

SPECIFICATION

TITLE OF THE INVENTION: WASTE TREATMENT FACILITY, RESOURCE RECOVERY SYSTEM, AND WASTE TREATMENT METHOD

5 TECHNICAL FIELD

[0001] The present disclosure relates to a waste treatment facility, a resource recovery system, and a waste treatment method for recovering plastic from waste containing biomass and plastic.

The present application claims priority based on Japanese Patent Application No. 2023-
10 193214 filed on November 13, 2023, the entire content of which is incorporated herein by reference.

BACKGROUND ART

[0002] A waste treatment device for recovering plastic from waste containing biomass and
15 plastic is known. For example, the waste treatment device disclosed in Patent Document 1 includes a hydrothermal treatment device that hydrolyzes waste with steam to generate a reformed material. This reformed material contains large-particle components such as plastic and small-particle components such as food.

20 Citation List

Patent Literature

[0003] Patent Document 1: WO2023/085241A

SUMMARY

25 Problems to be Solved

[0004] From the viewpoint of resource reuse, it is preferable that the proportion of plastic recovered from waste is high.

[0005] An object of the present disclosure is to provide a waste treatment facility, a resource

recovery system, and a waste treatment method with an improved recovery rate of plastic.

Solution to the Problems

[0006] A waste treatment facility according to at least one embodiment of the present
5 disclosure is a waste treatment facility for recovering granular plastic from waste containing biomass and plastic, including:

a biomass reduction device configured to perform a biomass reduction process on the waste for reducing a content of the biomass in the waste;

a plastic hydrothermal treatment device configured to perform a plastic hydrothermal
10 treatment on plastic waste which is the waste that has been subjected to the biomass reduction process; and

a plastic recovery device for recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

[0007] A waste treatment facility according to at least one embodiment of the present
15 disclosure is a waste treatment facility for recovering granular plastic from waste containing biomass and plastic, including:

a second measuring device for measuring a biomass ratio, which is a proportion occupied by the biomass in the waste;

a plastic hydrothermal treatment device configured to perform a plastic hydrothermal
20 treatment on the waste having the biomass ratio equal to or less than an upper limit value of a specified range; and

a plastic recovery device for recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.

[0008] A waste treatment method according to at least one embodiment of the present
25 disclosure is a waste treatment method for recovering granular plastic from waste containing biomass and plastic, including:

a biomass reduction step of performing a biomass reduction process on the waste for reducing a content of the biomass in the waste;

a plastic hydrothermal treatment step of performing a plastic hydrothermal treatment on plastic waste which is the waste that has been subjected to the biomass reduction process; and

a plastic recovery step of recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

5 [0009] A waste treatment method according to at least one embodiment of the present disclosure is a waste treatment method for recovering granular plastic from waste containing biomass and plastic, including:

a second measuring step of measuring a biomass ratio, which is a proportion occupied by the biomass in the waste;

10 a plastic hydrothermal treatment step of performing a plastic hydrothermal treatment on the waste having the biomass ratio equal to or less than an upper limit value of a specified range; and

a plastic recovery step of recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.

15

Advantageous Effects

[0010] The present disclosure provides a waste treatment facility, a resource recovery system, and a waste treatment method with an improved recovery rate of plastic.

20 BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. 1 is a schematic diagram of a waste treatment facility according to an embodiment.

FIG. 2 is a schematic diagram of the waste treatment facility (first embodiment).

FIG. 3 is a schematic diagram of a biomass reduction device according to an embodiment.

25 FIG. 4 is a schematic diagram of a biomass hydrothermal treatment device according to an embodiment.

FIG. 5 is a schematic diagram of a plastic hydrothermal treatment device according to an embodiment.

FIG. 6 is a schematic diagram of a plastic recovery device according to an embodiment.

FIG. 7 is a schematic diagram of a first measuring device according to an embodiment.

FIG. 8 is a schematic diagram of a captured image according to an embodiment.

FIG. 9 is a schematic diagram of a specifying device according to an embodiment.

5 FIG. 10 is a schematic diagram of spectrum data according to an embodiment.

FIG. 11 is a schematic diagram of a graph used by an identification unit according to an embodiment.

FIG. 12A is a schematic graph of the first relationship (first example).

FIG. 12B is a schematic graph of the first relationship (second example).

10 FIG. 12C is a schematic graph of the first relationship (third example).

FIG. 13A is a schematic graph showing a desalination effect when hydrolysis is performed on plastic (alkaline agent added).

FIG. 13B is a schematic graph showing a desalination effect when hydrolysis is performed on plastic (alkaline agent and biomass added).

15 FIG. 13C is a schematic graph showing a desalination effect when hydrolysis is performed on plastic (biomass added).

FIG. 14 is a flowchart of a waste treatment method (first embodiment).

FIG. 15 is a flowchart of a biomass reduction process.

FIG. 16 is a schematic diagram of a waste treatment facility according to a modified

20 example of the first embodiment.

FIG. 17 is a schematic diagram of the waste treatment facility (second embodiment).

FIG. 18 is a schematic diagram of a second measuring device according to an embodiment.

FIG. 19 is a flowchart of a waste treatment method (second embodiment).

FIG. 20 is a schematic diagram of a resource recovery system according to an embodiment.

25 FIG. 21 is a schematic diagram of a biomass conveying device according to an embodiment.

DETAILED DESCRIPTION

[0012] Embodiments of the present disclosure will be described below with reference to the accompanying drawings. It is intended, however, that unless particularly identified, dimensions, materials, shapes, relative positions, and the like of components described in the embodiments shall be interpreted as illustrative only and not intended to limit the scope of the present disclosure.

For instance, an expression of relative or absolute arrangement such as “in a direction”, “along a direction”, “parallel”, “orthogonal”, “centered”, “concentric” and “coaxial” shall not be construed as indicating only the arrangement in a strict literal sense, but also includes a state where the arrangement is relatively displaced by a tolerance, or by an angle or a distance whereby it is possible to achieve the same function.

For instance, an expression of an equal state such as “same” “equal” and “uniform” shall not be construed as indicating only the state in which the feature is strictly equal, but also includes a state in which there is a tolerance or a difference that can still achieve the same function.

Further, for instance, an expression of a shape such as a rectangular shape or a cylindrical shape shall not be construed as only the geometrically strict shape, but also includes a shape with unevenness or chamfered corners within the range in which the same effect can be achieved.

On the other hand, an expression such as “comprise”, “include”, “have”, “contain” and “constitute” are not intended to be exclusive of other components.

The same configurations are indicated by the same reference signs and may not be described again in detail.

[0013] <Overview of Waste Treatment Facility 5>

FIG. 1 is a schematic diagram of a waste treatment facility 5 according to an embodiment of the present disclosure. The waste treatment facility 5 is configured to recover granular plastic Pg, which is plastic Pc reduced in size, from waste Ws containing biomass Bs and plastic Pc. In a process of recovering the granular plastic Pg, the biomass Bs is separated from the waste Ws. In a more preferable embodiment, granular biomass Bg, which is biomass Bs

reduced in size, is also recovered. Merely as an example, the biomass Bs includes paper, vegetation, garbage, and cloth, and the plastic Pc includes polyvinyl chloride, polystyrene, polypropylene, and polyethylene.

[0014] The main components of the waste Ws to be treated by the waste treatment facility 5 of the present embodiment are the biomass Bs and the plastic Pc. The waste Ws may be, as an example, food waste which does not contain components other than the biomass Bs and the plastic Pc. However, the present disclosure is not limited thereto, and the food waste may contain moisture. Furthermore, the waste Ws may contain metal integrated with the plastic Pc.

[0015] In some embodiments, the granular biomass Bg and the granular plastic Pg may be converted into liquid ethanol. Liquid ethanol has a higher density than biogas, plastic gas, and the like, and is therefore easy to transport from the waste treatment facility 5 to another place. Liquid ethanol is generated from the granular biomass Bg and the granular plastic Pg through gasification by thermal decomposition and chemical reactions using catalysts or biological fermentation. However, the present disclosure is not limited thereto, and in other embodiments, the granular biomass Bg and the granular plastic Pg may be carried out from the waste treatment facility 5 as they are.

[0016] Several embodiments can be applied to the waste treatment facility 5 illustrated in FIG. 1. In the following description, a waste treatment facility 5A (5) according to the first embodiment and a waste treatment facility 5B (5) according to the second embodiment will be described. The first embodiment is shown in FIGs. 2 to 16, and the second embodiment is shown in FIGs. 17 to 19. FIGs. 20 and 21 show a resource recovery system 1 incorporating the waste treatment facility 5A of the first embodiment.

[0017] <Waste Treatment Facility 5A (5) According to First Embodiment>

As shown in FIG. 2, the waste treatment facility 5A (5) is provided with: a biomass reduction device 7 configured to perform a biomass reduction process on the waste Ws; a plastic hydrothermal treatment device 8 configured to perform a plastic hydrothermal treatment on the waste Ws that has been subjected to the biomass reduction process; and a plastic recovery

device 9 for recovering the granular plastic Pg from the waste Ws that has been subjected to the plastic hydrothermal treatment. The plastic hydrothermal treatment is a hydrothermal treatment for decomposing the plastic Pc using steam.

[0018] The biomass reduction process is a process for reducing the content of the biomass Bs in the waste Ws. An example of this process includes a biomass hydrothermal treatment for decomposing the biomass Bs into the granular biomass Bg, and a biomass recovery process for recovering the granular biomass Bg from the waste Ws (details will be described later with reference to FIG. 3).

[0019] It is preferable that a certain amount of the biomass Bs remains in the waste Ws that has been subjected to the biomass reduction process (hereinafter, also referred to as plastic waste Wp). This is because, if the biomass Bs does not remain at all, the plastic Pc may not be reduced in size or the plastic Pc reduced in size may not be dispersed in the plastic hydrothermal treatment following the biomass reduction process. On the contrary, the biomass Bs may contribute to making the plastic Pc into fine particles in the plastic hydrothermal treatment. For example, when powdery biomass such as bark is generated from the biomass Bs through the plastic hydrothermal treatment, granulation of the biomass Bs is promoted in the plastic hydrothermal treatment.

[0020] Technical advantages brought about by the waste treatment facility 5A are as follows. The inventors of the present application have found that the higher the proportion of the biomass Bs in the plastic waste Wp subjected to the plastic hydrothermal treatment, the more organic acids are generated from the biomass Bs, and the more biomass Bs, plastic Pc, and the like may be gasified by the organic acids (however, as described above, it is preferable to avoid completely or significantly reducing the biomass Bs in the waste Ws by the biomass reduction process. Organic acid may promote making the biomass Bs into fine particles). In this regard, with the above configuration, since the biomass reduction process is executed before the plastic hydrothermal treatment, the proportion of the biomass Bs in the plastic hydrothermal treatment can be reduced. As a result, it is possible to achieve the waste treatment facility 5A with an improved recovery rate of the granular plastic Pg by the plastic

recovery device 9.

If the biomass ratio is too low, the plastic Pc in the plastic waste Wp becomes a lump, which may cause a problem that it is entangled with an agitating blade constituting the plastic hydrothermal treatment device 8 or clogged at an outlet of the plastic hydrothermal treatment device 8. If the biomass ratio is high, a large amount of powdery biomass is generated, and it takes time and effort for separation of the plastic Pc and the powdery biomass, washing with water, and wastewater treatment when the plastic Pc is effectively utilized.

[0021] FIG. 3 illustrates details of the biomass reduction device 7. The biomass reduction device 7 includes a biomass hydrothermal treatment device 13 configured to perform a biomass hydrothermal treatment on the waste Ws, and a biomass recovery device 14 configured to recover the granular biomass Bg from the waste Ws that has been subjected to the biomass hydrothermal treatment.

[0022] The biomass hydrothermal treatment is a hydrothermal treatment for decomposing the biomass Bs contained in the waste Ws to generate the granular biomass Bg. The treatment temperature (temperature of steam) in the biomass hydrothermal treatment is lower than the treatment temperature of the above-described plastic hydrothermal treatment. Merely as an example, the temperature of steam used in the biomass hydrothermal treatment may be equal to or higher than 120° C and equal to or lower than 190° C, and more preferably equal to or higher than 140° C and equal to or lower than 170° C. When the temperature of the steam is equal to or higher than 120° C and equal to or lower than 190° C (more preferably equal to or higher than 140° C and equal to or lower than 170° C), decomposition of the plastic Pc contained in the waste Ws hardly occurs. Therefore, the granular plastic Pg is hardly recovered in the biomass recovery device 14. On the other hand, the temperature of steam used in the plastic hydrothermal treatment is equal to or higher than 230° C and equal to or lower than 250° C. That is, the heat load in the biomass hydrothermal treatment device 13 is greater than the heat load in the plastic hydrothermal treatment device 8. Therefore, reducing the biomass Bs to some extent in the plastic hydrothermal treatment contributes to reduction of the heat load in the plastic hydrothermal treatment device 8.

[0023] Three examples of recovery methods that may be employed in the biomass recovery device 14 will be described (detailed drawings are omitted).

As a first example, recovery using a vibratable screen may be performed. When the waste Ws discharged from the biomass hydrothermal treatment device 13 is dropped onto the screen, undecomposed plastic Pc of a large particle size remains on the screen, and the granular biomass Bg having a particle size smaller than a predetermined particle size due to decomposition falls through the screen.

As a second example, recovery using a cyclone may be performed. When the waste Ws flows into the cyclone with gas, which may be air, for example, and swirls in the cyclone, the plastic Pc and the granular biomass Bg are separated. The relatively heavy plastic Pc is discharged downward from the cyclone, and the granular biomass Bg having a weight less than a predetermined weight is discharged upward from the cyclone.

As a third example, recovery by a specific gravity separation method may be performed. More specifically, the waste Ws is put into a liquid such as water or oil. The plastic Pc having a small specific gravity floats to the liquid level, and the granular biomass Bg having a specific gravity equal to or higher than a predetermined specific gravity settles in the liquid.

In summary, the biomass recovery device 14 can recover, from the waste Ws, the granular biomass Bg having a particle size smaller than a predetermined particle size, the granular biomass Bg having a weight less than a predetermined weight, or the granular biomass Bg having a specific gravity equal to or higher than a predetermined specific gravity. The biomass recovery device 14 may recover the granular biomass Bg having a weight equal to or higher than a predetermined weight from the waste Ws.

[0024] The biomass Bs and the plastic Pc in the waste Ws put into the waste treatment facility 5A may be integrated. In this regard, with the above configuration, the biomass Bs is decomposed by subjecting the waste Ws to the biomass hydrothermal treatment, and the biomass recovery device 14 recovers the granular biomass Bg. As a result, the biomass Bs can be effectively removed from the plastic Pc to be recovered by the waste treatment facility 5A. Furthermore, since the treatment temperature of the biomass hydrothermal treatment is

lower than the treatment temperature of the plastic hydrothermal treatment, it is possible to suppress decomposition of the plastic Pc in the biomass hydrothermal treatment. Therefore, it is possible to prevent a decrease in recovery rate of the plastic Pc by the plastic recovery device 9.

5 [0025] Next, details of the biomass hydrothermal treatment device 13 will be illustrated with reference to FIG. 4. The biomass hydrothermal treatment device 13 includes a reaction vessel 21 into which the waste Ws is input. Steam also flows into the reaction vessel 21. The waste Ws that has been subjected to the biomass hydrothermal treatment and the steam used for the hydrothermal treatment are discharged from the reaction vessel 21.

10 [0026] The biomass hydrothermal treatment device 13 is configured to dry the waste Ws that has been subjected to the biomass hydrothermal treatment by using the steam supplied to the biomass hydrothermal treatment device 13 as a heat source. As a more specific example, the biomass hydrothermal treatment device 13 includes an external heating unit 22 for heating the reaction vessel 21 from the outside with steam. The external heating unit 22 includes
15 another wall portion surrounding at least a part of an outer wall of the reaction vessel 21 from the outside, and a part of the steam supplied to the biomass hydrothermal treatment device 13 passes through a space between the wall portion and the outer wall of the reaction vessel 21 (this steam does not flow into the reaction vessel 21). The remainder of the supplied steam flows into the reaction vessel 21. Since the temperature of the internal space of the reaction
20 vessel 21 is raised by the external heating unit 22, moisture is removed from the waste Ws that has been subjected to the biomass hydrothermal treatment. The steam supplied to the external heating unit 22 and the reaction vessel 21 may be returned to a circulation path of water and steam in a boiler plant.

[0027] With the above configuration, the external heating unit 22 can remove moisture
25 from the waste Ws that has been subjected to the biomass hydrothermal treatment. As a result, since the waste Ws having undergone the biomass hydrothermal treatment can be dispersed, the biomass recovery device 14 can improve the recovery rate of the granular biomass Bg. As a more specific example, aggregates of the granular biomass Bg fall through the screen without

remaining on the screen, whereby the recovery rate of the granular biomass Bg is improved. Moreover, the apparent specific gravity of the granular biomass Bg is higher than that of the biomass Bs, and the transportation efficiency is better than that of the biomass Bs. Furthermore, the biomass hydrothermal treatment serves as a sterilization treatment. Therefore, it also becomes possible to store the granular biomass Bg having a high energy density over a long period of time.

[0028] Next, details of the plastic hydrothermal treatment device 8 will be illustrated with reference to FIG. 5. The plastic waste Wp, steam, and an alkaline agent Ag are supplied to a reaction vessel 8a of the plastic hydrothermal treatment device 8. Thus, the plastic hydrothermal treatment device 8 is configured to add the alkaline agent Ag to the waste Ws and perform hydrolysis with steam. Both the waste Ws obtained by the hydrolysis (hereinafter, also referred to as treated waste Wd) and the steam used for the hydrolysis are discharged from the reaction vessel 8a. The treated waste Wd is supplied to the plastic recovery device 9.

[0029] Next, details of the plastic recovery device 9 will be illustrated with reference to FIG. 6. The plastic recovery device 9 includes a washing device 31 configured to perform a washing process on the treated waste Wd, and a plastic separation device 32 for separating the granular plastic Pg from the washed treated waste Wd. The plastic separation device 32 has the same structure as the biomass recovery device 14 (see FIG. 3), and a detailed description thereof will be omitted.

[0030] With the above configuration, the washing device 31 can wash away salts generated by the hydrolysis to which the alkaline agent Ag is added. Therefore, the plastic recovery device 9 can recover the high-quality granular plastic Pg mixed with no salts. For example, when the granular plastic Pg is supplied to the gasification furnace 51 (see FIG. 20) or a heat exchange device 52 (see FIG. 20) which may be a heat recovery steam generator, attachment of chlorine compounds is suppressed, so that corrosion in the gasification furnace 51 and the heat recovery steam generator can be suppressed.

[0031] Returning to FIG. 2, the waste treatment facility 5A (5) further includes a first measuring device 11. The first measuring device 11 is configured to measure a residual

biomass ratio (details of the first measuring device 11 will be described later). Here, the residual biomass ratio means a proportion occupied by the residual biomass Bs in the plastic waste Wp even after the biomass reduction process, and is determined by the following formula (A).

5
$$Rs = W_{Bs}/W_{Wp} \quad \text{Formula (A)}$$

In formula (A), Rs is the residual biomass ratio, W_{Bs} is the weight of the biomass Bs, and W_{Wp} is the total weight of the plastic waste Wp.

The residual biomass ratio has the same meaning as a proportion of the biomass Bs in the plastic waste Wp when supplied to the plastic hydrothermal treatment device 8.

10 [0032] With the above configuration, since the residual biomass ratio in the plastic waste Wp can be managed, it is possible to avoid the plastic waste Wp having a high residual biomass ratio from being put into the biomass hydrothermal treatment device 13. Therefore, the recovery rate of the granular plastic Pg by the plastic recovery device 9 can be improved. In the above-described embodiment, management is performed such that the residual biomass
15 ratio falls within a range from 10% to 75%.

[0033] Details of the first measuring device 11 will be illustrated with reference to FIGs. 7 to 11. The first measuring device 11 includes a camera 41, a specifying device 42, and a calculation device 43. The camera 41 is configured to capture an image of the waste Ws, and may be a near-infrared camera or a visible light camera.

20 [0034] FIG. 8 is a schematic diagram of a captured image Im of the camera 41, showing the plastic Pc and the biomass Bs. In the captured image Im, a region showing the plastic Pc is a plastic region R1, and a region showing the biomass Bs is a biomass region R2. As described above, the main components of the waste Ws are the plastic Pc and the biomass Bs. The same holds true for the plastic waste Wp. Accordingly, the plastic Pc in the plastic waste
25 Wp can be regarded as the remainder other than the biomass Bs (that is, “non-biomass”), and the plastic region R1 can be regarded as a “non-biomass region” showing “non-biomass.”

[0035] Returning to FIG. 7, the specifying device 42 is configured to specify the plastic region R1 and the biomass region R2 in the captured image Im of the camera 41. The

specifying device 42 specifies the plastic region R1 and the biomass region R2 by using a graph, a function formula, a data table, or the like. However, the present disclosure is not limited thereto, and the specifying device 42 according to another embodiment may specify these two regions by inputting the captured image Im into a learning model trained by machine learning.

5 [0036] The calculation device 43 is configured to calculate the residual biomass ratio based on a ratio between the plastic region R1 and the biomass region R2 and the specific gravity of each of the plastic Pc and the biomass Bs. The ratio between the two regions can be regarded as a volume ratio between the biomass Bs and the plastic Pc. Once the volume ratio and specific gravities are known, the weight ratio of the biomass Bs and the waste Ws (that is, the
10 residual biomass ratio) can be obtained.

[0037] With the above configuration, the residual biomass ratio can be automatically calculated based on a capturing result of the camera 41.

[0038] Details of the specifying device 42 will be illustrated with reference to FIGs. 9 to 11. In the example of FIG. 9, it is assumed that the camera 41 is a near-infrared camera. The
15 infrared camera is configured to generate spectrum data Sd (see FIG. 10) indicating the intensity of light in a predetermined wavelength band. FIG. 10 is a graph schematically showing the spectrum data Sd output from the infrared camera capturing an image of the plastic waste Wp. The horizontal axis of the graph represents the wavelength of light incident on the infrared camera, and the vertical axis represents the spectral intensity (intensity) of the light. The
20 spectrum data Sd changes depending on whether the target to be imaged by the infrared camera is the plastic Pc or the biomass Bs.

[0039] As shown in FIG. 9, the specifying device 42 has an intensity acquisition unit 45 and an identification unit 46. The identification unit 46 is configured to acquire, in the spectrum data Sd, a first intensity, a second intensity, a third intensity, and a fourth intensity
25 respectively corresponding to a first wavelength, a second wavelength, a third wavelength, and a fourth wavelength. All of these four wavelengths are included in the above-mentioned predetermined wavelength band. The first wavelength to the fourth wavelength correspond to λ_1 to λ_4 in FIG. 10, and the following formula (B) holds. The first intensity to the fourth

intensity correspond to Sp1 to Sp4 in FIG. 10.

$$\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4 \quad \text{Formula (B)}$$

[0040] The identification unit 46 is configured to identify whether the plastic waste Wp in the captured image Im is the plastic Pc or the biomass Bs based on a first ratio, which is a ratio between the first intensity and the second intensity, and a second ratio, which is a ratio between the third intensity and the fourth intensity. The first ratio is obtained by dividing the second intensity by the first intensity, and the second ratio is obtained by dividing the fourth intensity by the third intensity.

[0041] FIG. 11 is a schematic diagram of a graph Gr used for identifying the plastic Pc and the biomass Bs based on the first ratio and the second ratio. According to the inventors' findings, the plastic Pc and the biomass Bs absorb light having different wavelengths. That is, the wavelength of light incident on the infrared camera changes depending on whether the light is reflected light from the plastic Pc or the biomass Bs. The graph Gr outlines the results of this through experiments and verification. If coordinates indicated by the first ratio and the second ratio are included in the region A, the imaging target of the infrared camera is the plastic Pc, and if the coordinates are included in the region B, the imaging target is the biomass Bs.

[0042] The identification unit 46 of this example is configured to acquire the first ratio and the second ratio from the spectrum data Sd. Further, the identification unit 46 is configured to identify whether the plastic waste Wp captured in the image is the plastic Pc by applying the first ratio and the second ratio to the graph Gr.

[0043] With the above configuration, whether the imaged plastic waste Wp is the plastic Pc or the biomass Bs can be accurately identified based on the first ratio and the second ratio. The identification unit 46 may use a function formula or a data table instead of using the graph Gr. By applying the above identification principle, the plastic region R1 and the biomass region R2 can be specified from the captured image Im even with a function formula or a data table.

[0044] Returning to FIG. 2, additional components of the waste treatment facility 5A (5) will be described. As described above, if a certain amount of the biomass Bs remains in the

waste Ws in the plastic hydrothermal treatment, the plastic Pc can be finely granulated in the plastic hydrothermal treatment, which contributes to an improvement in the recovery rate of the granular plastic Pg. On the other hand, a heat load of the plastic hydrothermal treatment device 8 can be reduced by removing a certain amount of the biomass Bs through the biomass reduction process. In addition, it is expected that the gasification of plastic Pc in the plastic hydrothermal treatment can be suppressed depending on the operating conditions of the biomass reduction device 7. Therefore, it is preferable to set a target range as to how much the biomass Bs is to be reduced in the plastic reduction process.

[0045] Therefore, the waste treatment facility 5A (5) illustrated in FIG. 2 adjusts the proportion of the biomass Bs in the waste Ws to be subjected to the biomass reduction process. In the following description, for convenience of explanation, the proportion occupied by the biomass Bs in the waste Ws subjected to the biomass reduction process is referred to as a “biomass proportion”. On the other hand, the proportion occupied by the biomass Bs in the plastic waste Wp when supplied to the plastic hydrothermal treatment device 8 is the “residual biomass ratio” as described above. In this example, it is understood that the “biomass proportion” at the time of completion of the biomass reduction process is the same value as the “residual biomass ratio”. Both the biomass proportion and the residual biomass ratio are represented by percent by weight.

[0046] The waste treatment facility 5A includes a controller 90 for adjusting the biomass proportion by controlling the biomass reduction device 7. The controller 90 functions as a first acquisition unit 91, a target range setting unit 92, and a first control unit 93.

[0047] The first acquisition unit 91 is configured to acquire first data 25 defining a first relationship between the residual biomass ratio at the time of executing the plastic hydrothermal treatment and the plastic particle size. Here, the plastic particle size is the particle size of the plastic Pc contained in the plastic waste Wp after the plastic hydrothermal treatment. The first data 25 may define the first relationship by a function formula, a data table, or a combination thereof.

[0048] FIG. 12A shows a graph of the first relationship defined by first data 25A (25)

according to a first example of the present disclosure. The horizontal axis of the graph represents the residual biomass ratio. The vertical axis of the graph represents the plastic particle size ratio, and a plastic particle size confirmed when the plastic hydrothermal treatment is performed under a condition in which the residual biomass ratio is 0% is set as a reference.

5 [0049] The inventors of the present application have found that there is a correlation between the residual biomass ratio and the plastic particle size ratio (in other words, plastic particle size). FIG. 12A schematically illustrates this correlation as the first relationship. For example, point Q on the graph indicates that the plastic hydrothermal treatment on the plastic waste Wp having a residual biomass ratio of about 50% results in a plastic particle size ratio of
10 approximately 0.3.

[0050] Returning to FIG. 2, the target range setting unit 92 is configured to set a target range of the biomass proportion at the time of completion of the biomass reduction process based on the first data 25. Further, the first control unit 93 is configured to control the biomass hydrothermal treatment device 13 until the biomass proportion falls within the target range.

15 [0051] As just one example, in FIG. 12A, the target range setting unit 92 may set a range indicated by the two-dot-dash line L1 as the target range. If the biomass proportion at the start of the biomass reduction process is, for example, 80%, the first control unit 93 executes a process of supplying steam to the biomass reduction device 7 until the biomass proportion falls within the target range indicated by the two-dot-dash line L1. As a result, the plastic
20 hydrothermal treatment device 8 can execute the plastic hydrothermal treatment on the plastic waste Wp whose residual biomass ratio falls within the target range.

[0052] It is preferable that the first control unit 93 acquires the biomass proportion during the biomass reduction process. The biomass proportion may be specified based on a measurement result of the first measuring device 11. Alternatively, it may be specified based
25 on operation data including the treatment temperature of the biomass reduction device 7, the mass of the waste Ws, and the like. In this case, the biomass proportion is acquired by a relational expression based on a mass balance and an energy balance in the biomass reduction device 7.

[0053] FIG. 12B shows a graph of the first relationship defined by first data 25B (25) according to a second example of the present disclosure. As shown in the figure, a plurality of patterns of the first relationship are defined according to a biomass concentration. Here, the biomass concentration is a proportion of the biomass Bs with respect to moisture in the plastic waste Wp when supplied to the plastic hydrothermal treatment device 8.

[0054] The inventors of the present application have found that the first relationship changes depending on the biomass concentration. Specifically, as shown in the graph, the higher the biomass concentration (that is, the lower the water content), the smaller the plastic particle size ratio can be even with a lower residual biomass ratio. That is, as the biomass concentration increases, the plastic particle size ratio can be reduced while reducing the thermal load in the plastic hydrothermal treatment device 8.

[0055] In the second example, the target range setting unit 92 may set the target range based on a ratio between the biomass Bs and moisture at the start of the biomass reduction process. For example, if steam as a heat source for use in the external heating unit 22 (see FIG. 4) of the biomass reduction device 7 can be sufficiently secured, a sufficient drying process can be performed on the waste Ws. In this case, the range indicated by the two-dot-dash line L2 in FIG. 12B may be set as the target range. Moreover, it is preferable that the first control unit 93 acquires a ratio between the biomass Bs and moisture during the biomass reduction process. For example, it is possible to specify the water content of the waste Ws based on the amount of change in the temperature of the steam discharged from the biomass reduction device 7.

[0056] FIG. 12C shows a graph of the first relationship defined by first data 25C (25) according to a third example of the present disclosure. As shown in the figure, a plurality of patterns of the first relationship are defined according to the proportion of lignin in the biomass Bs in the plastic waste Wp.

[0057] The inventors of the present application have found that the first relationship changes depending on the proportion of lignin. Specifically, as shown in the graph, the higher the proportion of lignin (that is, the larger the amount of lignin), the smaller the plastic particle size ratio, and the granular plastic Pg is made into finer particles.

[0058] In the third example, the target range setting unit 92 may set the target range based on a predicted value of the proportion of lignin in the biomass Bs at the time of completion of the biomass reduction process. For example, if the proportion of lignin at the time of completion of the biomass reduction process is predicted to be moderate (for example, about 50%), the range indicated by the two-dot-dash line L3 in FIG. 3 may be set as the target range. Further, the first control unit 93 may be configured to acquire an actual proportion of lignin during the biomass reduction process.

[0059] For example, when the configuration according to the above-described first example is adopted as the biomass recovery device 14, lignin remains on the screen together with the undecomposed plastic Pc, and other biomass Bs such as cellulose falls through the screen. If the weight of the waste Ws before the start of the biomass reduction process, the biomass proportion in the waste Ws, and the weight ratio between the waste Ws remaining on the screen and the waste Ws falling through the screen are known, it is possible to specify the lignin proportion of the waste Ws remaining on the screen.

[0060] Although a part of lignin is dissolved in water by the plastic hydrothermal treatment of the plastic hydrothermal treatment device 8, it precipitates in a cooling step after the treatment, suppresses recombination of the plastic Pc, and is effective in making the plastic Pc into finer particles of a proper size.

Further, the composition of the raw material, the composition on the screen (including lignin weight, cellulose weight, and water content), and the composition below the screen can be estimated from the operation data (raw material weight, temperature change in the reactor, amount of dry steam, etc.) of the hydrothermal treatment in the plastic hydrothermal treatment device 8, and the amount of biomass is adjusted so as to attain a proper biomass ratio based on a separately created diagram (plastic particle size relative to biomass ratio for each cellulose/lignin ratio and biomass/water ratio). Thereby, it is possible to prevent an excessive drainage load.

[0061] With the configuration in which the first control unit 93 controls the biomass reduction device 7 until the biomass proportion falls within the predetermined target range, the

content of the biomass Bs in the plastic waste Wp is reduced, so that a heat load in the plastic hydrothermal treatment device 8 can be reduced.

[0062] In addition, with the configuration in which the target range setting unit 92 sets the target range based on the first data 25, the granular plastic Pg after performing the plastic hydrothermal treatment can be suitably made into finer particles.

[0063] In addition, with the configuration in which the plurality of patterns of the first relationship are defined according to the biomass concentration, the target range of the biomass proportion can be adjusted more suitably so that the granular plastic Pg is made into finer particles.

[0064] In addition, with the configuration in which the plurality of patterns of the first relationship are defined according to the proportion of lignin, the target range of the biomass proportion can be adjusted more suitably so that the granular plastic Pg is made into finer particles.

[0065] A desalination effect possessed by the biomass Bs will be described with reference to FIGs. 13A to 13C. The three graphs shown in these drawings indicate the degree of desalination effect when the plastic Pc is subjected to hydrolysis with steam. "Before treatment" in the three graphs indicates the chlorine concentration in the plastic Pc before the plastic hydrothermal treatment, all of which have the same value "S".

[0066] FIG. 13A shows a desalination effect when hydrolysis is performed with steam with addition of the alkaline agent Ag such as NH_3 , $\text{Ca}(\text{OH})_2$, or NaOH (biomass Bs is not added). FIG. 13B shows a desalination effect when the biomass Bs is added to each of these alkaline agents Ag, and hydrolysis is performed with steam. FIG. 13C shows a desalination effect when the biomass Bs is added, and hydrolysis is performed with steam (alkaline agent Ag is not added).

[0067] As can be seen from FIGs. 13A and 13C, when only the biomass Bs is added to the plastic Pc without using the alkaline agent Ag, the resulting desalination effect is equal to or higher than when only the alkaline agent Ag is added. Further, as can be seen from FIGs. 13A and 13B, when both the alkaline agent Ag and the biomass Bs are added, the resulting

desalination effect is equal to or higher than when only the alkaline agent Ag is added.

[0068] Returning to FIGs. 5 and 6, on the basis of the above findings obtained by the inventors of the present application, if the residual biomass ratio supplied to the plastic hydrothermal treatment device 8 is higher than a reference value, a certain desalination effect
5 can be obtained without using the alkaline agent Ag. Therefore, the plastic hydrothermal treatment device 8 may add the alkaline agent Ag to the plastic waste Wp and perform hydrolysis with steam only when the residual biomass ratio is lower than the reference value. On the other hand, when the residual biomass ratio is equal to or higher than the reference value, the plastic hydrothermal treatment device 8 may perform hydrolysis on the plastic waste Wp
10 with steam without adding the alkaline agent Ag. Whether or not the residual biomass ratio is equal to or higher than the reference value is found from the measurement result of the first measuring device 11.

[0069] With the above configuration, the alkaline agent Ag is added in the plastic hydrothermal treatment only when the amount of the biomass Bs contained in the plastic waste
15 Wp is small. This reduces consumption of the alkaline agent Ag.

[0070] A waste treatment method using the waste treatment facility 5A will be described with reference to FIG. 14. In the waste treatment method of this example, the granular biomass Bg and the granular plastic Pg are recovered from the waste Ws. In the following description, “step” may be abbreviated as “S”.

20 [0071] First, a biomass reduction step (S11) of performing a biomass reduction process on the waste Ws is executed. Specifically, a conveying device, such as a belt conveyor, a crane, or a robot arm, inputs the waste Ws into the biomass reduction device 7. By executing the biomass reduction process, the granular biomass Bg is recovered, and the plastic waste Wp is generated.

25 [0072] FIG. 15 is a flowchart showing details of the biomass reduction process. First, a processor mounted on the controller 90 executes a first data acquisition step (S51) of acquiring the first data 25. The processor executing S51 is an example of the first acquisition unit 91 of the controller 90.

[0073] Next, the processor executes a target range setting step (S53) of setting the target range of the biomass proportion. The processor executing S53 is an example of the target range setting unit 92. Then, the processor executes a control for supplying steam to the biomass reduction device 7 (S55). The processor executing S55 is an example of the first control unit 93.

[0074] Returning to FIG. 14, a first measuring step (S13) of measuring the residual biomass ratio in the plastic waste Wp is then executed. Specifically, the first measuring device 11 disposed between the biomass recovery device 14 and the plastic hydrothermal treatment device 8 measures the residual biomass ratio in the plastic waste Wp.

[0075] Next, it is determined whether the residual biomass ratio measured by the first measuring device 11 is within the target range set in S53 (S15). As a specific example, the measurement result of the first measuring device 11 is sent to the controller 90. The processor of the controller 90 determines whether the residual biomass ratio obtained by the measurement is within the target range. As another specific example, the measurement result of the first measuring device 11 may be displayed on a monitor or the like, and an operator may check the measurement result. In this case, the operator determines the magnitude relationship between the residual biomass ratio and the upper limit value of the target range.

[0076] When it is determined that the residual biomass ratio exceeds the target range, for example (S15: NO), the step returns to S55. More specifically, the plastic waste Wp is returned to the inlet side of the biomass reduction device 7 by a crane or the like, and S55 is executed again. This ensures that the residual biomass ratio is within the specified range. The processor that executes S15 and S55 is an example of the first control unit 93.

[0077] When it is determined that the residual biomass ratio is within the target range (S15: YES), a plastic hydrothermal treatment step (S17) of performing a plastic hydrothermal treatment on the plastic waste Wp is executed. More specifically, the plastic waste Wp is put into the plastic hydrothermal treatment device 8 by a conveying device such as a belt conveyor.

[0078] Next, a plastic recovery step (S19) of recovering the granular plastic Pg from the treated waste Wd that has been subjected to the plastic hydrothermal treatment is executed.

More specifically, the treated waste Wd is put into the plastic recovery device 9. Then, the waste treatment method ends.

[0079] In the above waste treatment method, when the residual biomass ratio is out of the target range (S15: NO), the biomass reduction step (S11) is executed again before the plastic hydrothermal treatment (S17). Since the residual biomass ratio that exceeded the target range can thereby be kept within the target range, the recovery rate of the granular plastic Pg can be improved, and the heat load of the plastic hydrothermal treatment device 8 can be reduced.

[0080] A waste treatment facility 5A' will be described with reference to FIG. 16 as a modified example of the waste treatment facility 5A (FIG. 1). The waste treatment facility 5A' includes a separation device 110. The separation device 110 includes a hydrothermal treatment device 111 for executing a hydrothermal treatment, a recovery device 112 for recovering the granular biomass Bg and the granular plastic Pg from the waste Ws, and a return pipe 113 connecting the outlet side of the recovery device 112 and the inlet side of the hydrothermal treatment device 111.

[0081] The hydrothermal treatment device 111 has the same configuration as the plastic hydrothermal treatment device 8 (see FIG. 5), and the recovery device 112 has the same configuration as the plastic recovery device 9 (see FIG. 6).

[0082] In FIG. 16, the biomass reduction step (S11), the plastic hydrothermal treatment (S17), and the plastic recovery step (S19) are all executed in the separation device 110.

[0083] In S11, the waste Ws is input into the hydrothermal treatment device 111. The temperature of steam supplied to the hydrothermal treatment device 111 at this time is equal to or higher than 120° C and equal to or lower than 190° C, and more preferably equal to or higher than 140° C and equal to or lower than 170° C. This causes decomposition of the biomass Bs in the waste Ws. Then, the waste Ws is supplied from the hydrothermal treatment device 111 to the recovery device 112, and the granular biomass Bg is recovered. Thus, the biomass reduction process is completed.

[0084] Thereafter, the plastic waste Wp is returned from the recovery device 112 to the inlet side of the hydrothermal treatment device 111 via the return pipe 113. This step (return step)

is preferably between S15 and S17 in FIG. 14.

[0085] Thereafter, in S17, the plastic waste Wp is put into the hydrothermal treatment device 111. At this time, the temperature of steam supplied to the hydrothermal treatment device 111 is 230° C to 250° C. The alkaline agent Ag is also supplied to the hydrothermal treatment device 111 at this timing. Thereby, the plastic Pc in the plastic waste Wp is decomposed.

[0086] Thereafter, the treated waste Wd that has been subjected to the hydrothermal treatment is supplied to the recovery device 112, and the granular plastic Pg is recovered from the treated waste Wd.

[0087] With the above configuration, the biomass reduction step (S11), the plastic hydrothermal treatment step (S17), and the plastic recovery step (S19) are executed by the hydrothermal treatment device 111 and the recovery device 112. The system configuration for waste treatment can be simplified compared to a case where a dedicated device is provided to perform each step.

[0088] <Waste Treatment Facility 5B (5) According to Second Embodiment>

The waste treatment facility 5B (5) according to the second embodiment will be described with reference to FIGs. 17 to 19. The same components as those of the waste treatment facility 5A (see FIG. 2) are given the same reference numerals in the drawings, and the description thereof may be omitted or skipped below.

[0089] The waste treatment facility 5B shown in FIG. 17 is configured to recover the granular plastic Pg from the waste Ws, and is provided with a plastic hydrothermal treatment device 8 for performing a plastic hydrothermal treatment on the waste Ws, and a plastic recovery device 9 for recovering the granular plastic Pg from the waste Ws.

[0090] The plastic hydrothermal treatment device 8 shown in FIG. 17 is configured to perform the plastic hydrothermal treatment on the waste Ws having a biomass ratio equal to or less than an upper limit value of a specified range. Here, the biomass ratio means a proportion occupied by the biomass Bs in the waste Ws, and is obtained by the following formula (C).

$$T_s = W_{Bs} / W_{Ws} \quad \text{Formula (C)}$$

In formula (C), T_s is the biomass ratio, W_{Bs} is the weight of the biomass B_s , and W_{Ws} is the total weight of the waste W_s .

[0091] The waste W_s put into the plastic hydrothermal treatment device 8 may be the plastic waste W_p described in the first embodiment. In this case, W_{Ws} in formula (C) is the same as the total weight of the plastic waste W_p , and the biomass ratio (T_s) is the same as the above-mentioned residual biomass ratio (R_s) (see formula (A)). The “residual biomass ratio” shown by the horizontal axis of each graph shown in FIGs. 12A to 12C is read as “biomass ratio” in the second embodiment.

[0092] The waste treatment facility 5B further includes a second measuring device 12 for measuring the biomass ratio in the waste W_s . If the biomass ratio measured by the second measuring device 12 is equal to or less than the upper limit value of the specified range, the waste W_s is put into the plastic hydrothermal treatment device 8. On the other hand, if the biomass ratio exceeds the upper limit value, the waste W_s is not put into the plastic hydrothermal treatment device 8 (finally disposed without being subjected to any treatment), or is put into the plastic hydrothermal treatment device 8 after being subjected to the biomass reduction process by the biomass reduction device 7 (see FIG. 2). In the latter case, the waste treatment facility 5B includes the biomass reduction device 7, and the biomass reduction device 7 treats only the waste W_s having a high biomass ratio.

[0093] With the above configuration, since the biomass ratio is measured by the second measuring device 12 before the plastic hydrothermal treatment is executed, it is possible to prevent the waste W_s having an extremely high biomass ratio from being subjected to the plastic hydrothermal treatment. This prevents organic acids or the like generated from the biomass B_s from gasifying the plastic P_c in the plastic hydrothermal treatment. Further, granulation of the plastic P_c is promoted by the biomass B_s (organic acids or powdery biomass suppresses the plastic P_c from becoming a lump). As a result, it is possible to achieve the waste treatment facility 5B with an improved recovery rate of the granular plastic P_g .

[0094] The waste treatment facility 5B may further include a biomass adding device 4 for adding a ratio adjusting biomass B_a to the waste W_s having a biomass ratio lower than the lower

limit value of the specified range, and a controller 100 for controlling the biomass adding device 4.

[0095] The ratio adjusting biomass Ba may be added to the waste Ws in the plastic hydrothermal treatment device 8. This ensures that the biomass ratio is within the specified range. The plastic hydrothermal treatment device 8 performs the plastic hydrothermal treatment on the waste Ws to which the ratio adjusting biomass Ba has been added. When the controller 100 controls the biomass adding device 4, the biomass ratio of the waste Ws in the plastic hydrothermal treatment device 8 falls within the specified range. The ratio adjusting biomass Ba may be lignin taken out from the plastic recovery device 9.

[0096] As described above, the biomass Bs contributes to making the plastic Pc into fine particles during the plastic hydrothermal treatment. With the above configuration, since the ratio adjusting biomass Ba is added to the waste Ws having a biomass ratio lower than the lower limit value of the specified range, the granular plastic Pg after the plastic hydrothermal treatment can be made into finer particles.

[0097] The controller 100 functions as a first acquisition unit 91, a specified range setting unit 105, and a second control unit 102.

[0098] The first acquisition unit 91 of the controller 100 has the same configuration as the first acquisition unit 91 shown in FIG. 2. That is, the first acquisition unit 91 of the controller 100 is configured to acquire the first data 25 indicating the first relationship. The first relationship may define a plurality of patterns according to the biomass concentration, or may define a plurality of patterns according to the proportion of lignin in the waste Ws. The specified range setting unit 105 is configured to set the specified range based on the first data 25.

[0099] The specified range setting unit 105 sets the specified range based on the biomass ratio obtained from the second measuring device 12 and the first data 25 acquired by the first acquisition unit 91. The range indicated by any of the two-dot-dash lines L1, L2, and L3 shown in FIGs. 13A to 13C may be set as the specified range. The second control unit 102 controls the biomass adding device 4 so that the biomass ratio falls within the specified range.

[0100] With the above configuration, since the specified range is adjusted based on the first data 25 acquired by the first acquisition unit 91, the granular plastic Pg after the plastic hydrothermal treatment can be made into finer particles. When the first relationship of the first data 25 defines a plurality of patterns according to the biomass concentration or when it
5 defines a plurality of patterns according to the proportion of lignin, the above technical advantages become more remarkable. The reason why the technical advantages are obtained is as described in the first embodiment, and a detailed description thereof will be omitted.

[0101] FIG. 18 is a schematic diagram showing the configuration of the second measuring device 12. The second measuring device 12 includes a camera 41, a specifying device 42, and
10 a calculation device 43. The second measuring device 12 has the same configuration as the first measuring device 11 described above, except that the imaging target of the camera 41 is the waste Ws. The specifying device 42 has an intensity acquisition unit 45 and an identification unit 46. In order to avoid duplication of description, a detailed description of the second measuring device 12 will be omitted.

[0102] A waste treatment method using the waste treatment facility 5B will be described with reference to FIG. 19. First, a second measuring step (S21) of measuring a biomass ratio in the waste Ws is executed. This step is executed by a processor of the controller 100. In
15 S21, the biomass concentration and the proportion of lignin may be specified.

[0103] Next, the first data 25 is acquired by the processor (S22). The processor executing
20 S22 is an example of the first acquisition unit 91 of the controller 100. Next, the processor sets the specified range (S23), based on process data such as the biomass ratio acquired in S22 and the first data 25 acquired in S22. The processor executing S23 is an example of the specified range setting unit 105.

[0104] Next, it is determined whether the biomass ratio measured by the second measuring
25 device 12 exceeds the upper limit value of the specified range (S25). This determination may be executed by the processor or an operator. When the biomass ratio exceeds the upper limit value (S25: YES), the waste treatment ends. When the biomass ratio is equal to or less than the upper limit value (S25: NO), it is determined whether the biomass ratio measured by the

second measuring device 12 is lower than the lower limit value of the specified range (S26). This determination is executed by the processor or the operator.

[0105] When the biomass ratio is equal to or higher than the lower limit value (S26: NO), a plastic hydrothermal treatment step (S27) of performing a plastic hydrothermal treatment on the waste Ws is executed. Then, a plastic recovery step (S29) of recovering the granular biomass Bg from the waste Ws is executed. S27 and S29 are respectively executed by the plastic hydrothermal treatment device 8 and the plastic recovery device 9. Then, the waste treatment method ends.

[0106] When the biomass ratio is lower than the lower limit value (S26: YES), the processor sends a control command for adding the ratio adjusting biomass Ba to the waste Ws to the biomass adding device 4 (S28). The processor executing S28 is an example of the second control unit 102. After execution of S28, the step shifts to the aforementioned S27. After execution of S27 and S29, the waste treatment method ends.

[0107] As described above, the waste treatment facility 5B may include the biomass reduction device 7. In this case, when the biomass ratio exceeds the upper limit value of the specified range (S25: YES), after the waste Ws is input into the biomass reduction device 7 and the biomass reduction process is executed, the plastic hydrothermal treatment step (S27) is executed.

[0108] <Resource Recovery System 1>

A resource recovery system 1 incorporating the waste treatment facility 5A will be described with reference to FIGs. 20 and 21. The resource recovery system 1 is configured to recover the granular biomass Bg and the granular plastic Pg from the waste Ws. In this example, the granular biomass Bg and the granular plastic Pg are recycled into resources.

[0109] As shown in FIG. 20, the resource recovery system 1 is provided with the waste treatment facility 5A. As described above, after the waste Ws is input into the biomass hydrothermal treatment device 13, the granular biomass Bg and the granular plastic Pg are discharged from the biomass recovery device 14 and the plastic recovery device 9, respectively.

[0110] The resource recovery system 1 includes: a gasification furnace 51 configured to

gasify each of the granular biomass Bg and the granular plastic Pg; a biomass conveying device 60 for conveying the granular biomass Bg from the biomass recovery device 14 to the gasification furnace 51; and a plastic conveying device 70 for conveying the granular plastic Pg from the plastic recovery device 9 to the gasification furnace 51.

5 [0111] The granular biomass Bg and the granular plastic Pg are supplied into the gasification furnace 51, and steam and oxygen are supplied as working gas of the gasification furnace 51. The steam and oxygen function as gasifying agents, and the granular biomass Bg and the granular plastic Pg are each gasified by a thermal decomposition reaction. As a result, a mixed gas containing high-temperature biogas, high-temperature plastic gas, carbon
10 monoxide gas, carbon dioxide gas, hydrogen gas, methane gas, and the like (hereinafter sometimes referred to as “syngas”) is generated.

[0112] The resource recovery system 1 further includes a heat exchange device 52 for recovering heat from each of the biogas and the plastic gas. The heat exchange device 52 may be a heat recovery steam generator. Alternatively, the heat exchange device 52 may be an
15 evaporator constituting an ORC system (ORC: Organic Rankine Cycle). The evaporator gasifies a working medium for driving a turbine by exchanging heat with the biogas and the plastic gas.

[0113] The syngas that has passed through the heat exchange device 52 is supplied to a resource conversion device 53. The resource conversion device 53 is configured to generate,
20 for example, liquid ethanol as a recyclable resource from the syngas by using a catalyst. The generated liquid ethanol can be conveyed from the resource recovery system 1 to any place.

[0114] The resource recovery system 1 further includes a steam supply device 55 configured to supply steam generated from water by using the heat recovered by the heat exchange device 52. In other words, the steam supply device 55 uses the syngas discharged
25 from the gasification furnace 51 as a heat source to generate steam from water. For example, when the heat exchange device 52 is a heat recovery steam generator, the steam supply device 55 is integrally incorporated in the heat exchange device 52.

[0115] The steam supply device 55 is configured to supply steam to each of the plastic

hydrothermal treatment device 8 and the biomass hydrothermal treatment device 13. Regarding the steam supply to the biomass hydrothermal treatment device 13 (see FIG. 4), the steam supply device 55 may supply steam to each of the external heating unit 22 and the reaction vessel 21. With the above configuration, steam utilized in both the plastic hydrothermal treatment device 8 and the biomass hydrothermal treatment device 13 is generated from water using the syngas as a heat source. The carbon dioxide emissions of the resource recovery system 1 can be reduced by eliminating the need to burn fuel to provide a heat source for generating steam from water.

The steam supply device 55 may supply steam to only one of the biomass hydrothermal treatment device 13 or the plastic hydrothermal treatment device 8. Even in this case, the above technical advantages can be obtained.

[0116] Further, the gasification furnace 51 gasifies the granular plastic Pg together with the granular biomass Bg. With this configuration, since the gasification furnace 51 can generate a plastic-derived gas in addition to a biomass-derived gas, a resource recovery efficiency from the waste Ws can be improved.

[0117] The biomass conveying device 60 will be described with reference to FIG. 21. The biomass conveying device 60 is configured to shield a conveying space Sf, in which the granular biomass Bg is conveyed, from outside air. More specifically, the biomass conveying device 60 includes a conveying unit 62 for conveying the granular biomass Bg toward the gasification furnace 51, and a pipe 65 surrounding the conveying unit 62. The conveying unit 62 may be, as an example, a belt conveyor. The pipe 65 accommodates all parts of the belt conveyor and extends in a conveying direction of the granular biomass Bg. As an example, the pipe 65 is connected to the biomass recovery device 14 and the gasification furnace 51. With the above configuration, it is possible to suppress mixing of outside air into the granular plastic Pg conveyed to the gasification furnace 51, so that it is possible to reduce air entering voids in the granular plastic Pg. This allows the gasification furnace 51 to produce high-quality biogas.

[0118] In this example, due to the hydrothermal treatment in the biomass hydrothermal treatment device 13, voids formed in the granular biomass Bg are reduced, and entrained air of

the granular biomass Bg is reduced. Further, employing the biomass conveying device 60 in which the conveying space Sf is shielded from the outside air prevents air from entering the voids in the granular plastic Pg even while it is conveyed from the biomass recovery device 14 toward the gasification furnace 51. As a result, it is possible to prevent a decrease in concentration of each of carbon monoxide gas and hydrogen gas constituting the syngas in the gasification furnace 51, and to contribute to generation of high-quality biogas.

[0119] The biomass conveying device 60 further includes a heater 68 for heating the conveying space Sf. The heater 68 is attached to an outer peripheral surface of the pipe 65, and is configured to generate heat by consuming supplied electric power. With the above configuration, the temperature drop of a gas in the conveying space Sf can be suppressed by the heating of the heater 68. Therefore, it is possible to suppress the entry of outside air into the conveying space Sf due to condensation of steam.

[0120] <Other Modified Examples>

The waste treatment facility 5 illustrated in FIG. 1 may be configured to recover only the granular plastic Pg from the waste Ws. For example, metal or ceramics may be mixed in the waste Ws described above. Although metal may be integrated with the plastic Pc, the plastic Pc can be separated from the metal in the plastic hydrothermal treatment.

[0121] The waste treatment facility 5A shown in FIG. 2 may not include the first measuring device 11. If it is known in advance that the biomass content of the waste Ws falls within a certain range, it is possible to stably keep the residual biomass ratio in the plastic waste Wp within a predetermined range (for example, not less than 1% and not more than 20%).

[0122] The biomass reduction device 7 illustrated in FIG. 2 may not include the biomass hydrothermal treatment device 13 (see FIG. 3). The biomass reduction process may be a process of separating and recovering the biomass Bs as it is from the waste Ws. Such a process may be realized by blowing air onto the waste Ws conveyed by a belt conveyor.

[0123] <Others>

Each of the specifying device 42, the calculation device 43, and the controllers 90, 100 described above is configured by at least one computer. The computer includes a processor, a

memory (storage medium), and an external communication interface. The processor is, for example, CPU, GPU, MPU, DSP, or a combination thereof. The processor according to another embodiment may be implemented by an integrated circuit of PLD, ASIC, FPGA, MCU, or the like. The memory is configured to temporarily or non-temporarily store various data, and is implemented by at least one of RAM, ROM, or a flash memory, for example. The processor executes various control processes in accordance with programs loaded in the memory.

[0124] <Conclusion>

The contents described in some embodiments described above would be understood as follows, for instance.

[0125] 1) A waste treatment facility (5) according to at least one embodiment of the present disclosure is a waste treatment facility (5) for recovering granular plastic (Pg) from waste (Ws) containing biomass (Bs) and plastic (Pc), including:

a biomass reduction device (7) configured to perform a biomass reduction process on the waste for reducing a content of the biomass in the waste;

a plastic hydrothermal treatment device (8) configured to perform a plastic hydrothermal treatment on plastic waste (Pc) which is the waste that has been subjected to the biomass reduction process; and

a plastic recovery device (9) for recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

[0126] According to the inventors' findings, the higher the proportion of biomass in waste in a plastic hydrothermal treatment, the more organic acids are generated from the biomass, and the more biomass, plastic, and the like may be gasified by the organic acids. In this regard, with the configuration 1), since the biomass reduction process is executed before the plastic hydrothermal treatment, the above proportion in the plastic hydrothermal treatment can be reduced. As a result, it is possible to achieve the waste treatment facility with an improved recovery rate of the plastic.

[0127] 2) In some embodiments, in the waste treatment facility as defined in the above 1),

the biomass reduction device includes:

a biomass hydrothermal treatment device (13) configured to perform a biomass hydrothermal treatment on the waste at a treatment temperature lower than a treatment temperature of the plastic hydrothermal treatment; and

5 a biomass recovery device (14) configured to recover granular biomass from the waste that has been subjected to the biomass hydrothermal treatment.

[0128] Biomass and plastic contained in waste put into a waste treatment facility may be integrated. In this regard, with the configuration 2), the biomass is decomposed by subjecting the waste to the biomass hydrothermal treatment, and the biomass recovery device recovers the granular biomass. As a result, the biomass can be effectively removed from the plastic to be recovered by the waste treatment facility. Furthermore, since the treatment temperature of the biomass hydrothermal treatment is lower than the treatment temperature of the plastic hydrothermal treatment, it is possible to suppress decomposition of the plastic in the biomass hydrothermal treatment. Therefore, it is possible to prevent a decrease in recovery rate of the plastic in the plastic recovery device.

[0129] 3) In some embodiments, in the waste treatment facility as defined in the above 2), the biomass hydrothermal treatment device is configured to dry the waste that has been subjected to the biomass hydrothermal treatment by using steam supplied to the biomass hydrothermal treatment device as a heat source.

20 [0130] With the configuration 3), moisture can be removed from the waste by drying the waste that has been subjected to the biomass hydrothermal treatment. As a result, since the waste having undergone the biomass hydrothermal treatment can be dispersed, the biomass recovery device can improve the recovery rate of the granular biomass. Moreover, the apparent specific gravity of the granular biomass is higher than the apparent specific gravity of the biomass before the treatment, and the transport efficiency is better than that of the biomass. Furthermore, the biomass hydrothermal treatment serves as a sterilization treatment. Therefore, it also becomes possible to store the granular biomass having a high energy density over a long period of time.

[0131] 4) In some embodiments, the waste treatment facility as defined in any of the above 1) to 3) further includes a controller (90) for controlling the biomass reduction device until a biomass proportion, which is a proportion occupied by the biomass in the waste, falls within a predetermined target range.

5 [0132] With the configuration 4), the content of the biomass in the plastic waste is reduced, so that a heat load in the plastic hydrothermal treatment device can be reduced. When the plastic hydrothermal treatment requires a higher treatment temperature than the biomass reduction process, the above technical advantages become more remarkable.

[0133] 5) In some embodiments, in the waste treatment facility as defined in the above 4),
10 the controller includes:
a first acquisition unit (91) for acquiring first data (25) defining a first relationship between a biomass ratio, which is a proportion of the biomass in the plastic waste when supplied to the plastic hydrothermal treatment device, and a particle size of the plastic in the plastic waste that has been subjected to the plastic hydrothermal treatment; and
15 a target range setting unit (92) for setting the target range based on the first data.

[0134] According to the inventors' findings, in a plastic hydrothermal treatment, there is a correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment. In this regard, with the configuration 5), by adjusting the target range of the biomass proportion in the waste in the biomass reduction process, the granular plastic
20 after the plastic hydrothermal treatment can be suitably made into finer particles.

[0135] 6) In some embodiments, in the waste treatment facility as defined in the above 5),
the first data defines a plurality of patterns of the first relationship according to a biomass concentration, which is a proportion of the biomass with respect to moisture in the plastic waste when supplied to the plastic hydrothermal treatment device.

25 [0136] According to the inventors' findings, the correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment changes depending on the biomass concentration. In this regard, with the configuration 6), the target range of the biomass proportion can be more suitably adjusted so that the granular plastic is made into finer

particles.

[0137] 7) In some embodiments, in the waste treatment facility as defined in the above 5) or 6),

the first data defines a plurality of patterns of the first relationship according to a proportion of lignin in the biomass in the plastic waste when supplied to the plastic hydrothermal treatment device.

[0138] According to the inventors' findings, in a plastic hydrothermal treatment, the correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment changes depending on the proportion of lignin in plastic waste. In this regard, with the configuration 7), the target range of the biomass proportion can be more suitably adjusted so that the granular plastic is made into finer particles.

[0139] 8) In some embodiments, the waste treatment facility as defined in any of the above 1) to 7) further includes a first measuring device (11) for measuring a residual biomass ratio, which is a proportion occupied by the biomass remaining in the plastic waste.

[0140] With the configuration 8), since the residual biomass ratio in the plastic waste can be managed, it is possible to avoid the plastic waste having a high residual biomass ratio from being put into the biomass hydrothermal treatment device. Therefore, the recovery rate of the granular plastic by the plastic recovery device can be improved.

[0141] 9) In some embodiments, in the waste treatment facility as defined in the above 8), the first measuring device includes:

a camera (41) for capturing an image of the plastic waste;

a specifying device (42) for specifying, in a captured image (Im) of the camera, a non-biomass region (plastic region R1) showing non-biomass (plastic Pc) in the plastic waste and a biomass region (R2) showing the biomass in the plastic waste; and

a calculation device (43) for calculating the residual biomass ratio based on a ratio between the biomass region and the non-biomass region and a specific gravity of each of the biomass and the non-biomass.

[0142] With the configuration 9), the residual biomass ratio can be automatically calculated

based on a capturing result of the camera.

[0143] 10) In some embodiments, in the waste treatment facility as defined in the above 9), the camera is configured to generate spectrum data (Sd) indicating an intensity of light in a predetermined wavelength band, and

5 the specifying device has:

an intensity acquisition unit (45) for acquiring, in the spectrum data, a first intensity, a second intensity, a third intensity, and a fourth intensity respectively corresponding to a first wavelength, a second wavelength, a third wavelength, and a fourth wavelength; and

an identification unit (46) for identifying whether the plastic waste captured in the
10 image is the biomass or the plastic based on a first ratio, which is a ratio of the first intensity to the second intensity, and a second ratio, which is a ratio of the third intensity to the fourth intensity.

[0144] According to the inventors' findings, the wavelength of light absorbed by an object shown in a captured image changes depending on whether the object is biomass or plastic. In
15 this regard, with the configuration 10), the identification unit can accurately identify whether the plastic waste captured in the image is biomass or plastic based on the first ratio and the second ratio.

[0145] 11) A waste treatment facility (5) according to at least one embodiment of the present disclosure is a waste treatment facility (5) for recovering granular plastic (Pg) from
20 waste (Ws) containing biomass (Bs) and plastic (Pc), including:

a second measuring device (12) for measuring a biomass ratio, which is a proportion occupied by the biomass in the waste;

a plastic hydrothermal treatment device (8) configured to perform a plastic hydrothermal treatment on the waste having the biomass ratio equal to or less than an upper limit value of a
25 specified range; and

a plastic recovery device (9) for recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.

[0146] According to the inventors' findings, the higher the proportion of biomass in waste

in a plastic hydrothermal treatment, the more organic acids are generated from the biomass, and the more biomass, plastic, and the like may be gasified by the organic acids. In this regard, with the configuration 11), since the biomass ratio is measured before the plastic hydrothermal treatment is executed, it is possible to prevent the waste having an extremely high biomass ratio from being subjected to the plastic hydrothermal treatment. As a result, it is possible to achieve the waste treatment facility with an improved recovery rate of the plastic.

[0147] 12) In some embodiments, the waste treatment facility as defined in the above 11) further includes:

a biomass adding device (4) for adding a ratio adjusting biomass (Ba) to the waste having the biomass ratio lower than a lower limit value of the specified range; and

a controller (100) for controlling the biomass adding device until the biomass ratio falls within the specified range.

The plastic hydrothermal treatment device is configured to perform the plastic hydrothermal treatment on the waste to which the ratio adjusting biomass has been added.

[0148] According to the inventors' findings, biomass contributes to making plastic into finer particles during a plastic hydrothermal treatment. In this regard, with the configuration 12), since the ratio adjusting biomass is added to the waste having a biomass ratio lower than the lower limit value of the specified range, the granular plastic after the plastic hydrothermal treatment can be made into finer particles.

[0149] 13) In some embodiments, in the waste treatment facility as defined in the above 12),

the controller includes:

a first acquisition unit (91) for acquiring first data defining a first relationship between the biomass ratio when supplied to the plastic hydrothermal treatment device and a particle size of the plastic in the waste that has been subjected to the plastic hydrothermal treatment; and

a specified range setting unit (105) for setting the specified range based on the first data.

[0150] According to the inventors' findings, in a plastic hydrothermal treatment, there is a correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment. In this regard, with the configuration 13), by adjusting the specified range of the biomass ratio, the granular plastic after the plastic hydrothermal treatment can be made into finer particles.

[0151] 14) In some embodiments, in the waste treatment facility as defined in the above 13),
the first data defines a plurality of patterns of the first relationship according to a biomass concentration, which is a proportion of the biomass with respect to moisture in the waste when supplied to the plastic hydrothermal treatment device.

[0152] According to the inventors' findings, in a plastic hydrothermal treatment, the correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment changes depending on a biomass concentration. In this regard, with the configuration 14), the specified range of the biomass ratio can be more suitably adjusted so that the granular plastic is made into finer particles.

[0153] 15) In some embodiments, in the waste treatment facility as defined in the above 13) or 14),
the first data defines a plurality of patterns of the first relationship according to a proportion of lignin in the biomass in the waste when supplied to the plastic hydrothermal treatment device.

[0154] According to the inventors' findings, in a plastic hydrothermal treatment, the correlation between the biomass ratio and the particle size of granular plastic after the plastic hydrothermal treatment changes depending on the proportion of lignin in plastic waste. In this regard, with the configuration 15), the specified range of the biomass ratio can be more suitably adjusted so that the granular plastic is made into finer particles.

[0155] 16) In some embodiments, in the waste treatment facility as defined in any of the above 7) to 15),

the second measuring device includes:

a camera (41) for capturing an image of the waste;

a specifying device (42) for specifying, in a captured image (Im) of the camera, a non-biomass region (plastic region R1) showing non-biomass (plastic Pc) in the waste and a biomass region (R2) showing the biomass in the waste; and

5 a calculation device (43) for calculating the biomass ratio based on a ratio between the biomass region and the non-biomass region and specific gravities of each of the biomass and the non-biomass.

[0156] With the above configuration 16), the same technical advantages as in the above 9) are achieved.

10 [0157] 17) In some embodiments, in the waste treatment facility as defined in the above 16),

the camera is configured to generate spectrum data (Sd) indicating an intensity of light in a predetermined wavelength band, and

the specifying device has:

15 an intensity acquisition unit (45) for acquiring, in the spectrum data, a first intensity, a second intensity, a third intensity, and a fourth intensity respectively corresponding to a first wavelength, a second wavelength, a third wavelength, and a fourth wavelength; and

an identification unit (46) for identifying whether the waste captured in the image is the biomass or the plastic based on a first ratio, which is a ratio of the first intensity to the second intensity, and a second ratio, which is a ratio of the third intensity to the fourth intensity.

20

[0158] With the above configuration 17), the same technical advantages as in the above 10) are achieved.

[0159] 18) In some embodiments, in the waste treatment facility as defined in any of the above 1) to 17),

25 the plastic hydrothermal treatment device is configured to add an alkaline agent (Ag) to the waste and perform hydrolysis with steam, and

the plastic recovery device includes a washing device (31) configured to perform a washing process on treated waste (Wd) which is the waste obtained by the hydrolysis of the

waste.

[0160] With the configuration 18), the washing device can wash away salts generated by the hydrolysis to which the alkaline agent is added. Therefore, the plastic recovery device can recover high-quality granular plastic mixed with no salts.

5 [0161] 19) In some embodiments, in the waste treatment facility as defined in the above 1) or 11),

the plastic hydrothermal treatment device is configured to, when a biomass ratio, which is a proportion of the biomass in the waste when supplied to the plastic hydrothermal treatment device, is lower than a reference value, add an alkaline agent to the waste and perform
10 hydrolysis with steam, and

the plastic recovery device includes a washing device configured to perform a washing process on treated waste which is the waste obtained by the hydrolysis of the waste.

[0162] According to the inventors' findings, in a plastic hydrothermal treatment, biomass in waste exhibits a desalination effect. In this regard, with the configuration 19), an alkaline
15 agent is added only when the amount of biomass expected to have a desalination effect is small. This reduces consumption of the alkaline agent.

[0163] 20) A resource recovery system (1) according to at least one embodiment of the present disclosure includes:

the waste treatment facility (5) as defined in the above 2);
20 a gasification furnace (51) for gasifying the granular biomass recovered by the biomass recovery device; and

a biomass conveying device (60) for conveying the granular biomass discharged from the biomass recovery device to the gasification furnace.

The biomass conveying device is configured to shield a conveying space (Sf), in which
25 the granular biomass is conveyed, from outside air.

[0164] With the configuration 20), since it is possible to suppress outside air from mixing into granular biomass conveyed into the gasification furnace, the apparent density of the granular biomass can be increased, and high-quality biogas can be obtained.

[0165] 21) In some embodiments, in the resource recovery system as defined in the above 20),

the biomass conveying device further includes a heater (68) for heating the conveying space.

5 [0166] With the configuration 21), the temperature drop of a gas in the conveying space can be suppressed by the heating of the heater. Therefore, it is possible to suppress the entry of outside air into the conveying space.

[0167] 22) In some embodiments, the resource recovery system as defined in the above 20) or 21) further includes a steam supply device (55) configured to supply steam generated from 10 water by using a gas (at least one of biomass or plastic gas) discharged from the gasification furnace as a heat source.

The steam supply device is configured to supply the steam to at least one of the plastic hydrothermal treatment device or the biomass hydrothermal treatment device.

[0168] With the configuration 22), steam utilized in at least one of the plastic hydrothermal 15 treatment device or the biomass hydrothermal treatment device is generated from water using the gas as a heat source. This eliminates the need to burn fuel to provide a heat source for generating steam from water, thus reducing carbon dioxide emissions of the resource recovery system.

[0169] 23) In some embodiments, in the resource recovery system as defined in any of the 20 above 20) to 22),

the gasification furnace is configured to gasify the granular plastic recovered by the plastic recovery device.

[0170] With the configuration 23), the gasification furnace can generate a plastic-derived 25 gas in addition to a biomass-derived gas. Therefore, the resource recovery rate from waste can be improved.

[0171] 24) A waste treatment method according to at least one embodiment of the present disclosure is a waste treatment method for recovering granular plastic (Pg) from waste (Ws) containing biomass (Bs) and plastic (Pc), including:

a biomass reduction step (S12) of performing a biomass reduction process on the waste for reducing a content of the biomass in the waste;

a plastic hydrothermal treatment step (S17) of performing a plastic hydrothermal treatment on plastic waste (Wp) which is the waste that has been subjected to the biomass reduction process; and

a plastic recovery step (S19) of recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

[0172] With the above method 24), the same technical advantages as in the above 1) are achieved.

10 [0173] 25) In some embodiments, the waste treatment method as defined in the above 24) further includes a first measuring step (S13) of measuring a residual biomass ratio, which is a proportion occupied by the biomass remaining in the plastic waste.

[0174] With the above configuration 25), the same technical advantages as in the above 8) are achieved.

15 [0175] 26) In some embodiments, in the waste treatment method as defined in the above 25),

when the residual biomass ratio exceeds a predetermined target range, the biomass reduction step is executed again before the plastic hydrothermal treatment step.

[0176] With the configuration 26), when the residual biomass ratio of the plastic waste that has been subjected to the biomass reduction process exceeds the target range, the biomass reduction process is executed again. As a result, the residual biomass ratio can be reduced, so that the recovery rate of granular plastic in the plastic recovery step can be improved.

[0177] 27) In some embodiments, in the waste treatment method as defined in any of the above 24) to 26),

25 the biomass reduction step is executed by a hydrothermal treatment device (111) for hydrothermally treating the waste and a recovery device (112) for recovering a specific material from the waste that has been hydrothermally treated,

the waste treatment method further comprises a return step of returning the waste

discharged from the recovery device to the hydrothermal treatment device, and

the plastic hydrothermal treatment step and the plastic recovery step are respectively executed by the hydrothermal treatment device and the recovery device.

[0178] With the configuration 27), the biomass reduction step, the plastic hydrothermal treatment step, and the plastic recovery step are executed by the hydrothermal treatment device and the recovery device. This simplifies the system configuration for waste treatment compared to a case where a dedicated device is provided to perform each step.

[0179] 28) A waste treatment method according to at least one embodiment of the present disclosure is a waste treatment method for recovering granular plastic (Pg) from waste (Ws) containing biomass (Bs) and plastic (Pc), including:

a second measuring step (S23) of measuring a biomass ratio, which is a proportion occupied by the biomass in the waste;

a plastic hydrothermal treatment step (S27) of performing a plastic hydrothermal treatment on the waste having the biomass ratio equal to or less than an upper limit value of a specified range; and

a plastic recovery step (S29) of recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.

[0180] With the above configuration 28), the same technical advantages as in the above 11) are achieved.

[0181]

Reference Signs List

1	Resource recovery system
4	Biomass adding device
5	Waste treatment facility
7	Biomass reduction device
8	Plastic hydrothermal treatment device
8a, 21	Reaction vessel

	9	Plastic recovery device
	11	First measuring device
	12	Second measuring device
	13	Biomass hydrothermal treatment device
5	14	Biomass recovery device
	22	External heating unit
	31	Washing device
	32	Plastic separation device
	41	Camera
10	42	Specifying device
	43	Calculation device
	45	Intensity acquisition unit
	46	Identification unit
	51	Gasification furnace
15	52	Heat exchange device
	53	Resource conversion device
	55	Steam supply device
	60	Biomass conveying device
	62	Conveying unit
20	65	Pipe
	68	Heater
	70	Plastic conveying device
	90, 100	Controller
	91	First acquisition unit
25	92	Target range setting unit
	93	First control unit
	105	Specified range setting unit
	110	Separation device

	111	Hydrothermal treatment device
	112	Recovery device
	113	Return pipe
	A, B	Region
5	Ag	Alkaline agent
	Ba	Ratio adjusting biomass
	Bg	Granular biomass
	Bs	Biomass
	Gr	Graph
10	Im	Captured image
	Pc	Plastic
	Pg	Granular plastic
	R1	Plastic region
	R2	Biomass region
15	Sd	Spectrum data
	Sf	Conveying space
	Wd	Treated waste
	Wp	Plastic waste
	Ws	Waste

20

CLAIMS

1. A waste treatment facility for recovering granular plastic from waste containing biomass and plastic, comprising:

5 a biomass reduction device configured to perform a biomass reduction process on the waste for reducing a content of the biomass in the waste;

a plastic hydrothermal treatment device configured to perform a plastic hydrothermal treatment on plastic waste which is the waste that has been subjected to the biomass reduction process; and

10 a plastic recovery device for recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

2. The waste treatment facility according to claim 1,
wherein the biomass reduction device includes:

15 a biomass hydrothermal treatment device configured to perform a biomass hydrothermal treatment on the waste at a treatment temperature lower than a treatment temperature of the plastic hydrothermal treatment; and

a biomass recovery device configured to recover granular biomass from the waste that has been subjected to the biomass hydrothermal treatment.

20

3. The waste treatment facility according to claim 2,

wherein the biomass hydrothermal treatment device is configured to dry the waste that has been subjected to the biomass hydrothermal treatment by using steam supplied to the biomass hydrothermal treatment device as a heat source.

25

4. The waste treatment facility according to any one of claims 1 to 3, further comprising a controller for controlling the biomass reduction device until a biomass proportion, which is a proportion occupied by the biomass in the waste, falls within a predetermined target range.

5. The waste treatment facility according to claim 4,
wherein the controller includes:
a first acquisition unit for acquiring first data defining a first relationship between a
5 biomass ratio, which is a proportion of the biomass in the plastic waste when supplied to the
plastic hydrothermal treatment device, and a particle size of the plastic in the plastic waste that
has been subjected to the plastic hydrothermal treatment; and
a target range setting unit for setting the target range based on the first data.
- 10 6. The waste treatment facility according to claim 5,
wherein the first data defines a plurality of patterns of the first relationship according to a
biomass concentration, which is a proportion of the biomass with respect to moisture in the
plastic waste when supplied to the plastic hydrothermal treatment device.
- 15 7. The waste treatment facility according to claim 5,
wherein the first data defines a plurality of patterns of the first relationship according to a
proportion of lignin in the biomass in the plastic waste when supplied to the plastic
hydrothermal treatment device.
- 20 8. The waste treatment facility according to any one of claims 1 to 3, further comprising a
first measuring device for measuring a residual biomass ratio, which is a proportion occupied
by the biomass remaining in the plastic waste.
9. The waste treatment facility according to claim 8,
25 wherein the first measuring device includes:
a camera for capturing an image of the plastic waste;
a specifying device for specifying, in a captured image of the camera, a non-biomass
region showing non-biomass in the plastic waste and a biomass region showing the biomass in

the plastic waste; and

a calculation device for calculating the residual biomass ratio based on a ratio between the biomass region and the non-biomass region and a specific gravity of each of the biomass and the non-biomass.

5

10. The waste treatment facility according to claim 9,

wherein the camera is configured to generate spectrum data indicating an intensity of light in a predetermined wavelength band, and

wherein the specifying device has:

10 an intensity acquisition unit for acquiring, in the spectrum data, a first intensity, a second intensity, a third intensity, and a fourth intensity respectively corresponding to a first wavelength, a second wavelength, a third wavelength, and a fourth wavelength; and

an identification unit for identifying whether the plastic waste captured in the image is the biomass or the plastic based on a first ratio, which is a ratio between the first intensity and the second intensity, and a second ratio, which is a ratio between the third intensity and the fourth intensity.

15

11. A waste treatment facility for recovering granular plastic from waste containing biomass and plastic, comprising:

20 a second measuring device for measuring a biomass ratio, which is a proportion occupied by the biomass in the waste;

a plastic hydrothermal treatment device configured to perform a plastic hydrothermal treatment on the waste having the biomass ratio equal to or less than an upper limit value of a specified range; and

25 a plastic recovery device for recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.

12. The waste treatment facility according to claim 11, further comprising:

a biomass adding device for adding a ratio adjusting biomass to the waste having the biomass ratio lower than a lower limit value of the specified range; and

a controller for controlling the biomass adding device until the biomass ratio falls within the specified range,

5 wherein the plastic hydrothermal treatment device is configured to perform the plastic hydrothermal treatment on the waste to which the ratio adjusting biomass has been added.

13. The waste treatment facility according to claim 12,
 wherein the controller includes:

10 a first acquisition unit for acquiring first data defining a first relationship between the biomass ratio when supplied to the plastic hydrothermal treatment device and a particle size of the plastic in the waste that has been subjected to the plastic hydrothermal treatment; and
 a specified range setting unit for setting the specified range based on the first data.

15 14. The waste treatment facility according to claim 13,
 wherein the first data defines a plurality of patterns of the first relationship according to a biomass concentration, which is a proportion of the biomass with respect to moisture in the waste when supplied to the plastic hydrothermal treatment device.

20 15. The waste treatment facility according to claim 13 or 14,
 wherein the first data defines a plurality of patterns of the first relationship according to a proportion of lignin in the biomass in the waste when supplied to the plastic hydrothermal treatment device.

25 16. The waste treatment facility according to claim 15,
 wherein the second measuring device includes:
 a camera for capturing an image of the waste;
 a specifying device for specifying, in a captured image of the camera, a non-biomass

region showing non-biomass in the waste and a biomass region showing the biomass in the waste; and

a calculation device for calculating the biomass ratio based on a ratio between the biomass region and the non-biomass region and a specific gravity of each of the biomass and the non-biomass.

17. The waste treatment facility according to claim 16,

wherein the camera is configured to generate spectrum data indicating an intensity of light in a predetermined wavelength band, and

wherein the specifying device has:

an intensity acquisition unit for acquiring, in the spectrum data, a first intensity, a second intensity, a third intensity, and a fourth intensity respectively corresponding to a first wavelength, a second wavelength, a third wavelength, and a fourth wavelength; and

an identification unit for identifying whether the waste captured in the image is the biomass or the plastic based on a first ratio, which is a ratio between the first intensity and the second intensity, and a second ratio, which is a ratio between the third intensity and the fourth intensity.

18. The waste treatment facility according to claim 1 or 11,

wherein the plastic hydrothermal treatment device is configured to add an alkaline agent to the waste and perform hydrolysis with steam, and

wherein the plastic recovery device includes a washing device configured to perform a washing process on treated waste which is the waste obtained by the hydrolysis of the waste.

19. The waste treatment facility according to claim 1 or 11,

wherein the plastic hydrothermal treatment device is configured to, when a biomass ratio, which is a proportion of the biomass in the waste when supplied to the plastic hydrothermal treatment device, is lower than a reference value, add an alkaline agent to the waste and perform

hydrolysis with steam, and

wherein the plastic recovery device includes a washing device configured to perform a washing process on treated waste which is the waste obtained by the hydrolysis of the waste.

5 20. A resource recovery system, comprising:

the waste treatment facility according to claim 2;

a gasification furnace for gasifying the granular biomass recovered by the biomass recovery device; and

10 a biomass conveying device for conveying the granular biomass discharged from the biomass recovery device to the gasification furnace,

wherein the biomass conveying device is configured to shield a conveying space, in which the granular biomass is conveyed, from outside air.

21. The resource recovery system according to claim 20,

15 wherein the biomass conveying device further includes a heater for heating the conveying space.

22. The resource recovery system according to claim 20 or 21, further comprising a steam supply device configured to supply steam generated from water by using a gas discharged from
20 the gasification furnace as a heat source,

wherein the steam supply device is configured to supply the steam to at least one of the plastic hydrothermal treatment device or the biomass hydrothermal treatment device.

23. The resource recovery system according to claim 20 or 21,

25 wherein the gasification furnace is configured to gasify the granular plastic recovered by the plastic recovery device.

24. A waste treatment method for recovering granular plastic from waste containing biomass

and plastic, comprising:

a biomass reduction step of performing a biomass reduction process on the waste for reducing a content of the biomass in the waste;

5 a plastic hydrothermal treatment step of performing a plastic hydrothermal treatment on plastic waste which is the waste that has been subjected to the biomass reduction process; and

a plastic recovery step of recovering the granular plastic from the plastic waste that has been subjected to the plastic hydrothermal treatment.

25. The waste treatment method according to claim 24, further comprising a first measuring
10 step of measuring a residual biomass ratio, which is a proportion occupied by the biomass remaining in the plastic waste.

26. The waste treatment method according to claim 25,
wherein when the residual biomass ratio exceeds a predetermined target range, the
15 biomass reduction step is executed again before the plastic hydrothermal treatment step.

27. The waste treatment method according to any one of claims 24 to 26,
wherein the biomass reduction step is executed by a hydrothermal treatment device for
hydrothermally treating the waste and a recovery device for recovering a specific material from
20 the waste that has been hydrothermally treated,

wherein the waste treatment method further comprises a return step of returning the waste discharged from the recovery device to the hydrothermal treatment device, and

wherein the plastic hydrothermal treatment step and the plastic recovery step are respectively executed by the hydrothermal treatment device and the recovery device.

25

28. A waste treatment method for recovering granular plastic from waste containing biomass and plastic, comprising:

a second measuring step of measuring a biomass ratio, which is a proportion occupied by

the biomass in the waste;

a plastic hydrothermal treatment step of performing a plastic hydrothermal treatment on the waste having the biomass ratio equal to or less than an upper limit value of a specified range; and

- 5 a plastic recovery step of recovering the granular plastic from the waste that has been subjected to the plastic hydrothermal treatment.