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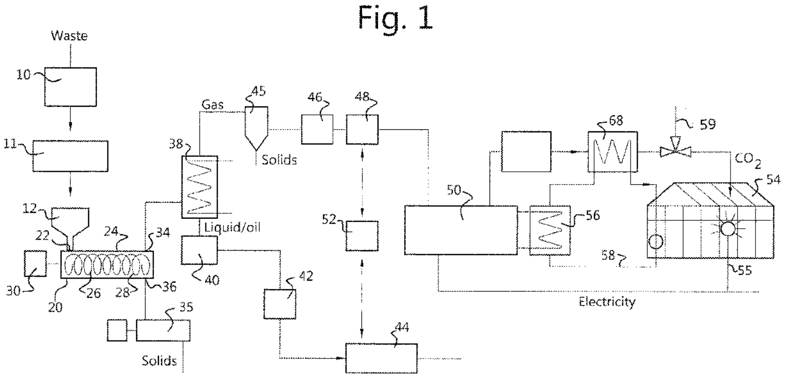
(54) Title: PRODUCTION METHOD OF GASEOUS FUEL, STARTING MATERIAL AND GREENHOUSE

Fig. 1



(57) Abstract: The invention concerns a method of producing a gaseous fuel, with a composition similar as Dutch Natural gas from secondary fuel comprising the steps of - providing a starting material, comprising a composition of free flowing particles of secondary fuel, wherein the particles have a particle size up to 20 mm, the composition has a density of more than 500 kg/m3 and a moisture content of less than 2% by weight and a nett calorific value of more than 35 MJ/kg thermal decomposing the starting material by direct contact heating at a temperature in the range of 550-800 °C under atmospheric pressure conditions in an anaerobe atmosphere collecting the produced gaseous fuel. The invention also relates to a starting material for use in this method, and a greenhouse.

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PRODUCTION METHOD OF GASEOUS FUEL, STARTING MATERIAL AND GREENHOUSE

The present invention relates to a production method of a gaseous fuel, a starting material for use in said production method comprising a free flowing particulate composition of secondary fuel, and a greenhouse.

In general, there is a need for sustainable economics. This applies to the consumption of natural resources, energy production, waste processing and the like. It is known to produce energy carriers, in particular gaseous and/or oil like fuels from biomass, but also from secondary fuels. In the production of gaseous energy carriers from secondary fuels the composition of the produced gas and its caloric value are important parameters, which in general are desired to be similar to those of natural gas. On the one hand this allows injection of the produced gas into an existing gas distribution network, on the other hand it allows to burn the fuel directly in existing equipment operating on natural gas without requiring significant modifications thereof. Furthermore yield is considered an important factor.

E.g. from US 2014/0284198 A1 an installation for pyrolyzing divided solids such as waste plastics, rubbers or elastomers is known, which installation comprises a pre-treatment device for preparing the divided solids in order to enable pyrolysis in a subsequent pyrolysis reactor. This pyrolysis reactor is connected to the pre-treatment device in a leak-tight manner. The reactor is provided with a transfer member, that is made of a material associated with means for heating by the Joule effect. In the pre-treatment device the divided solids are subjected to liquefaction thereby bringing the solids into a liquid state, which are pyrolized to obtain pyrolytic oils and pyrolysis gas. It is said that the divided solids upon liquefaction are capable of producing in particular pyrolytic oils by recondensation of gas when the solids are pyrolyzed at 400-600 °C. Such oils can be recycled. A pyrolysis gas containing industrially useful components like methane, hydrogen, acetylene is obtained when pyrolyzing the solids at temperatures in the range of 600-900 °C. In an example of treating very high density polyethylene waste using a pyrolysis temperature in the core of the pyrolysis reactor of 600 °C a gas ratio of more than 75% with a methane content of more than 40% is achieved. These results are said to be spectacular in terms of the methane content in the pyrolysis gas. Pyrolysis is understood to be a heat treatment that takes place in the absence of oxygen, i.e. with an oxygen content remaining below about 5% according to US2012/0043194 A1, to which US 2014/0284198 A1 refers regarding pyrolysis and the pyrolysis reactor. It is also stated that the higher the (pyrolysis) temperature, the greater the proportion of gas.

The invention generally aims at improving the yield of methane from thermal decomposition of plastic material, thereby improving the quality and/or value of the raw gaseous fuel produced.

An object of the invention is to provide a method of producing a gaseous fuel similar to Dutch natural gas regarding its composition and calorific value from secondary fuels in a high yield.

A further object of the present invention is to provide a composition of secondary fuels that allows to produce a gaseous energy carrier similar to Dutch natural gas regarding its composition and calorific value in a high yield.

Another object is to provide a greenhouse for growing plants, flowers, crops and the like wherein the greenhouse is provided with an installation for treating secondary fuels thereby producing heat, electricity and carbon dioxide, that are used in the energy (heat and electricity) supply and conditioning of the internal cultivation environment of the greenhouse.

In a first aspect the invention provides a method of producing a gaseous fuel from secondary fuel, comprising the steps of

- providing a starting material, comprising a composition of free flowing particles of secondary fuel, wherein the particles have a particle size up to 20 mm, preferably ≤ 15 mm, such as about 10 mm or less, the composition has a density of more than 500 kg/m^3 and a moisture content of less than 2% by weight and a nett calorific value of more than 35 MJ/kg,
- thermal decomposing the starting material by direct contact heating at a temperature in the range of 550-800 °C under atmospheric pressure conditions in an anaerobe atmosphere,
- collecting the produced gaseous fuel.

In a second aspect the invention also relates to a starting material for use in the method according to the invention, comprising a composition of free flowing particles from secondary fuel, comprising secondary fuel particles having a particle size of up to 20 mm, preferably ≤ 15 mm, such as about 10 mm or less, and a density of more than 500 kg/m^3, wherein the moisture content is less than 2%.

In a third aspect the invention also relates to a greenhouse for growing plants, flowers, crops and the like comprising a reactor for thermal decomposition of free flowing particulate of secondary fuel material having a reactor inlet and a reactor outlet, which is provided between the reactor and the reactor outlet with at least one combined transfer and heating member having a longitudinal axis and a helical portion mounted to rotate about its own longitudinal axis inside a tubular reactor housing, which transfer member is connected to the outlet shaft of a rotary drive motor, wherein at least the helical portion of the transfer member is constituted by electrically conductive material, wherein the transfer member has connection means for connecting it to an electricity power supply, wherein a reactor outlet is connected to a combined heat and power engine, of which the heat output is connected to the heating system of the greenhouse, the electricity output is connected to the electricity system of the greenhouse, and the CO_2 discharge is connected to the air conditioning system of the greenhouse.

In this regard the term “secondary fuel” defines a product that classifies under EN 15359, advantageously in classes 1 regarding the properties of net calorific value (≥ 25 MJ/kg (as received)), chlorine (≤ 0.2 %) and mercury (median: ≤ 0.02 mg/MJ (as received); 80th percentile: ≤0.04 mg/MJ (as received)) content and has not achieved the so called “end-of-waste” status according to Directive 2008/98/EC, Art. 6.

It has appeared that a composition comprising secondary fuel particles additionally having the specific size and density and dryness as defined above allows to produce a gaseous fuel in an economical way by thermal decomposition through direct contact heating, in particular gasification in the presence of an anaerobe atmosphere under prevailing atmospheric conditions regarding pressure at elevated temperature according to the method of the invention. In particular it has been possible to achieve a gas yield of over 80 vol.% with a methane content of more than 70 vol.% even more than 80 vol.%. The composition comprises a granular material which is composed of particles, preferably those which are considered as non-recyclable thermoplastics that are otherwise incinerated in a suitable incinerator in e.g. the cement industry, or discarded via landfills. Generally the composition according to the invention comprises any non-recyclable components comprising polyalkenes, polycarbonate, polyamide and polyester, of which the polyalkenes based on lower (C_1-C_4) alkenes, in particular polyethylenes and polypropylenes, are preferred.

The particle size may range up to 20 mm, preferably ≤ 15 mm. Advantageously the particles have a maximum size of about 10 mm in view of transport limitations in the process. The density thereof is at least 500 kg/m^3 for reason of capacity restrictions in the reactor. Moisture content should be below 2%, because otherwise the reactor is used as vaporizer instead of supporting the reaction kinetics.

The secondary fuel particulates as defined above preferably fulfil the further conditions that the content of halogen containing compounds, in particular chloro and fluoro compounds, is minimal, in particular they are completely absent (wt% = 0). Preferably heavy metals are absent as well. Advantageously Hg and Cd, if any, are present in an amount of less than 1 mg Hg/kg respectively, less than 2 mg Cd/kg. The absence of these contaminations and/or impurities ensures the production of clean gaseous fuel, which can be further combusted in a conventional gas burner or furnace.

A preferred plastic starting material has a chemical composition

Water	wt.%	≤ 2
Ash content	wt. %	≤ 20
S	wt.%	≤ 0.16
Cl	wt.%	≤ 0.1
F	wt.%	≤ 0.1
Heavy metals:		
Cd	mg/kg	≤ 4
Tl	mg/kg	≤ 4
Hg	mg/kg	≤ 0.6
As	mg/kg	≤ 5
Co	mg/kg	≤ 6
Ni	mg/kg	≤ 80
Se	mg/kg	≤ 10
Sb	mg/kg	≤ 100
Pb	mg/kg	≤ 190
Cr	mg/kg	≤ 125
Cu	mg/kg	≤ 350
Mn	mg/kg	≤ 250
V	mg/kg	≤ 10
Sn	mg/kg	≤ 30
Zn	mg/kg	≤ 1000
Be	mg/kg	≤ 2

the remainder being plastic, and has a maximum particle size of 20 mm, a density of 500-600 kg/m^3, a lower heating value (LHV) of 35.41 MJ/kg, mean LHV of > 38.35 MJ/kg.

The starting material can be prepared from a primary feedstock of non-recyclable plastics, advantageously non-recyclable thermoplastics, using an agglomerator. Among others plastic film, fibre, filament and foam can be easily converted into a free flowing granular composition according to the invention. Composites are another suitable source of raw material for the composition according to the invention.

In the process according to the invention the granular composition as discussed above is subjected to thermal decomposition (direct gasification) at a temperature in the range of 550-800 °C and at atmospheric pressure in the presence of an anaerobe atmosphere. Contrary to known high pressure, high temperature processes like pyrolysis the direct gasification method according to the invention is carried out under prevailing atmospheric conditions at temperatures below this temperature range conversion efficiency is small and the yield in terms of methane leaves something to be desired. At temperatures above the upper temperature limit significant improvements regarding composition and yield are not achieved. The method does not require the use of specially designed pressure vessels and the like as reactor(s). Anaerobe atmosphere in the context of this application means 3 vol.% O2 or less. Preferably the O2 content is at most 2.5 vol.%.

Typically the process according to the invention produces a gaseous fuel having a composition (vol.%)

CO	0-4.5
CO2	2.0-11.0
CH4	70-90
CnHn	2-16
H2	0-5.0
O2	0-0.5
Others, mainly N2	0-0.1
Chlorine	< 1 mg/kg
Flurorine	< 1 mg/kg
Density	0.8-1.1 kg/m3
Gross calorific value	30.0-40.0 MJ/m3
Nett calorific value	32.0-42.0 MJ/m3

The process according to the invention is carried out by direct contact heating, preferably in a reactor as disclosed in WO 9939549 A1. Basically such a reactor comprises at least one transfer member having a longitudinal axis and a helical portion mounted to rotate about its own longitudinal axis inside a reactor housing, which extends from the inlet of the reactor to the outlet thereof. The transfer member is driven by a suitable motor. At least the helical portion of the transfer member is constituted in its bulk by an electrically conductive material and the transfer member has connection means for connecting it to an electricity power supply so that it itself constitutes the heater means.

It has appeared that use of this direct heating for gasification of the composition according to the invention enables to produce gaseous fuel having a methane content that is considerably higher than the pyrolysis gas produced according to US 2014/0284198 A1.

The gaseous fuel produced is suitable for further combustion in a combustor and the like. In a further advantageous embodiment the thus produced gaseous fuel is fed to a combined heat and power plant (CHP), wherein the gaseous fuel is converted into heat, electricity and carbon dioxide. On its turn this heat, electricity and carbon dioxide are advantageously consumed in a greenhouse.

The invention is further illustrated by means of the single figure that shows an embodiment of the process and greenhouse according to the invention.

In Fig. 1 an agglomeration unit for producing a composition according to the invention is generally indicated by reference numeral 10. In this agglomerator waste secondary fuel material is sintered or plasticized by friction and pressed through a cylindrical die. The material exiting the die at the outer periphery thereof is cut by knives rotating around the die. The thus cut material is fed to a hot melt granulator, wherein co-operating knives further reduce the material size. Then the material is passed through a screen of which the size of the screen openings determine the granulate dimensions. Dust and the like can be easily separated off by means of further screening, e.g. using a cyclone, and recycled back. If necessary, the produced granular material can be cooled. Optionally after temporary storage in container 11, the free flowing particulate composition of secondary fuel is fed via hopper 12 as starting material to a reactor 20 at the inlet 22 thereof. The reactor 20 comprises a cylindrical housing 24. In the housing a screw conveyor 26 is arranged, of which the helical portion 28 is made from an electrically conductive material. At one end of the housing 24 a motor 30 is arranged for driving the screw conveyor 26. The housing 24 has a gas top outlet 34 at the end opposite to the end where the inlet 22 is arranged and a bottom outlet 36 for the residue of the treated particles. The residue is cooled in cooler 35. In this embodiment the gas top outlet 34 is connected to a condenser 38 for condensing the liquid (oil) fraction from the produced gas. This fraction can be collected at 40 and for example used after treatment in an oil/water separator 42 as diesel fuel in a diesel motor generator 44 that produces electricity that .e.g. can be used for the reactor 20 and/or any other equipment, e.g. at the plant. Typically this diesel thus produced comprises hydrocarbons (98-99.5 wt.%), the remainder being mainly water, and has a nett calorific value of about 39 MJ/kg (38.5-42.0 MJ/kg). Optionally the non-condensed gas fraction after solid separation in cyclone 45 is further purified, e.g. in active carbon filter 46 and/or $CaCO_3$ filter 48. The solids from cyclone 45 may be combined with the solids resulting from cooler 35. The gas thus produced can be used as a fuel in a combined heat and power engine 50 as shown. Temporarily storing in a suitable storage container 52 is another option. The combined heat and power engine 50 produces a CO2 gas containing exhaust gas, which can be used for conditioning the climate in greenhouse 54. Electricity generated by engine 50 can also be used in the greenhouse 54, e.g. for lighting 55 as illustrated. The heat produced in engine 50 can also be used, e.g. by heat exchange in heat exchanger 56 with a heat exchanging fluid that flows in a heating system 58 comprising a closed loop for this fluid, which loop passes at least partially through the greenhouse 54. CO_2 is also fed to the greenhouse 54 for conditioning the internal atmosphere thereof. Surplus exhaust gas can be discharged into the atmosphere via exhaust 59, preferably after cooling in heat exchanger 68 with the heat exchanging fluid flowing in heating system 58. If diesel motor generator 44 allows, and if necessary, the gas produced can also be fed to this device.

In an example secondary fuel starting material made of plastic was prepared in an agglomerator. The characteristic data thereof comprised particle size about 10 mm, an LHV (BG SBS 10/2013;L) of 36360 kJ/kg, a chlorine content (DIN 51727;L) < 0.1 wt.% and Hg content (DIN EN 1483;L) < 0.1 wt.%.

Detailed chemical analysis (inter alia according to DIN 51727;L and DIN EN ISO 17294-2;L) offered the following data.

Ash content	0.62	wt.%
Sulphur (total)	< 0.1	
Fluor (total)	< 0.1	
Chlorine (total)	< 0.1	
Sb	104	mg/kg
As	< 1	
Pb	1.1	
Cd	<0.1	
Cr (total)	2.9	
Co	<1	
Cu	1.9	
Mn	39.1	
Hg	< 0.1	
Tl	<0.4	
Sn	<1	

The agglomerate was subjected to thermal decomposition in the thermal decomposition reactor 20 as described referring to Fig. 1 in the presence of an anaerobe atmosphere under atmospheric conditions regarding pressure at various temperatures. The below Table 1 shows the results of the gas thus obtained in terms of composition regarding the main components and their yield.

Table 1. Gas analysis data (in %)

	Temperature (°C)				
Component (%)	650	700	750	800	
CO	3.24	2.98	1.71	1.69	
CO2	5.17	6.38	3.73	2.47	
CH4	76.7	74.8	78.6	82.4	
CnHn	14.8	15.2	15.9	13.4	
H2	0.00	0.00	0.00	0.00	
O2	0.06	0.56	0.01	0.00	
LHV (MJ/m3)	37.5	37.03	38.7	38.4	

LHV= Nett calorific value

As is apparent a CH4 yield of over 70% is achieved at all temperatures.

CLAIMS

1. Method of producing a gaseous fuel from secondary fuel, comprising the steps of

- providing a starting material, comprising a composition of free flowing particles of secondary fuel, wherein the particles have a particle size up to 20 mm, the composition has a density of more than 500 kg/m^3 and a moisture content of less than 2% by weight and a nett calorific value of more than 35 MJ/kg
- thermal decomposing the starting material by direct contact heating at a temperature in the range of 550-800 °C under atmospheric pressure conditions in an anaerobe atmosphere
- collecting the produced gaseous fuel.

2. Method according to claim 1, wherein the secondary fuel is a product that classifies under EN 15359, advantageously in classes 1 regarding the properties of net calorific value (≥ 25 MJ/kg (as received)), chlorine (≤ 0.2 %) and mercury (median: ≤ 0.02 mg/MJ (as received); 80th percentile: ≤0.04 mg/MJ (as received)) content and has not achieved the so called “end-of-waste” status according to Directive 2008/98/EC, Art. 6.

3. Method according to claim 1, wherein direct contact heating is carried out in a reactor (20) comprising a reactor housing (24) having a reactor inlet (22) and a reactor outlet (34; 36), wherein the starting material is advanced from the reactor inlet (22) to the reactor outlet (36) by at least one driven combined transfer and heating element (26) having a longitudinal axis and a helical portion (28) mounted to rotate about its own longitudinal axis inside the reactor housing (20), which element is constituted by electrically conductive material, connected to a power supply (30), wherein the starting material is heated by direct contact with at least the helical portion (28) of the transfer element(26).

4. Method according to any one of the preceding claims, wherein the starting material is a plastic starting material having a chemical composition:

Water	wt.%	≤ 2
Ash content	wt. %	≤ 20
S	wt.%	≤ 0.16
Cl	wt.%	≤ 0.1
F	wt.%	≤ 0.1
Heavy metals:		
Cd	mg/kg	≤ 4
Tl	mg/kg	≤ 4

Hg	mg/kg	≤ 0.6
As	mg/kg	≤ 5
Co	mg/kg	≤ 6
Ni	mg/kg	≤ 80
Se	mg/kg	≤ 10
Sb	mg/kg	≤ 100
Pb	mg/kg	≤ 190
Cr	mg/kg	≤ 125
Cu	mg/kg	≤ 350
Mn	mg/kg	≤ 250
V	mg/kg	≤ 10
Sn	mg/kg	≤ 30
Zn	mg/kg	≤ 1000
Be	mg/kg	≤ 2

the remainder being plastic, and has a maximum particle size of 20 mm, a density of 500-600 kg/m^3, a lower heating value (LHV) of 35.41 MJ/kg, mean LHV of > 38.35 MJ/kg.

5. Method according to any one of the preceding claims, wherein the produced gaseous fuel has a composition (vol.%)

CO	0-4.5
CO2	2.0-11.0
CH4	70-90
CnHn	2-16
H2	0-5.0
O2	0-0.5
Others	0-0.1
Chlorine	< 1 mg/kg
Fluorine	< 1 mg/kg
Density	0.8-1.1 kg/m3
Gross calorific value	30.0-40.0 MJ/m3
Nett calorific value	32.0-42.0 MJ/m3

6. Method according to any one of the preceding claims, wherein the produced gaseous fuel is fed to a combined heat and power plant (50), wherein the gaseous fuel is consumed to generate heat, electricity and exhaust gas comprising carbon dioxide.

7. Method according to claim 6, further comprising the step of providing the generated electricity, heat and carbon dioxide to a greenhouse (54) for growing plants, flowers, crops and the like.

8. Starting material for use in the production method according to any one of the preceding claims, comprising a composition of free flowing particles of secondary fuel, wherein the particles have a particle size up to 20 mm, the composition has a density of more than 500 kg/m3 and a moisture content of less than 2% by weight and a nett calorific value of more than 35 MJ/kg.

9. Starting material according to claim 8, wherein the secondary fuel is a product that classifies under EN 15359, advantageously in classes 1 regarding the properties of net calorific value (≥ 25 MJ/kg (as received)), chlorine (≤ 0.2 %) and mercury (median: ≤ 0.02 mg/MJ (as received); 80th percentile: ≤0.04 mg/MJ (as received)) content and has not achieved the so called “end-of-waste” status according to Directive 2008/98/EC, Art. 6.

10. Starting material according to claim 8 or 9, wherein the starting material is a plastic starting material having a chemical composition:

Water	wt.%	≤ 2
Ash content	wt. %	≤ 20
Sulphur	wt.%	≤ 0.16
Chlorine	wt.%	≤ 0.1
Fluorine	wt.%	≤ 0.1
Heavy metals:		
Cadmium	mg/kg	≤ 4
Thallium	mg/kg	≤ 4
Mercury	mg/kg	≤ 0.6
Arsenic	mg/kg	≤ 5
Cobalt	mg/kg	≤ 6
Nickel	mg/kg	≤ 80
Selenium	mg/kg	≤ 10
Antimon	mg/kg	≤ 100
Lead	mg/kg	≤ 190
Chromium	mg/kg	≤ 125
Copper	mg/kg	≤ 350
Manganese	mg/kg	≤ 250
Vanadium	mg/kg	≤ 10

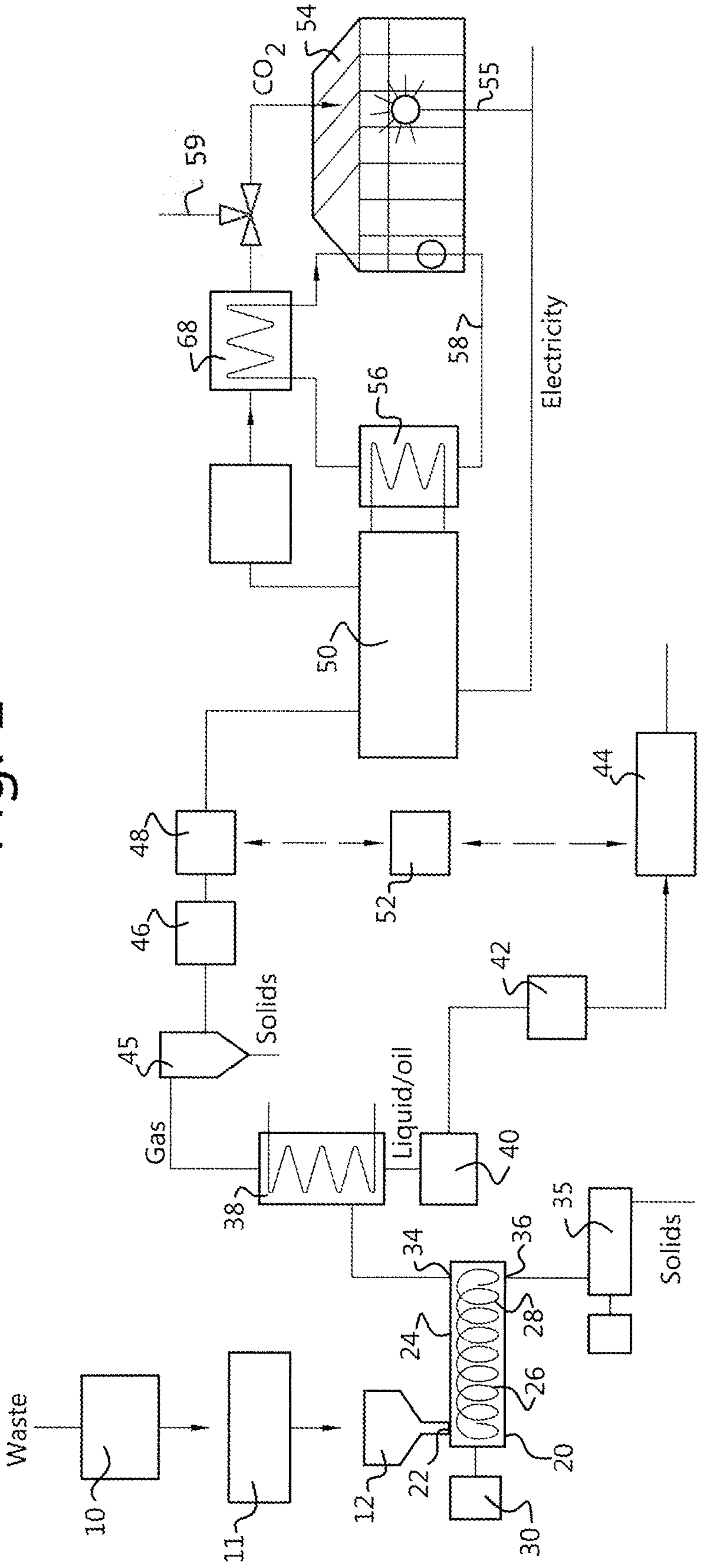
Tin	mg/kg	≤ 30
Zinc	mg/kg	≤ 1000
Beryllium	mg/kg	≤ 2,

the remainder being plastic,

and has a maximum particle size of 20 mm, a density of 500-600 kg/m^3, a lower heating value (LHV) of 35.41 MJ/kg, mean LHV of > 38.35 MJ/kg.

11. Greenhouse (54) for growing plants, flowers, crops and the like comprising a reactor (20) for thermal decomposition of free flowing particulate, secondary fuel material comprising a reactor housing (24) having a reactor inlet (22) and a reactor outlet (34, 36), which reactor (20) is provided between the reactor inlet (22) and the reactor outlet (36) with at least one combined transfer and heating element (26) having a longitudinal axis and a helical portion (28) mounted to rotate about its own longitudinal axis inside the reactor housing (24), which transfer element (26) is connected to a drive (30), wherein at least the helical portion (28) of the transfer member (26) is constituted by electrically conductive material, wherein the transfer member (26) has connection means for connecting it to an electricity power supply (30), wherein a reactor outlet (34) is connected to a combined heat and power engine (50), of which the heat output is connected to the heating system (58) of the greenhouse (54), the electricity output is connected to the electricity system (55) of the greenhouse (54), and the CO_2 discharge is connected to the air conditioning system of the greenhouse (54).

Fig. 1


Waste
10
11
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30
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26
28
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36
35
Solids
38
Gas
Liquid/oil
40
42
44
45
Solids
46
48
52
50
56
58
68
59
CO_2
54
55
Electricity

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2017/050049

A. CLASSIFICATION OF SUBJECT MATTER
INV. C10L3/08 C10L5/40 C10B7/10 C10B53/07
ADD.

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)
C10L C10B

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 practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 188 571 B2 (NUSIMOVICH SERGIO [AU]) 13 March 2007 (2007-03-13)	1,2,4-10
Y	column 10, lines 30-65 column 5, lines 1-21; claims; figures 1,8 -----	3
Y	US 2012/043194 A1 (LEPEZ OLIVIER [FR] ET AL) 23 February 2012 (2012-02-23) cited in the application abstract; claims; figure 1 paragraphs [0056] - [0059] -----	3,11
Y	US 2011/041395 A1 (NEWBOLD RICHARD [US] ET AL) 24 February 2011 (2011-02-24) paragraphs [0026] - [0030]; figure 1 -----	11
	-/--	

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

[X] See patent family annex.

* Special categories of cited documents :

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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
1 June 2017	14/06/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bertin, Séverine

2

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/218457 A1 (JACOBSEN JØRN [ES]) 6 August 2015 (2015-08-06) paragraphs [0080], [0087] - [0106]; claims; figures 2,3	11
A	US 2006/280669 A1 (JONES FRED L [US]) 14 December 2006 (2006-12-14) abstract; claims; figures	1-10
A	DE 38 19 699 C1 (GREUL, ARTUR RICHARD) 24 August 1989 (1989-08-24) abstract; claims; figures	1-10
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A	US 2015/275114 A1 (TUMIATTI VANDER [IT] ET AL) 1 October 2015 (2015-10-01) abstract; claims; figures	11

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL2017/050049

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-10

   Method of producing a gaseous fuel by decomposing a starting material comprising secondary fuel at 550-800°C

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2. claim: 11

   Greenhouse for growing plants, flowers, crops and the like comprising a reactor suitable for thermal decomposition of free flowing particulate, secondary fuel material, with recuperation of heat, electricity and CO_2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2017/050049

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