end wall means and present a discharge mouth disposed concentrically within the chamber and positioned beyond the inlet means toward the second end wall means. Means are further provided for heating the chamber sufficiently to at least partially decompose the waste products. Flow control means are disposed adjacent the second wall of the chamber to trap partially decomposed waste products adjacent the second end while constraining the gas to reverse its flow and form a compressible vortex from the flow control means to the discharge mouth of the exhaust conduit.
DEVICE FOR SEPARATING SOLID OR LIQUID PARTICLES FROM A GASEOUS MEDIUM

BACKGROUND OF THE INVENTION

This application is a division of my copending U.S. Pat. No. 3,848,550 filed Apr. 21, 1971, and is also a division of my copending U.S. Pat. No. 3,802,164. It is further provided for heating the chamber sufficiently to cause the ash by-products of combustion at said other end while constraining the gas to reverse its flow and form a compressible vortex from the flow control means to the discharge mouth of the exhaust conduit.

In another form of the invention, an incinerator is provided for use in disposing of particulate agricultural waste products. The incinerator comprises a housing defining an elongated cylindrical chamber and means for introducing the particulate waste product and combustion supporting gas to sweep helically from one end of the chamber to the other end thereof in close adjacency to the chamber wall. An exhaust conduit extends into the chamber with an inlet opening between the ends of the chamber, facing the other end thereof and disposed substantially on the axis of the chamber. Means for heating the housing sufficiently to incinerate the waste product are also provided. A contoured plug is disposed at the other end of the chamber to trap the ash by-products of combustion at said other end while constraining the gas to reverse its flow and form a compressible vortex from the plug to the inlet opening of the exhaust conduit.

BRIEF DESCRIPTION OF THE FIGURES OF DRAWING

FIG. 1 is a longitudinal section taken through a material separating device which may be used in conjunction with the present invention which illustrates the axial flow directions of the helical flow layers obtained within the device;

FIG. 2 is a transverse section taken substantially along the plane of section line 2—2 in FIG. 1 and illustrating the inlet means which is particularly adapted to reduce erosion due to impingement of solid particles against the inner wall of the container;

FIG. 3 is a transverse section taken substantially along the plane of section line 3—3 of FIG. 1 and illustrating the constructed entrance mouth for the particle residence chamber;

FIG. 4 is a transverse section taken substantially along the plane of section line 4—4 in FIG. 1 and illustrating the flow patterns of the various helical flow layers;

FIG. 5 is a longitudinal section taken through an incinerator embodying principles of the present invention in one form and which shows means for removing ash by-products of combustion;

FIG. 6 is a transverse section taken substantially along the plane of section line 6—6 in FIG. 5 and illustrating the manner of end-feeding the combustion supporting gas and particulate waste material; and

FIG. 7 is a fragmentary longitudinal section taken through a modified embodiment showing means for removing particulate material, by scrubbing with a liquid spray in the base region.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

Referring now to the drawings, the illustrative em-
bodiments embodying the principles of the present invention will be described with reference to a material separating device, as shown in FIGS. 1 – 4; a material incinerator, as shown in FIGS. 5 and 6; and a modified separating device having means for removing particulate material, as shown in FIG. 7.

MATERIAL SEPARATING DEVICE

With reference to FIG. 1, a housing is indicated generally by the reference character 10 which will be seen to include a cylindrical wall portion 12 having opposite end closures 14 and 16. The inner wall surface 18 of the housing or body 10 forms a cylindrical chamber 20 into which, at the upper end thereof in FIG. 1, particulate material such as solids or liquid droplets and a stream of gas entraining such particles are introduced to flow helically downward within the chamber 20 toward the lower end thereof. The inlet means may be a single inlet duct or a plurality of inlet ducts as will be hereinafter described; but, in any event, the inlet means causes gaseous medium with particulate material entrained therein to swirl helically downward in a layer closely adjacent the inner surface 18 and which has a net axial direction as indicated by the arrows 22 in FIG. 1. A contoured flow control plug 26 is provided in the lower end of the chamber and defines, with the inner wall of the chamber, a residence chamber 34. The flow emanating from the tube 52 and the streamline of gas entraining such particles are introduced to cause a positioning of the flow as indicated by the reference character 29 and creates a high pressure within this region; and the separating efficiency increases continuously as the total flow rate increases. The sharper the point on plug 26, the sturdier the vortex remains. The vortex core attaches itself to needle tip portion of the plug and if the plug tip is shifted laterally, the vortex core will follow.

In FIG. 2 a preferred embodiment of inlet means is shown and will be seen to consist of a tangentially directed tube 52 having a discharge port 56 directing flow tangentially and in slightly axially inclined relationship into the chamber 20 and, additionally, an inlet tube 44 is directed to cause flow chordwise of the chamber, as indicated by the reference character 48, so that the flow emanating from the tube 52 and the chordwise flow emanating from the tube 44 intersect at 57 and join to provide the tangential inlet flow 58 as indicated. If desired, further inlet tubes 46 and 54 may be provided, the former having a chordwise flow inlet as indicated by the reference character 50. A preferred axial inclination of the inlet means is in the order of 60°.

The arrangement of FIG. 2 is intended to minimize erosion of the inner wall 18 of the cylinder 10; and, for this purpose, the tangentially directed tubes 52 and 54 are intended to contain a flow of gaseous material having little, if any, solids or liquids entrained therein, whereas the flow through the tubes 44 and 46 are heavily laden with the particulate material desired to be removed. This configuration primarily lends itself to adaptation for incinerator use wherein a gas inlet would be effected at the tubes 52 and 54 and particulate material to be incinerated would be induced through tubes 44 and 46. In this manner, the interior of the chamber 20 would be supporting combustion and decomposing the particulate material; while, at the same time, retaining the residue within the residence chamber 40 so that the exhaust emanating from the outlet means 38 would be substantially free from entrained particles.

FIG. 3 is intended to show the annular arrangement of the constricted entrance mouth 36 for the residence chamber 40. It will be seen that the bulbous contoured plug 26 forms the constriction 36, and for this purpose it is preferred that the width of the entrance mouth 36 be in the order of 0.34 times the diameter of the cylinder 12.

It has been found that to best control the flow characteristics of the device as indicated in FIG. 1, the height of the base portion of the plug 28 should be in the order of 0.58 times the diameter of the cylinder 12, the diameter of the discharge mouth 27 should be in the order of 0.2 times the inner diameter of the cylinder 12 and the surface 62 of the tip portion 30 of the flow control plug 26 should be radiused on an arc about 0.375 times the diameter of the inner surface of the cylinder 12. Additionally, as mentioned hereinbefore, the length of the vortex core 34 should be in the order of 40 times its diameter.

MATERIAL INCINERATOR

As shown in FIGS. 5, 6 and 7, the present invention is here constructed in the form of an incinerator capable of disposing of waste material, such as peanut hulls.
The incinerator is indicated generally by the reference character 100 which will be seen to include a cylindrical wall portion 101 having opposite end closure means 103, 104. The cylindrical wall 101 and end closure 103 are constructed of conventional refractory material for defining a combustion chamber 105 into which, at the upper end thereof in FIG. 5, particulate waste product material, such as peanut hulls, and a stream or streams of combustion supporting gas are introduced to flow helically downward within chamber 105 toward the lower end thereof. The flow pattern of the particulate material and gaseous medium will be the same as described hereinabove and as illustrated by arrows in FIGS. 1 - 4.

The combustion supporting gas, such as air, is introduced into chamber 105 through conduits 106, 107. Conventional blower and heat producing means 108, 190 are operatively associated with conduits 106, 107, respectively. The heat producing means produce a sufficient elevation of temperature to cause the waste products to be ignited and burned in the incinerator chamber 100. As shown in FIG. 6, entrained waste products in air are introduced by conduits 110, 111 which are directed chordwise with respect to cylindrical wall 101, in slightly downward inclined relationship. The combustion supporting gas introduced by the conduits 106 and 107 is substantially tangentially of the cylindrical wall 101, the openings, 106a, 107a of these conduits being located substantially at the points at which flows of material from the conduits 110 and 111 would otherwise impinge the inner wall surface of the chamber wall 101, thereby minimizing erosion due to the inflow of material.

The net effect of this manner of introduction of the material and the air is such as to create a helical flow of waste product entrained in the air substantially as it is indicated hereinabove. This flow of material and air of course closely hugs the inner wall surface 101 of the chamber and continues this helical downward flow of gas, still helical, reverses itself as previously described hereinabove and as shown in FIGS. 1 - 4, and reference is made to the above indicated description for the details of the material flow pattern within combustion chamber 105.

The air and gas by-products of combustion are exhausted from combustion chamber 105 by a flue means 138 located within end closure means 103. Flue means 138 is detailed in location, relative to flow control plug 126, in the same manner as the location of conduit 38 relative to plug 26 described above.

MODIFIED MATERIAL SEPARATING DEVICE

Referring now to FIG. 7, a modified embodiment is described which includes means for purging the separation chamber of separated material. The device of FIG. 7 includes a separation chamber 205 having a collection hopper and grate means. Collection hopper is indicated generally by reference character 214 and includes a controlled discharger valve means 215 operable for discharging material from hopper 214 outwardly through a discharge conduit 216. Grate means 220 having a plurality of spaced vane means 221 is supported above hopper 214 to allow separated material to pass from a residence chamber 240 to collection hopper 214.

As shown in FIG. 7, separation chamber 205 includes a flow control plug 226 supported above grate means 220. Plug 226 is supported relative to chamber wall 236 and an inlet means 227 communicates with the residence chamber 240. Flow control plug 226 is identical to plug 26 and will control the flow pattern within chamber 205 in the same manner as described above relative to FIGS. 1 - 4.

An annular perforated dispersing manifold 250 is concentrically supported around plug 226 above grate 220. Dispersing manifold 250 is connected by suitable means to conventional fluid supply means (not shown) for spraying a quantity of fluid into the particle separation region and down through grate 220, hopper 214, valve 215 and out through conduit 216 for purging the residence chamber 240 and hopper 214 of separated material contained therein.

It now becomes apparent that the illustrative embodiments described herein are capable of obtaining the above stated objects and advantages. It is obvious that those skilled in the art may make modifications in the details of construction without departing from the spirit of the invention which is to be limited only by the scope of the appended claims.

What is claimed is:

1. A device for decomposing particulate agricultural waste products such as peanut hulls, which comprises:

   a. an elongate cylinder having first end wall means at one end thereof and second end wall means at the opposite end thereof whereby to define a chamber;

   b. inlet means for forcibly introducing the particulate waste product and combustion supporting gas tangentially into said chamber adjacent said first end wall means and axially toward said second end wall means, whereby to form an outer helical flow layer adjacent the inner surface of said cylinder which reacts with said second end wall means to reverse axial direction and form a second helical flow layer within the confines of said outer layer;

   c. exhaust conduit means extending through said first end wall means and presenting a discharge mouth disposed concentrically within said chamber and positioned beyond said inlet means toward said second end wall means;
7. A device according to claim 1 wherein said flow control means disposed adjacent said second wall of said chamber to trap partially decomposed waste products adjacent said second end while constraining the gas to reverse its flow and form a compressible vortex from said flow control means to said discharge mouth of the exhaust conduit.

8. The device according to claim 8 wherein said plug includes an inverted frusto-conical base surmounted by a concave cone.

9. The device according to claim 9 wherein said plug is based at said other end of the chamber and projects axially therefrom toward said one end of the chamber.

10. The device according to claim 1 wherein said flow control means defines an annular residence pocket for retaining said ash material and wherein means is provided in said hopper for removing ash therefrom.

11. The device according to claim 11 wherein said elongate cylinder includes a hopper located below said contoured plug for retaining said ash material and wherein means is provided in said hopper for removing ash therefrom.

12. The device according to claim 11 wherein said elongate cylinder includes means for purging said cylinder and said hopper of separated ash material contained therein.

13. A device for separating and removing entrained material from a gaseous medium, comprising:

a. an elongate cylinder having first end wall means at one end thereof and second end wall means at the opposite end thereof whereby to define a chamber;

b. inlet means for forcibly introducing the gaseous medium and entrained material tangentially into chamber adjacent said first end wall means to flow axially toward said second end wall means, whereby to form an outer helical flow layer adjacent the inner surface of said cylinder which reacts with said second end wall means to reverse axial direction and form a second helical flow layer within the confines of said outer layer;

c. outlet passage means extending through said first end wall means and presenting a discharge mouth disposed concentrically within said chamber and positioned beyond said inlet means toward said second end wall means;

d. flow control means defining an annular residence pocket for said entrained material adjacent said second end wall means and within which pocket said axial flow reversal takes place, said flow control means providing a constricted annular entrance mouth which positions said second flow layer toward said outer flow layer and causes said second layer to extend to the region of said discharge mouth whereat it reverses axial direction to form a third helical flow layer within the confines of said second layer, said flow control means including a tip portion spaced from said discharge mouth and contoured to reverse the axial direction of said third flow layer and create a stable vortex extending therefrom to said discharge mouth.

14. The device according to claim 13 wherein said elongate cylinder includes means for purging said cylinder and said hopper of separated material contained therein.