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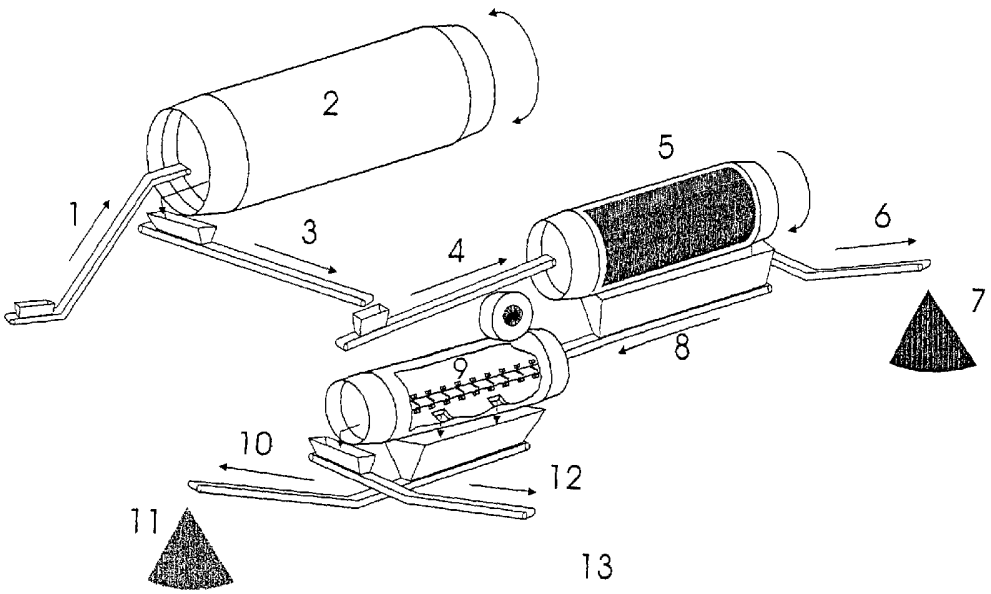
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[Continued on next page]

(54) Title: PRODUCTION OF REFINED CELLULOSE FIBRE FROM WASTE MATERIALS



(57) Abstract: A method of treating fibres produced by the thermal treatment of waste materials with pressurised steam (in a vessel 2), which method includes, drying the fibres (in a drier 9) such that the moisture content of the fibre is in the range of from about 4 to about 15% by weight of the fibre; substantially removing debris (such as grit and/or plastics material) from the treated fibre (in the drier 9); and optionally reducing the size of the refined treated fibre to length typically less than about 35mm (preferably less than 25mm).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PRODUCTION OF REFINED CELLULOSE FIBRE FROM WASTE MATERIALS

The present invention is concerned with a method of producing refined cellulose fibres from household, commercial and industrial wastes and, in particular, the production of dried fibres suitable for further processing into, for example, fuel or wood replacement items.

It is frequently a problem to convert household, commercial and industrial waste into a form readily useable either as a fuel or for the manufacture of wood replacement products. The cheapest and most cost effective way is generally to briquette or pelletise the waste. However, such briquetting or pelletising typically results in a product that is difficult to convert to a more commercially useful product.

Household, commercial and industrial wastes are mainly disposed of in landfill sites, are partially disposed of by incineration or partially recovered for recycling.

All of these disposal methods are high-risk pollutants of the environment and may therefore be considered environmentally unfriendly.

An alternative method is the thermal treatment of these wastes in an autoclave type process; such processes are known in the field of waste treatment. This steam treatment or autoclave system produces, as its main by-product, a fibre product typically containing moisture in the range 35% to 60% by weight and other unwanted materials such as glass, metals and aggregates described further as grit particles.

In its present form the fibre by-product is used as a low

value soil enhancer or can be further processed to manufacture a compost. However, it is typically dumped to land-fill sites.

It is therefore an aim of the present invention to alleviate at least some of the disadvantages identified above.

It is a further aim of the present invention to provide a method of treating fibre waste material so as to produce a raw material suitable for use in the manufacture of fuels and/or wood replacement items.

It is yet a further aim of the present invention to provide a fibre suitable for solid fuel manufacture or compacted form suitable for wood replacement item production.

Therefore, according to a first aspect of the present invention, there is provided a method of treating fibres produced by the thermal treatment of waste materials with pressurised steam, which method includes,
drying the fibres such that the moisture content of the fibre is in the range of from about 4 to about 15% by weight of the fibre; and
substantially removing debris (such as grit and/or plastics material) from the treated fibre.

Typically, the method further includes reducing the size of the refined treated fibre to length typically less than about 35mm (preferably less than 25mm.

The refined treated fibre is both clean and sterilised.

The length of the fibre is typically adjusted to suit the requirements of products manufactured from the treated

refined cellulose material.

The resultant dry fibrous material produced by the steam treatment of the waste, typically comprises substantially cellulose material derived from mixed vegetable matter.

The fibres produced by the treatment of waste materials with pressurised steam typically have a moisture content in the range 25-50% calculated by weight ratio, such fibres prior to treatment according to the present invention are difficult to separate from inert and plastics material which contaminate them.

"Wood replacement products" as used herein, may include cardboard, paper, insulation board, hardboard, or the like. The communition of household, commercial and industrial packaging waste is achieved by applying steam to the unsorted waste in a rotating pressure vessel. The paper, cardboard and petruscibles are converted to cellulose fibres. The thermoplastics are partially melted during this process and become ball shaped as a consequence of vessel rotation, whilst the thermoset plastics together with metals, aggregates, glass and other inert materials are cleaned, sterilised and physically remain unchanged. The cellulose fibres remain as a residue upon the removal of all other elements, listed previously, are separated.

Pressurised steam is advantageous over the prior art methods as it substantially doesn't slip, doesn't break, never turns it's edge, doesn't wear and conditions the derived fibres just as effectively. The combination of steam pressure and temperature, as applied to the waste, also renders potentially harmful bacteria and pathogens harmless in contrast to many prior art methods which do not.

It is particularly preferred that the pressurised steam has a pressure in the range 3Bar to 8Bar, such as about 5Bar.

The temperature of the pressurised steam is preferably in the range about 100°C to 250°C, further preferably 130°C to 200°C, such as about 160°C.

The fibres produced by the thermal treatment of waste materials may include undesirable waste material such as textiles, wood, aggregate, glass, metal and plastics during a screening process. A preferred screening process includes the use of a rotary trommel-type screen, which separates through apertures of preferably 4-20mm (such as 6-12mm). The fibres that pass through the screen as the undersize product may still contain inert and/or plastic particles. Preferably, the inert and/or plastic particles are substantially removed.

Advantageously, the moisture content of the fibre is reduced to moisture content in the range 4 to 15% by use of a drying apparatus. Preferably, the drying apparatus may also be used to substantially remove debris from the fibre and/or reduce the particle size of the debris. This process is typically a combination of both mechanical and thermal energy.

Advantageously, the fibres in the drying apparatus achieve a temperature in the range 120°C to 350°C, preferably about 150°C to 300°C, thereby evaporating the moisture present.

The drying apparatus preferably includes a removal device for inert material and/or plastics removal. The removal device is typically a rotating shaft fitted with a series of strategically placed paddles, diametrically opposing and

along the length of the shaft. The paddles when rotated at a predetermined peripheral speed advantageously induces a forward movement of the fibres and a centrifugal force to act on the heavier inert and plastic particles, which are directed to the sidewall of the drying apparatus for collection and disposal

It is particularly preferred that moisture removed during the production of the refined fibre is passed, typically in vapour form, through an oxidizing device to remove potential odour pollutants.

Advantageously, the density of fibres processed according to the present invention are typically in the range of about 50 to 120kg/m^3. However, the pre-treated fibres have a density typically in the range of about 250 to 500kg/m^3.

The refined cellulose material is typically graded according to its density. The grading is typically carried out using an air current separator. Alternatively, the refined cellulose material can be water washed through sieves, which is particularly desirable for use in the manufacture of cardboard and/or paper.

The pre-treated fibres are typically not suitable for the use as fuel or the manufacture of wood replacement products. The pre-treated fibres contain too much moisture and grit particles to use as a gasifier fuel or to agglomerate as solid fuel or to manufacture wood replacement products. The reduction of moisture to a range of 4-15% by weight and the removal of grit particles advantageously enables the use of the fibres as a gasified fuel or agglomeration as solid fuel or the manufacture of wood replacement products.

Therefore, according to a further aspect of the present invention, there is provided a method of producing a refined cellulose material, which method includes:

a) providing a fibre material obtained from the treatment of waste materials with pressurised steam;

b) drying the fibre material such that the moisture content is in the range from about 4% to about 15% by weight of the fibre; and

c) substantially removing undesirable debris (such as plastics material and/or grit) from the product obtained in b), so as to obtain the refined cellulose material.

Desirably, the fibre material is graded and/or sorted prior to step b). Typically, inert and/or plastics particulate material are substantially removed. Such removal may be by use of a screening vessel, for example a rotary trommel-type screen.

It is particularly preferred that the refined material is in the finely divided form, typically having a length of less than about 35mm, preferably less than about 30mm, further preferably less than 20mm.

Advantageously, the refined cellulose fibres according to the present invention can be used in the manufacture of gasified fuel, agglomerated solid fuel, in the manufacture of replacement wood products, insulation materials and/or attenuation material.

Therefore, according to yet a further aspect of the present invention, there is provided a use of the refined cellulose fibres according to the first aspect of the present invention in the manufacture of gasified fuel, solid fuel (such as agglomerated solid fuel), and/or replacement wood

products.

Advantageously, the refined cellulose material according to the present invention can be blended with a carbonaceous material (such as coal, coke fines or the like) to produce a fuel. The carbonaceous material can be present in the blend in an amount in the range 1 to 99%, preferably 5 to 95%, by weight of the blend of carbonaceous material and refined cellulose material.

The blend of carbonaceous material and refined cellulose material is typically agglomerated using standard agglomeration techniques. The blend is typically mixed with a binder prior to agglomeration. Typical binders include lignin and urea, molasses and lime, resins, polymers (especially polyvinyl acetate); however, it is envisaged that any binder known in the art of agglomeration may be used.

Advantageously, the refined cellulose material according to the first aspect of the present invention may also be used in the manufacture of wood replacement products, such as, for example, multi density fibreboard products.

The present invention will now be descried by way of example only, with reference to the accompanying Figure 1, which represents apparatus for the treatment, segregation and drying of the carbonaceous fraction of household, commercial and industrial wastes in order to produce a clean and sterile cellulose fibre.

The bulk substance consisting of household, commercial and industrial packaging waste is continuously placed on conveyor 1. The bulk substance has been subjected to inspection upon receipt and only coarse materials

unsuitable to the process are removed. Examples of coarse materials are rolls of carpet, wooden pallets, tree trunks, car engines and the like. From conveyor belt 1, the bulk substance enters into the process vessel 2. when a sufficient batch of the bulk substance is filled into the vessel, conveyor 1 is stopped, the filing operation ceases and the sealed vessel door is closed. Pressurised steam is applied to vessel 2 until an internal steam pressure (typically 5 Bar) is achieved. The pressure vessel 2 is rotated at a speed in the range 5 to 10 revolutions per minute for a period of 25 to 45 minutes. The rotational speed of the vessel and the duration of this period is determined by the quality requirement of the resulting processed cellulose fibre product. On completion of the applied steam pressure cycle (referred to as the 'cooking cycle'), the steam flow is stopped and the steam pressure is released from vessel 2 until normal ambient conditions prevail internal to the vessel. Only when these conditions are achieved can the vessel sealed door be opened. The method for discharging the processed bulk substance is by reversal of the rotational direction of the vessel compared to the direction of rotation used during the filing operation.

The processed bulk substance is transferred along conveyors 3 and 4, in the direction of the arrows, and deposited into the rotary trommel screen 5. The rotary trommel screen 5 serves to separate the bulk substance into two fractions, namely the oversized, typically above 12mm, and the undersized, which is smaller than 12mm. The oversized materials are delivered via conveyor 6 to the stockpile 7 for additional sorting.

The undersized material is then subjected to the method of the present invention. The undersized material is

delivered via rotary screen 5 to conveyor 8, which contains the cellulose fibres with inert and plastic particulate materials which are considered to be contaminants.

From the conveyor 8 the undersized materials are delivered into the drier 9, which is specifically designed to remove the inert and plastic particulate material of the cellulose fibres. The drier performs two functions in drying the substances and removal of the inert and plastics particulate material. Heat transferred from heated air flowing through the drier whilst the fibres are in suspension in the direr, dries the cellulose fibres. The fibres whilst passing through the drier are cleaned of inert and plastics particulate material by coming into contact with a rotating shaft fitted with paddles. The paddles are attached to the shaft in a predetermined pattern such that centrifugal force created by the rotating shaft acts on all particles in contact with the particles. The fibres which are low in density remain in the airflow and are deposited at the outlet of the drier subsequently to be delivered on conveyor 12. the denser and inert plastics particulate material are thrown by centrifugal force into the inner wall of the drier tube and collected in the base of the tube. Situated at the base of the drier tube are a series of power operated doors which allow the passage of the inert and plastics particulate material but prevent the ingress of air. The ingress of additional air into the drying chamber would interfere with the steady air flow conditions necessary for the efficient segregation and transfer of fibres through the drier. The residual inert and plastics particulate material are deposited from the dyer onto conveyor 10 for transfer to stock pile 11 for disposal. Simultaneously, the conditioned cellulose fibres are transported along conveyor 10 and deposited on stock pile 13. The cellulose fibres in stock pile 13 are clean

and sterile after the completion of the aforementioned production process. The preferred embodiment described above is of only one process cycle. Repeated batch cycles carried through a multiple of pressure vessels will determine the throughput of the process plant.

Claims

1. A method of treating fibres produced by the thermal treatment of waste materials with pressurised steam, which method includes,
drying the fibres such that the moisture content of the fibre is in the range of from about 4 to about 15% by weight of the fibre; and
substantially removing debris from the treated fibre.

2. A method according to claim 1, wherein the size of the refined treated fibre is reduced to length typically less than about 35mm (preferably less than 25mm).

3. A method according to claim 1 or 2, wherein the dry fibrous material produced by the steam treatment of waste comprises substantially cellulose material derived from mixed vegetable matter.

4. A method according to any preceding claim, wherein the moisture content of the fibre is reduced to a moisture content in the range 4 to 15% by use of a drying apparatus.

5. A method according to claim 4, wherein the drying apparatus is also used to substantially remove debris from the fibre and/or reduce the particle size of the fibre.

6. A method according to claim 4 or 5, wherein the drying apparatus dries the fibres to a temperature in the range 120°C to 350°C, thereby evaporating at least some of the moisture present.

7. A method according to any of claims 4 to 6, wherein the

drying apparatus includes a removal device arranged to substantially remove inert and/or plastics particulate material.

8. A method according to claim 7, wherein the removal device includes a rotating shaft fitted with at least two paddles diametrically opposing along the length of the shaft.

9. A method according to any preceding claim wherein, moisture removed during the production of the refined fibre is passed, typically in vapour form, through an oxidizing device to remove potential odour pollutants.

10. A method according to any preceding claim, wherein the density of the refined treated fibres are in the range of 50 to 120kg/m^3.

11. A method according to any preceding claim, wherein the refined or treated fibre is graded according to its density.

12. A method according to claim 7, wherein the grading is carried out using an air current separator.

13. A method according to any preceding claim, wherein the refined or treated fibre is water washed through sieves.

14. A method of producing a refined cellulose material, which method includes:

a) providing a fibre material obtained from the thermal treatment of waste materials with pressurised steam;

b) drying the fibre material such that the moisture

content is in the range from about 4% to about 15% by weight of the fibre; and

c) substantially removing undesirable debris (such as plastics material and/or grit) from the product obtained in b), so as to obtain the refined cellulose material.

15. A method according to claim 14, wherein the refined material is in finely divided form, preferably having a length of less than about 35mm.

16. A method according to claim 15, wherein the refined material typically has a length less than about 30mm, further preferably less than about 20mm.

17. A method according to any of claims 14 to 16, wherein the refined cellulose material is blended with a carbonaceous material to produce a fuel

18. A method according to claim 17, wherein the carbonaceous material includes coal, coke fines or the like.

19. A method according to claim 17 or 18, wherein the carbonaceous material is present in the blend in an amount in the range 1 to 99%, preferably 5 to 95%, by weight of the blend of carbonaceous material and refined cellulose material.

20. A method according to any of claims 17 to 19, wherein the blend of carbonaceous material and refined cellulose material is agglomerated using standard agglomeration techniques.

21. A method according to any of claims 17 to 21, wherein

the blend is mixed with a binder prior to agglomeration.

22. A method according to claim 21, wherein the binder includes lignin and urea, molasses and lime, resins, polymers (such as polyvinyl acetate).

23. Use of refined cellulose material produced according to any proceeding claim, in the manufacture of gasification/pyrolysis fuel, solid fuel (such as agglomerated solid fuel), and/or replacement wood products.

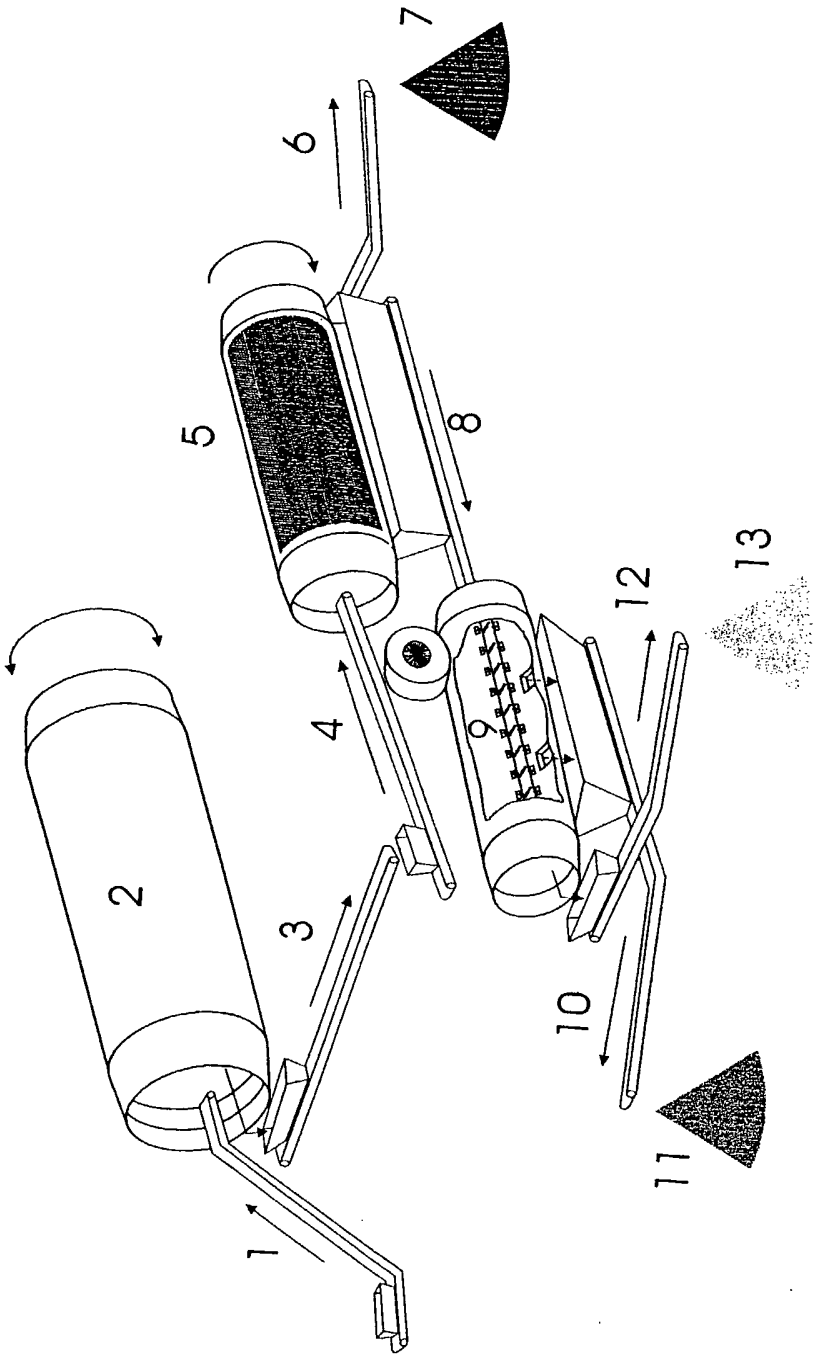


Figure 1

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D21B1/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D21B D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAPERCHEM, WPI Data

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"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

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 November 2003	12/11/2003

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/03756

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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