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(54) IMPROVEMENTS IN WASTE PROCESSING

VERBESSERTE ABFALLVERARBEITUNG

AMÉLIORATIONS DU TRAITEMENT DES DÉCHETS

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Description

[0001] This invention relates to the processing of organic material, in particular this invention relates to improvements in processing of material having an organic content by gasification and/or pyrolysis.

[0002] Gasification and Pyrolysis of organic matter are known techniques in which the material is heated in the absence of oxygen (pyrolysis) or in a low oxygen environment (gasification) to produce syngas. One example of this is in waste to energy systems wherein waste material, for example municipal solid waste, is pyrolysed/gasified to produce syngas which is then used to create electricity. However when material having a large amount of organic material with a low calorific value, for example wood (in contrast to materials such as plastics which have a high calorific value), is pyrolysed a carbonic residue remains which is a char or coke like substance referred to collectively herein as char.

[0003] After the pyrolysis reaction is complete this char still contains a large amount of unrecovered energy. This can be recovered by increasing the oxygen content to a level sufficient for gasification of the char to occur without combustion (approximately 3% to 12% by volume oxygen content). However, the gasification can take some time and adds to the overall processing time for the waste which reduces overall efficiency of the processing.

[0004] EP0822374 describes a rotating drum pyrolysis reactor with therein disposed iron balls with the gas inlet suitable for the introduction of hot gas with no or little oxygen content and a gas outlet suitable as outlet for the produced synthesis gas.

[0005] US4676439 describes a ball mill consisting of a rotating drum rotating around an axle having inside ferro-magnetic balls, wherein electromagnets are situated around the outer wall of the rotating reactor, which are controlled in such a way that they trap the metal balls on a lower position of the rotating drum, lift the metal balls as the reactor rotates, and release the metal balls near the top position of the rotating drum, causing the metal balls to fall in a parabolic arc to the bottom of the reactor causing a high impact milling action.

[0006] It is the purpose of the present invention to reduce the overall processing time of waste by pyrolysis/gasification.

[0007] According to a first aspect of the present invention there is provided an apparatus for pyrolysing or gasifying material containing an organic content; the apparatus comprising: an oven mounted for rotation on at least one support, said oven having an inlet for receiving hot gas having a low or zero oxygen content to heat the material therein so as to process it to produce syngas, and an outlet for said syngas; an electromagnet disposed in or adjacent said oven so as to create a magnetic field therein; a plurality of ferrous elements freely disposed within the oven; and control means for controlling the electromagnet and the rotation of the oven; wherein when activated said electromagnet retains said ferrous elements as the oven rotates, wherein the apparatus further comprises at least one gas analyser configured to analyse the composition of the gas exiting said oven; and wherein the control means is configured to receive signals from said gas analyser and when said signals indicate that processing of the material in said oven is substantially complete, control the electromagnet to release the ferrous elements when they are substantially at the top of the oven's rotation.

[0008] The oven may further comprise a first portion and a second portion, wherein said first portion is disposed above said second portion in a first rotational position and wherein said second portion is disposed above said first portion in a second rotational position; wherein said control means is configured to control the oven to rotate it between the first position and the second position.

[0009] The control means can be configured to activate the electromagnet to retain the ferrous elements as the oven rotates between the second rotational position to the first rotational position. In one arrangement the electromagnet can be located in the first portion and the control means is configured deactivate the electromagnet in the first position so that the ferrous elements fall, under the influence of gravity, into the second portion and in another arrangement the electromagnet can be located in the second portion and the control means is configured deactivate the electromagnet in the second position so that the ferrous elements fall, under the influence of gravity, into the first portion.

[0010] In this manner the ferrous elements can fall from above onto the char, which will be at the lowest point of the rotating oven due to gravity, and will break the char into smaller pieces. This increases the surface area of the char which increases the speed at which it is processed.

[0011] The apparatus comprises at least one gas analyser for analysing the composition of the gas exiting said oven. As described below, by analysing the gas exiting the oven the extent of the processing of the material in the oven can be determined, and in particular it can be determined when the majority of the material in the oven has been processed. The control means is configured to receive signals from the gas analysers and when said signals indicate that processing of the material in said oven is substantially complete, the control means controls the electromagnet to release the ferrous elements when they are substantially at the top of the ovens rotation. The control means can optionally also increase the oxygen content of the oven at this stage to gasify the char therein.

[0012] The ferrous elements may have a mass of at least 500g. Optionally the ferrous elements may have a mass of at least 1 kg. The ferrous elements comprise steel and/or may be substantially spherical. Optionally the ferrous elements may have one or more groove on their surface.

[0013] According to a second aspect of the invention

there is provided a method of pyrolysing and/or gasifying material containing an organic content; the method comprising: providing an oven mounted for rotation on at least one support, said oven having an inlet and an outlet; providing a flow of hot gas having a low or zero oxygen content to the oven via the inlet to heat the material therein to process it to produce syngas; providing an electromagnet disposed in or adjacent said oven so as to create a magnetic field therein; providing a plurality of ferrous elements freely disposed within the oven; and activating said electromagnet to retain said ferrous elements as the oven rotates, wherein the method further comprises analysing the composition of the gas exiting said oven to determine when processing of the material in said oven is substantially complete, and when said process is substantially complete, controlling the electromagnet to release the ferrous elements when they are substantially at the top of the ovens rotation.

[0014] The oven may comprise a first portion and a second portion, and the method may further comprise: controlling the oven to rotate between a first rotational position in which the first portion is disposed above said second portion and a second rotational position wherein said second portion is disposed above said first portion. In one arrangement the electromagnet can be located in the first portion and the method further comprises activating the electromagnet to retain the ferrous elements as the oven rotates from the second rotational position to the first rotational position. The method then further comprises deactivating the electromagnet in the first rotational position so that the ferrous elements fall, under the influence of gravity, into the second portion. In an alternative arrangement the electromagnet is located in the second portion and the method may comprise activating the electromagnet to retain the ferrous elements as the oven rotates from the first rotational position and the second rotational position. The method then further comprises deactivating the electromagnet in the second position so that the ferrous elements fall, under the influence of gravity, into the first portion.

[0015] The method comprises analysing the composition of the gas exiting said oven. By analysing the composition of the gas exiting said oven it can be determined when processing of the material in said oven is substantially complete. The method further comprises, when said process is substantially complete, controlling the electromagnet to release the ferrous elements when they are substantially at the top of the ovens rotation. The method may comprise, when processing of the material in said oven is substantially complete, increasing the oxygen content of the oven. Increasing the oxygen content of the oven may comprise increasing the oxygen content of the oven to between 3 and 12 % volumetric flow rate

[0016] Specific embodiments of the invention are described below, without limitation, with reference to the accompanying drawings in which:

Figure1 shows a schematic diagram of an apparatus of the invention;

Figure 2 shows a side view of an apparatus of the invention;

Figure 3 - 5 show the operation of the invention; and

Figure 6 shows an example of a ferrous element for use in the invention.

[0017] Referring to Figures 1 and 2 an oven 10 is shown comprising a first portion 12 and a second portion 14. The second portion 14 is detachable from the first portion 12 to load and unload material to be treated into the oven 10.

[0018] The oven is pivotally mounted on two mounts 16 and a drive 18 is provided to rotate the oven between a first rotational position in which the first portion 12 is above the second portion 14 and a second rotational position in which the second portion 14 is above the first portion 12.

[0019] A supply of hot gas is provided to the oven via a conduit 20 from a hot gas supply 22, and exits the oven via a further conduit 24. A gas analyser 26 is provided to analyse the composition of the gas exiting the oven. The gas analyser may measure one or more of: hydrogen content, carbon monoxide content and carbon dioxide content, of the gas.

[0020] An electromagnet 28 is provided in the oven. The electromagnet may be provided in either the first or the second portion of the oven and is shown in the first portion in Figure 1 for illustration purposes. A plurality of ferrous elements 30 are provided in the oven. The ferrous elements are described in more detail in relation to Figure 6 below.

[0021] Referring to Figures 3 to 5 the operation of the oven is shown.

[0022] A batch of material to be processed is loaded into the oven and hot gas, containing substantially no oxygen is passed through the oven as it rotates so as to pyrolyse the material therein. As the material pyrolyses hydrogen and carbon monoxide is released and exits the oven via the outlet conduit 24. The gas analyser 26 monitors the composition of the gas as it exits the oven and sends signals to the controller 32. Once the controller determines that the signals from the gas analyser indicate that the pyrolysis of the material is nearing completion it increases the amount of oxygen in the gas so that the reaction in the chamber moves from pyrolysis to gasification. The controller may respond to, for example, the reduction below a specific threshold value of the hydrogen or carbon monoxide level in the gas exiting the oven.

[0023] At this stage in processing, when the majority of the material in the oven has been pyrolysed a residue 34 containing inert material and carbonic residue formed from the pyrolysis of low calorific value organic material will remain in the oven. As the oven rotates the electromagnet is activated so that the ferrous elements 30 are

attracted to and retained as the oven rotates into the first position (Figure 3). When the oven reaches this position the electromagnet 28 is deactivated and the ferrous elements are therefore released and fall from the top of the oven to the bottom of the oven where they will collide with the char and due to their mass and the more brittle nature of the char will break or crush the char into smaller pieces (Figure 4).

[0024] The oven then rotates from the second first position to the second position (Figure 5) and the electromagnet 28 is then activated again to attract and retains the ferrous elements. The oven then continues to rotate back towards the first position (Figure 3) and the process is repeated. Once the gas analysers show that the gasification reaction is substantially complete the process is finished, the oven returned to the first position and the second portion 14 is removed, emptied and recharged with a fresh batch of material.

[0025] Breaking the char into smaller pieces increases its surface area available to react with the oxygen in the hot gas passing through the oven and thereby reduces the time taken to gasify the char.

[0026] Decreasing the overall processing time increases the efficiency of the waste processing as the amount of time the hot gas needs to be provided is reduced. The gas released as syngas can be used for energy production and accordingly by reducing the amount of that energy that needs to be used for producing the hot gas (by reducing the amount of time the hot gas is needed for) the overall percentage of the energy recovered that is available for export is increased.

[0027] Referring to Figure 6 an example of a ferrous element for use in the apparatus is shown. The element 30 is substantially spherical in shape and is made of ferrous steel. Each element preferably weighs above 500g and elements having a mass of 1kg or above may be beneficial in crushing the char. As can be seen the element has a number of grooves 36 around its edge separating the surface into a plurality of raised shapes 38. These raised features improve the friction as the elements impact on the char and assist in preventing them from glancing off large pieces which is more likely if the elements a have a smooth spherical outer surface. It will be appreciated that any surface that gives this effect may be used and the ferrous elements are not limited to the shapes shown.

Claims

1. An apparatus for pyrolysing or gasifying material containing an organic content; the apparatus comprising:

   an oven (10) mounted for rotation on at least one support (16), said oven (10) having an inlet for receiving hot gas having a low or zero oxygen content to heat the material therein so as to process it to produce syngas, and an outlet for said syngas;
   an electromagnet (28) disposed in or adjacent said oven (10) so as to create a magnetic field therein;
   a plurality of ferrous elements (30) freely disposed within the oven (10); and
   control means (32) for controlling the electromagnet (28) and the rotation of the oven (10) such that when activated said electromagnet (28) retains said ferrous elements (30) as the oven (10) rotates; **characterised in that**
   the apparatus further comprises at least one gas analyser (26) configured to analyse the composition of the gas exiting said oven (10); and
   wherein the control means (32) is configured to receive signals from said gas analyser (26) and when said signals indicate that processing of the material in said oven (10) is substantially complete, control the electromagnet (28) to release the ferrous elements (30) when they are substantially at the top of the oven's rotation.

2. The apparatus according to claim 1 wherein the oven (10) further comprises a first portion (12) and a second portion (14), wherein said first portion (12) is disposed above said second portion (14) in a first rotational position and wherein said second portion (14) is disposed above said first portion (12) in a second rotational position; wherein said control means (32) is configured to control the oven (10) to rotate it between the first position (12) and the second position (14).

3. The apparatus according to claim 2 wherein the electromagnet (28) is located in the first portion (12) and the control means (32) is configured to deactivate the electromagnet (28) in the first position so that the ferrous elements (30) fall, under the influence of gravity, into the second portion (14).

4. The apparatus according to claim 3 wherein the control means (32) is configured to activate the electromagnet (28) to retain the ferrous elements (30) as the oven (10) rotates from the second rotational position to the first rotational position.

5. The apparatus according to claim 2 wherein the electromagnet (28) is located in the second portion (14) and the control means (32) is configured deactivate the electromagnet (28) in the second rotational position so that the ferrous elements (30) fall, under the influence of gravity, into the first portion (12).

6. The apparatus according to claim 5 wherein the control means (32) is configured to activate the electromagnet (28) to retain the ferrous elements (30) as the oven (10) rotates from the first rotational position

to the second rotational position.

7. The apparatus according to any preceding claim wherein the ferrous elements (30) have one or more groove (36) on their surface.

8. A method of pyrolysing and/or gasifying material containing an organic content; the method comprising:

providing an oven (10) mounted for rotation on at least one support (16), said oven (10) having an inlet and an outlet;
providing a flow of hot gas having a low or zero oxygen content to the oven (10) via the inlet to heat the material therein to process it to produce syngas;
providing an electromagnet (28) disposed in or adjacent said oven (10) so as to create a magnetic field therein;
providing a plurality of ferrous elements (30) freely disposed within the oven (10); and
activating said electromagnet (28) to retain said ferrous elements (30) as the oven (10) rotates; and **characterised in that**
the method further comprises analysing the composition of the gas exiting said oven (10) to determine when processing of the material in said oven (10) is substantially complete, and
when said process is substantially complete, controlling the electromagnet (28) to release the ferrous elements (30) when they are substantially at the top of the oven's rotation.

9. The method according to claim 8 wherein the oven (10) comprises a first portion (12) and a second portion (14), the method further comprising:
controlling the oven (10) to rotate between a first rotational position in which the first portion (12) is disposed above said second portion (14) and a second rotational position wherein said second portion (14) is disposed above said first portion (12).

10. The method according to claim 9 wherein the electromagnet (28) is located in the first portion (12) and wherein the method further comprises activating the electromagnet (28) to retain the ferrous elements (30) as the oven (10) rotates from the second rotational position to the first rotational position and optionally deactivating the electromagnet (28) in the first rotational position so that the ferrous elements (30) fall, under the influence of gravity, into the second portion (14).

11. The method according to claim 10 wherein the electromagnet (28) is located in the second portion (14) and wherein the method comprises activating the electromagnet (28) to retain the ferrous elements (30) as the oven (10) rotates from the first rotational position and the second rotational position and optionally deactivating the electromagnet (28) in the second position so that the ferrous elements (30) fall, under the influence of gravity, into the first portion (12).

12. The method according to any one of claim 8 to 11, wherein the method further comprises:

analysing the composition of the gas exiting said oven (10) to determine when processing of the material in said oven (10) by pyrolysis is substantially complete; and
when said pyrolysis process is substantially complete, increasing the oxygen content of the oven (10).

Patentansprüche

1. Gerät zum Pyrolysieren oder Gasifizieren von Material, welches einen Gehalt an organischen Stoffen enthält, wobei das Gerät Folgendes beinhaltet:

einen Ofen (10), welcher zur Rotation auf mindestens einer Stütze (16) montiert ist, wobei der Ofen (10) einen Einlass zur Aufnahme von heißem Gas mit einem niedrigen oder null Sauerstoffgehalt, um das Material hierin zu erhitzen und zwecks Erzeugen von Synthesegas zu behandeln, und einen Auslass für das Syngas besitzt;
einen Elektromagneten (28), welcher in dem oder angrenzend an den Ofen (10) angeordnet ist, um ein magnetisches Feld hierin zu erzeugen;
eine Vielzahl von eisenhaltigen Elementen (30), welche frei innerhalb des Ofens (10) angeordnet sind; und
Steuerungsmittel (32) zum Steuern des Elektromagneten (28) und der Rotation des Ofens (10) in der Weise, dass, wenn er aktiviert ist, der Elektromagnet (28) die eisenhaltigen Elemente (30) zurückhält, während der Ofen (10) rotiert; **dadurch gekennzeichnet, dass**
das Gerät zudem mindestens einen Gasanalysator (26) beinhaltet, welcher konfiguriert ist, um die Zusammensetzung des aus dem Ofen (10) austretenden Gases zu analysieren; und
wobei das Steuerungsmittel (32) konfiguriert ist, um Signale von dem Gasanalysator (26) zu empfangen und wenn die Signale anzeigen, dass die Behandlung des Materials in dem Ofen (10) im Wesentlichen abgeschlossen ist, um den Elektromagneten (28) zum Lösen der eisenhaltigen Elementen (30) anzusteuern, wenn diese im Wesentlichen an der Oberseite der Ofen-

rotation sind.

2. Gerät nach Anspruch 1, bei welchem der Ofen (10) zudem einen ersten Abschnitt (12) und einen zweiten Abschnitt (14) beinhaltet, wobei der erste Abschnitt (12) oberhalb des zweiten Abschnittes (14) in einer ersten Rotationsposition angeordnet ist und wobei der zweite Abschnitt (14) oberhalb des ersten Abschnittes (12) in einer zweiten Rotationsposition angeordnet ist; wobei das Steuerungsmittel (32) konfiguriert ist, um den Ofen (10) zu steuern, um ihn zwischen der ersten Position (12) und der zweiten Position (14) zu drehen.

3. Gerät nach Anspruch 2, bei welchem der Elektromagnet (28) in dem ersten Abschnitt (12) befindlich ist und das Steuerungsmittel (32) konfiguriert ist, um den Elektromagneten (28) in der ersten Position zu deaktivieren, so dass die eisenhaltigen Elemente (30) unter der Einwirkung von Schwerkraft in den zweiten Abschnitt (14) fallen.

4. Gerät nach Anspruch 3, bei welchem das Steuerungsmittel (32) konfiguriert ist, um den Elektromagneten (28) zu aktivieren, um die eisenhaltigen Elemente (30) zurückzuhalten, während der Ofen (10) von der zweiten Rotationsposition in die erste Rotationsposition dreht.

5. Gerät nach Anspruch 2, bei welchem der Elektromagnet (28) in dem zweiten Abschnitt (14) befindlich ist und das Steuerungsmittel (32) konfiguriert ist, um den Elektromagneten (28) in der zweiten Rotationsposition zu deaktivieren, so dass die eisenhaltigen Elemente (30) unter der Einwirkung von Schwerkraft in den ersten Abschnitt (12) fallen.

6. Gerät nach Anspruch 5, bei welchem das Steuerungsmittel (32) konfiguriert ist, um den Elektromagneten (28) zu aktivieren, um die eisenhaltigen Elemente (30) zurückzuhalten, während der Ofen (10) von der ersten Rotationsposition in die zweite Rotationsposition dreht.

7. Gerät nach einem der vorhergehenden Ansprüche, bei welchem die eisenhaltigen Elemente (30) eine oder mehrere Rillen (36) an deren Oberfläche besitzen.

8. Verfahren zum Pyrolysieren und/oder Gasifizieren von Material, welches einen Gehalt an organischen Stoffen enthält, wobei das Verfahren Folgendes beinhaltet:

Bereitstellen eines Ofens (10), welcher zur Rotation an mindestens einer Stütze (16) montiert ist, wobei der Ofen (10) einen Einlass und einen Auslass besitzt;

Bereitstellen eines Stroms von heißem Gas, welches einen niedrigen oder null Sauerstoffgehalt besitzt, an den Ofen (10) über den Einlass zum Erhitzen des Materials hierin zum Behandeln des Materials zur Erzeugung von Syngas;
Bereitstellen eines Elektromagneten (28), welcher in dem oder angrenzend an den Ofen (10) angeordnet ist, um ein magnetisches Feld hierin zu erzeugen;
Bereitstellen einer Vielzahl von eisenhaltigen Elementen (30), welche frei innerhalb des Ofens (10) angeordnet sind; und
Aktivieren des Elektromagneten (28) zum Zurückhalten der eisenhaltigen Elemente (30), während der Ofen (10) dreht; und **dadurch gekennzeichnet, dass**
das Verfahren zudem Analysieren der Zusammensetzung des aus dem Ofen (10) austretenden Gases beinhaltet, um zu bestimmen, wann das Behandeln des Materials im Ofen (10) im Wesentlichen abgeschlossen ist, und
wenn dieser Prozess im Wesentlichen abgeschlossen ist, Steuern des Elektromagneten (28) zum Lösen der eisenhaltigen Elemente (30), wenn diese im Wesentlichen an der Oberseite der Ofenrotation sind.

9. Verfahren nach Anspruch 8, bei welchem der Ofen (10) einen ersten Abschnitt (12) und einen zweiten Abschnitt (14) beinhaltet, wobei das Verfahren zudem Folgendes beinhaltet:
Steuern des Ofens (10) zum Drehen zwischen einer ersten Rotationsposition, in welcher der erste Abschnitt (12) oberhalb des zweiten Abschnittes (14) angeordnet ist, und einer zweiten Rotationsposition, bei welcher der zweite Abschnitt (14) oberhalb des ersten Abschnittes (12) angeordnet ist.

10. Verfahren nach Anspruch 9, bei welchem der Elektromagnet (28) in dem ersten Abschnitt (12) befindlich ist und bei welchem das Verfahren zudem Aktivieren des Elektromagneten (28) zum Zurückhalten der eisenhaltigen Elemente (30) beinhaltet, während der Ofen (10) von der zweiten Rotationsposition in die erste Rotationsposition dreht und optionsweise, Deaktivieren des Elektromagneten (28) in der ersten Position, so dass die eisenhaltigen Elemente (30) unter der Einwirkung von Schwerkraft in den zweiten Abschnitt (14) fallen.

11. Verfahren nach Anspruch 10, bei welchem der Elektromagnet (28) in dem zweiten Abschnitt (14) befindlich ist und bei welchem das Verfahren Aktivieren des Elektromagneten (28) zum Zurückhalten der eisenhaltigen Elemente (30) beinhaltet, während der Ofen (10) von der ersten Rotationsposition und der zweiten Rotationsposition dreht und optionsweise, Deaktivieren des Elektromagneten (28) in der zwei-

ten Position, so dass die eisenhaltigen Elemente (30) unter der Einwirkung von Schwerkraft in den ersten Abschnitt (12) fallen.

12. Verfahren nach einem der Ansprüche 8 bis 11, bei welchem das Verfahren zudem Folgendes beinhaltet:

Analysieren der Zusammensetzung des aus dem Ofen (10) austretenden Gases, um zu bestimmen, wann das Behandeln des Materials im Ofen (10) durch Pyrolyse im Wesentlichen abgeschlossen ist; und
wenn der Pyrolyseprozess im Wesentlichen abgeschlossen ist, Erhöhen des Sauerstoffgehaltes des Ofens (10).

Revendications

1. Appareil de pyrolyse ou de gazéification d'un matériau contenant un contenu organique ; l'appareil comprenant :

un four (10) monté de façon à tourner sur au moins un support (16), ledit four (10) présentant une entrée permettant de recevoir un gaz chaud présentant une teneur en oxygène faible ou nulle, afin de chauffer le matériau qu'il contient, de façon à le traiter afin de produire un gaz de synthèse, et une sortie pour ledit gaz de synthèse ;
un électroaimant (28) disposé dans ou près dudit four (10), de façon à créer un champ magnétique à l'intérieur ;
une pluralité d'éléments ferreux (30) librement disposés dans le four (10) ; et
des systèmes de commande (32) permettant de commander l'électroaimant (28) et la rotation du four (10) de sorte que, lorsqu'il est activé, ledit électroaimant (28) retienne lesdits éléments ferreux (30) lorsque le four (10) tourne ; **caractérisé en ce que**
l'appareil comprend en outre au moins un analyseur de gaz (26) configuré afin d'analyser la composition du gaz sortant dudit four (10) ; et
dans lequel le système de commande (32) est configuré afin de recevoir des signaux dudit analyseur de gaz (26) et lorsque lesdits signaux indiquent que le traitement du matériau dans ledit four (10) est sensiblement terminé, commander l'électroaimant (28) afin de libérer les éléments ferreux (30) lorsqu'ils sont sensiblement dans la partie supérieure de la rotation du four.

2. Appareil selon la revendication 1, dans lequel le four (10) comprend en outre une première partie (12) et une seconde partie (14), dans lequel ladite première partie (12) est disposée au-dessus de ladite seconde partie (14) dans une première position de rotation et dans lequel ladite seconde partie (14) est disposée au-dessus de ladite première partie (12) dans une seconde position de rotation ; dans lequel ledit système de commande (32) est configuré afin de commander le four (10) afin qu'il tourne entre la première position (12) et la seconde position (14).

3. Appareil selon la revendication 2, dans lequel l'électroaimant (28) est situé dans la première partie (12) et le système de commande (32) est configuré afin de désactiver l'électroaimant (28) dans la première position, de sorte que les éléments ferreux (30) tombent, sous l'influence de la gravité, dans la seconde partie (14).

4. Appareil selon la revendication 3, dans lequel le système de commande (32) est configuré afin d'activer l'électroaimant (28) afin qu'il retienne les éléments ferreux (30) lorsque le four (10) tourne de la seconde position de rotation à la première position de rotation.

5. Appareil selon la revendication 2, dans lequel l'électroaimant (28) est situé dans la seconde partie (14) et le système de commande (32) est configuré afin de désactiver l'électroaimant (28) dans la seconde position de rotation, de sorte que les éléments ferreux (30) tombent, sous l'influence de la gravité, dans la première partie (12).

6. Appareil selon la revendication 5, dans lequel le système de commande (32) est configuré afin d'activer l'électroaimant (28) afin qu'il retienne les éléments ferreux (30) lorsque le four (10) tourne de la première position de rotation à la seconde position de rotation.

7. Appareil selon l'une quelconque des revendications précédentes, dans lequel les éléments ferreux (30) présentent une ou plusieurs cannelure(s) (36) à leur surface.

8. Procédé de pyrolyse et/ou de gazéification d'un matériau contenant un contenu organique ; le procédé comprenant :

la fourniture d'un four (10) monté de façon à tourner sur au moins un support (16), ledit four (10) présentant une entrée et une sortie ;
la fourniture d'un flux de gaz chaud présentant une teneur faible ou nulle en oxygène au four (10), via l'entrée, permettant de chauffer le matériau qu'il contient de façon à le traiter afin de produire un gaz de synthèse ;
la fourniture d'un électroaimant (28) disposé dans ou près dudit four (10) de façon à créer un champ magnétique à l'intérieur ;
la fourniture d'une pluralité d'éléments ferreux (30) librement disposés dans le four (10) ; et

l'activation dudit électroaimant (28) afin qu'il retienne lesdits éléments ferreux (30) lorsque le four (10) tourne ; et **caractérisé en ce que**
le procédé comprend en outre l'analyse de la composition du gaz sortant dudit four (10) afin de déterminer quand le traitement du matériau dans ledit four (10) est sensiblement terminé, et lorsque ledit procédé est sensiblement terminé, la commande de l'électroaimant (28) afin de libérer les éléments ferreux (30) lorsqu'ils sont sensiblement dans la partie supérieure de la rotation du four.

9. Procédé selon la revendication 8, dans lequel le four (10) comprend une première partie (12) et une seconde partie (14), le procédé comprenant en outre : la commande du four (10) afin qu'il tourne entre une première position de rotation, dans laquelle la première partie (12) est disposée au-dessus de ladite seconde partie (14) et une seconde position de rotation dans laquelle ladite seconde partie (14) est disposée au-dessus de ladite première partie (12).

10. Procédé selon la revendication 9, dans lequel l'électroaimant (28) est situé dans la première partie (12) et dans lequel le procédé comprend en outre l'activation de l'électroaimant (28) afin qu'il retienne les éléments ferreux (30) lorsque le four (10) tourne de la seconde position de rotation à la première position de rotation et éventuellement la désactivation de l'électroaimant (28) dans la première position de rotation, de sorte que les éléments ferreux (30) tombent, sous l'influence de la gravité, dans la seconde partie (14).

11. Procédé selon la revendication 10, dans lequel l'électroaimant (28) est situé dans la seconde partie (14) et dans lequel le procédé comprend l'activation de l'électroaimant (28) afin qu'il retienne les éléments ferreux (30) lorsque le four (10) tourne de la première position de rotation à la seconde position de rotation et éventuellement la désactivation de l'électroaimant (28) dans la seconde position, de sorte que les éléments ferreux (30) tombent, sous l'influence de la gravité, dans la première partie (12).

12. Procédé selon l'une quelconque des revendications 8 à 11, dans lequel le procédé comprend en outre :

l'analyse de la composition du gaz sortant dudit four (10) permettant de déterminer quand le traitement du matériau dans ledit four (10) par pyrolyse est sensiblement terminé ; et
lorsque ledit procédé de pyrolyse est sensiblement terminé, l'augmentation de la teneur en oxygène du four (10).

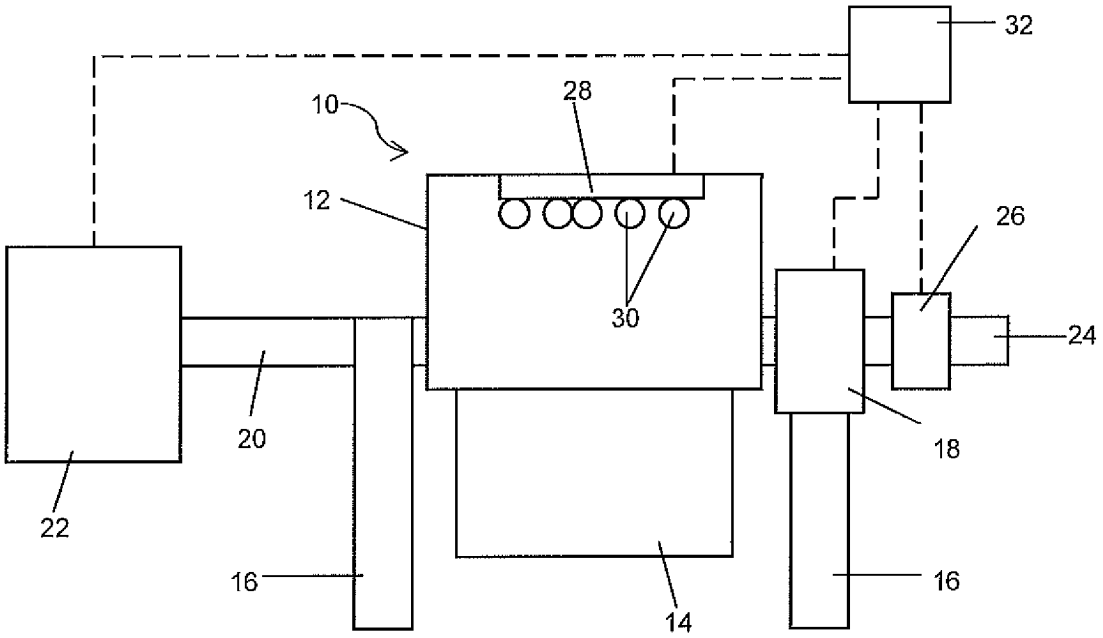

Figure 1

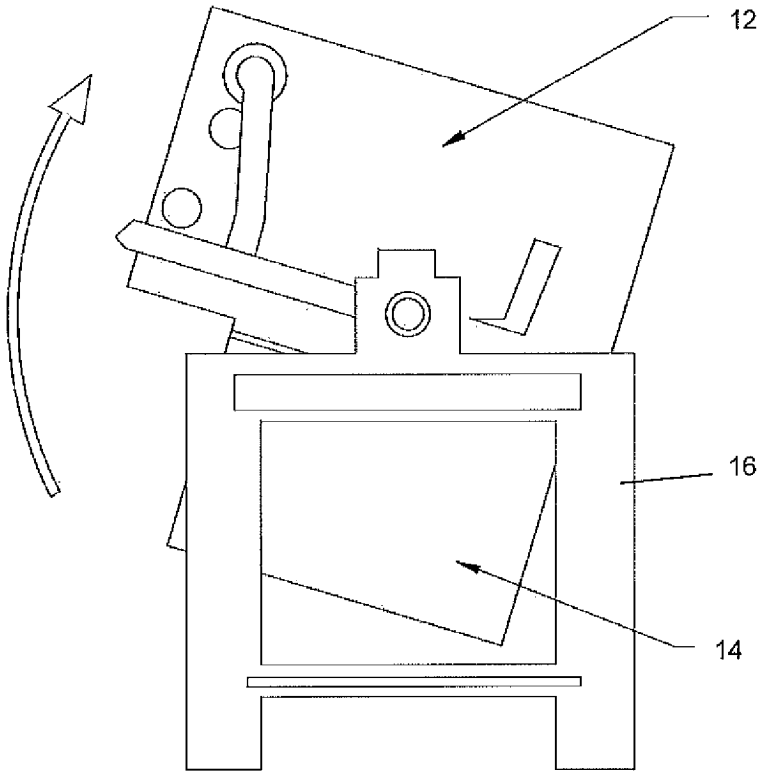

Figure 2

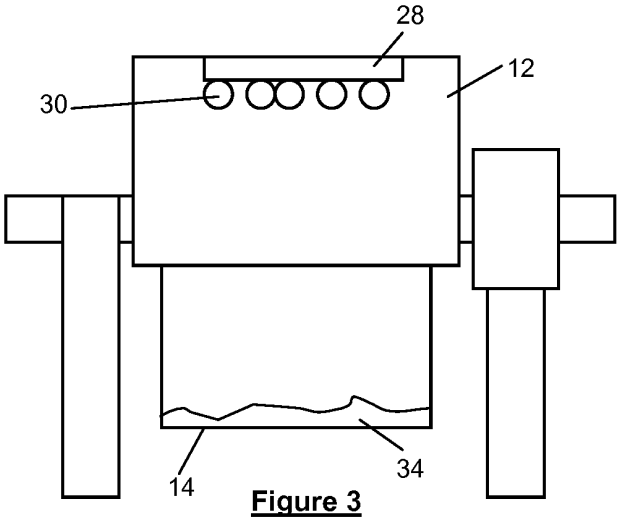

Figure 3

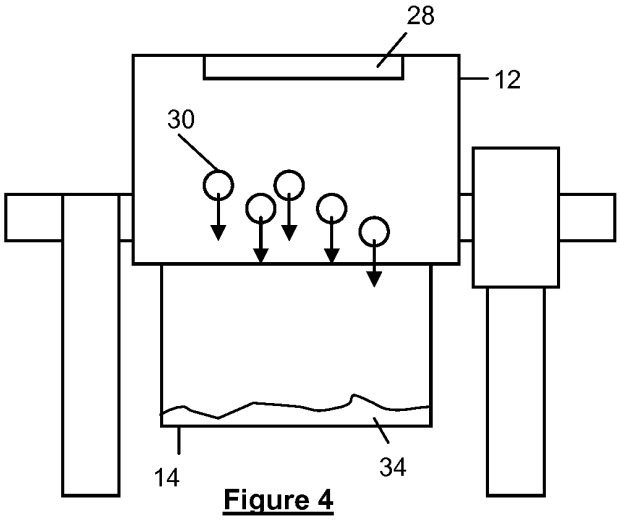

Figure 4

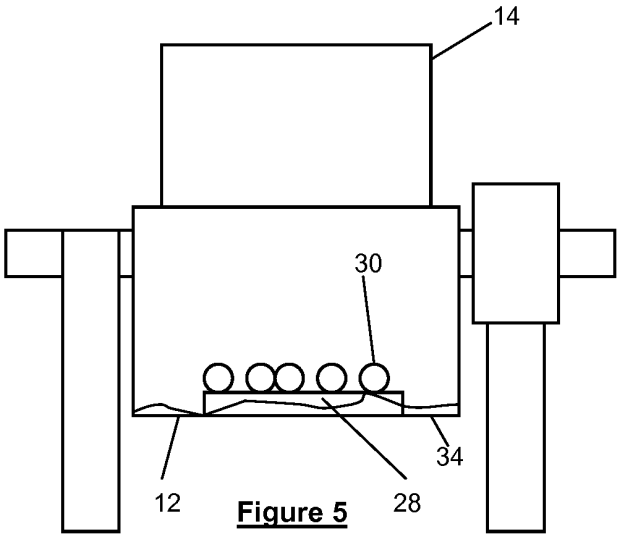

Figure 5

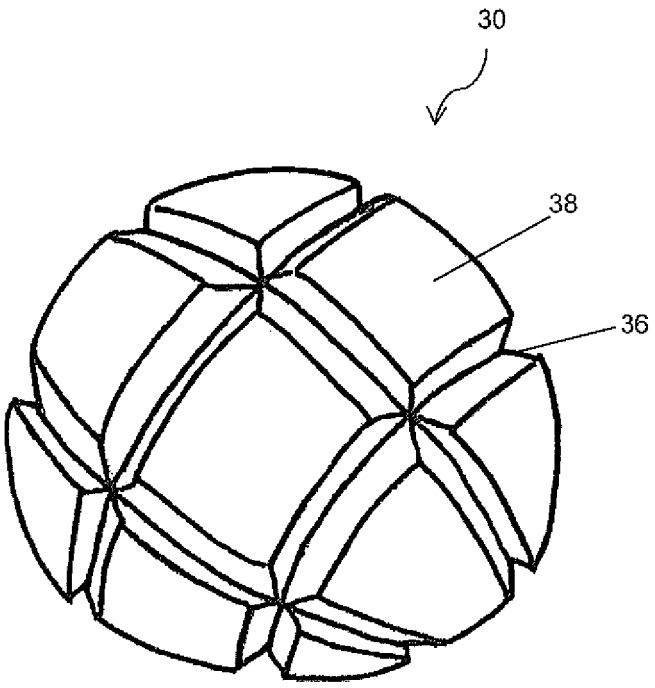

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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