

DESCRIPTION

Title of Invention

PYROLYSIS TREATMENT SYSTEM AND PYROLYSIS TREATMENT METHOD

5 Technical Field

[0001] The present invention relates to a pyrolysis treatment system and a pyrolysis treatment method for pyrolyzing treatment object containing oxygen atoms, such as biomass or municipal waste, and recovering oil from the generated pyrolysis gas.

Background Art

10 [0002] Material recycling and chemical recycling, which treat and reuse materials that contain oxygen atoms, such as biomass and municipal waste, have been developed. In particular, the chemical recycling, which uses a pyrolysis furnace to recover oil from biomass, is attracting attention.

[0003] A fluidized-bed furnace is used in the chemical recycling. This fluidized-bed
15 furnace has a structure such that the inside of the furnace is divided by a partition wall into a pyrolysis furnace and a medium regeneration furnace. Treatment object, such as biomass, is fed into the pyrolysis furnace while fluidized medium circulates between the pyrolysis furnace and the medium regeneration furnace. The treatment object is heated by the fluidized medium in the pyrolysis furnace, and most of the treatment object is
20 gasified in pyrolysis. The residue of the treatment object is transported by the fluidized medium to the medium regeneration furnace. The residue of the treatment object is burned in the medium regeneration furnace to heat the fluidized medium. The heated fluidized medium moves into the pyrolysis furnace and functions as a heat source in the pyrolysis furnace.

25 [0004] The treatment object generates pyrolysis gas by pyrolysis. Gaseous hydrocarbon contained in the pyrolysis gas is condensed, so that cracked oil is recovered. The above-mentioned internal circulating fluidized-bed gasification system is expected to provide a technology that can pyrolyze the treatment object and recover cracked oil and cracked gas

as pyrolysis products from the treatment object.

Citation List

Patent Literature

[0005] Patent document 1: Japanese Patent No. 6933577

5 **Summary of Invention**

Technical Problem

[0006] However, the cracked oil recovered by the pyrolysis of the treatment object contains a large amount of oxygen atoms, and therefore the cracked oil is poor in quality as a chemical feedstock or fuel, making it difficult to use the cracked oil as a basic chemical
10 product or use the cracked oil in engines or high-efficiency power generation equipment. In particular, bio-oil generated by the pyrolysis of biomass has a high oxygen-atom content rate, and a calorific value of the bio-oil is less than half that of petroleum-based fuel oil. Furthermore, water and acid-by-products corrode equipment, and can cause fouling of the equipment and catalyst due to increased coke production.

15 [0007] Therefore, the present invention provides a pyrolysis treatment system and a pyrolysis treatment method that can recover high-quality oil from an oxygen-atom-containing treatment object, such as biomass.

Solution to Problem

[0008] In an embodiment, there is a pyrolysis treatment system for treating a treatment
20 object containing oxygen atoms, comprising: a fluidized-bed furnace having a pyrolysis furnace configured to generate pyrolysis gas by pyrolyzing the treatment object, and a medium regeneration furnace configured to combust residue of the pyrolyzed treatment object; a condenser configured to condense oil component and moisture contained in the pyrolysis gas to recover oil-water mixture and light gas separately; a gas separator
25 configured to recover reducing gas from the light gas; a reducing-gas transfer line configured to transfer the reducing gas, recovered by the gas separator, to the pyrolysis furnace; and a fuel line configured to transfer the light gas, from which the reducing gas has been separated, to the medium regeneration furnace.

[0009] In an embodiment, the fluidized-bed furnace is an internal circulating fluidized-bed gasification system in which fluidized medium circulates between the pyrolysis furnace and the medium regeneration furnace.

In an embodiment, the pyrolysis treatment system further comprises a solid-gas separator disposed between the pyrolysis furnace and the condenser, the solid-gas separator being configured to separate particles from the pyrolysis gas discharged from the pyrolysis furnace.

In an embodiment, the condenser includes an oil scrubber and a water scrubber.

In an embodiment, the pyrolysis treatment system further comprises an oil-water separator configured to divide the oil-water mixture, discharged from the water scrubber, into oil and water.

In an embodiment, the pyrolysis treatment system further comprises a hydrocracker configured to perform hydrogenation on the oil recovered from the oil-water mixture.

[0010] In an embodiment, there is provided a pyrolysis treatment method for treating a treatment object containing oxygen atoms, comprising: pyrolyzing the treatment object in a pyrolysis furnace of a fluidized-bed furnace to generate pyrolysis gas; condensing oil component and moisture contained in the pyrolysis gas by a condenser to recover oil-water mixture and light gas separately; recovering reducing gas from the light gas by a gas separator; transferring the reducing gas, recovered by the gas separator, to the pyrolysis furnace to cause hydrogen, contained in the reducing gas, to perform hydrogenation of the treatment object containing oxygen atoms and the pyrolysis gas in the pyrolysis furnace; and delivering, as fuel, the light gas from which the reducing gas has been separated to a medium regeneration furnace of the fluidized-bed furnace to combust residue of the pyrolyzed treatment object.

[0011] In an embodiment, the fluidized-bed furnace is an internal circulating fluidized-bed gasification system in which fluidized medium circulates between the pyrolysis furnace and the medium regeneration furnace.

In an embodiment, the pyrolysis treatment method further comprises separating particles from the pyrolysis gas discharged from the pyrolysis furnace by a solid-gas separator disposed between the pyrolysis furnace and the condenser.

In an embodiment, the condenser includes an oil scrubber and a water scrubber.

5 In an embodiment, the pyrolysis treatment method further comprises dividing the oil-water mixture, discharged from the water scrubber, into oil and water.

Advantageous Effects of Invention

[0012] The gas separator separates the reducing gas containing hydrogen from the pyrolysis gas. The reducing gas is delivered to the pyrolysis furnace. The hydrogen
10 contained in the reducing gas reacts with the oxygen atoms contained in the pyrolysis gas in the pyrolysis furnace, thereby causing the hydrogenation of the pyrolysis gas. The moisture produced by the hydrogenation is condensed in the condenser. The liquid oil and the water are separated, so that the oil can be recovered. In particular, the high heat of the pyrolysis gas can be used directly for the hydrogenation in the pyrolysis furnace.

Brief Description of Drawings

[0013]

[FIG. 1] FIG. 1 is a block diagram showing an embodiment of a pyrolysis treatment system;

[FIG. 2] FIG. 2 is a block diagram showing another embodiment of a pyrolysis treatment system;

20 [FIG. 3] FIG. 3 is a block diagram showing yet another embodiment of a pyrolysis treatment system;

[FIG. 4] FIG. 4 is a block diagram showing yet another embodiment of a pyrolysis treatment system; and

[FIG. 5] FIG. 5 is a block diagram showing yet another embodiment of a pyrolysis treatment
25 system.

Description of Embodiments

[0014] Hereinafter, embodiments of the present invention will be described with

reference to the drawings. FIG. 1 is a block diagram showing an embodiment of a pyrolysis treatment system for treating a treatment object containing oxygen atoms. The treatment object to be treated by the pyrolysis treatment system is a material containing oxygen atoms, such as biomass or municipal waste. In the embodiments described below, biomass, which is an example of the treatment object, is treated by the pyrolysis treatment system.

[0015] As shown in FIG. 1, the pyrolysis treatment system includes a fluidized-bed furnace 40 configured to pyrolyze and combust biomass, which is an example of the treatment object containing oxygen-atoms. The fluidized-bed furnace 40 includes a pyrolysis furnace 1 configured to pyrolyze the biomass to generate pyrolysis gas, and a medium regeneration furnace 44 configured to combust residue of the pyrolyzed biomass.

[0016] The pyrolysis furnace 1 and the medium regeneration furnace 44 are formed within the single fluidized-bed furnace 40. Specifically, an interior of the fluidized-bed furnace 40 is divided by a partition wall 45 into the pyrolysis furnace 1 and the medium regeneration furnace 44. The biomass, which is the treatment object, is fed into the pyrolysis furnace 1 by a raw-material feeding device (not shown). An overall shape of the fluidized-bed furnace 40 is not particularly limited, and may be, for example, cylindrical or rectangular.

[0017] The pyrolysis furnace 1 is configured to generate the pyrolysis gas by heating and pyrolyzing the biomass. A decomposition catalyst may be added to the pyrolysis furnace 1 in order to promote the pyrolysis.

[0018] The pyrolysis treatment system includes a hydrogen-gas supply source 10 configured to supply the hydrogen gas to the pyrolysis furnace 1. The hydrogen-gas supply source 10 is coupled to the pyrolysis furnace 1. An example of the hydrogen-gas supply source 10 is a hydrogen-gas cylinder.

[0019] A fluidized medium (e.g., silica sand) is contained in the pyrolysis furnace 1 and the medium regeneration furnace 44. A fluidizing gas is supplied into the pyrolysis furnace 1 and the medium regeneration furnace 44 to fluidize the fluidized medium. The fluidizing gas supplied to the pyrolysis furnace 1 includes reducing gas containing

hydrogen gas recovered by a gas separator 15, which will be discussed later, and fresh hydrogen gas supplied from the hydrogen-gas supply source 10. Specifically, the reducing gas containing the hydrogen gas recovered by the gas separator 15 is introduced to the pyrolysis furnace 1 through the reducing-gas transfer line 17 together with the fresh hydrogen gas, and serves as the fluidizing gas to fluidize the fluidized medium. Compressed air is supplied as the fluidizing gas to the medium regeneration furnace 44.

[0020] The biomass is fed into the pyrolysis furnace 1 while the fluidized medium circulates between the pyrolysis furnace 1 and the medium regeneration furnace 44. The biomass is heated by the fluidized medium in the pyrolysis furnace 1 and pyrolyzed to generate the pyrolysis gas. A residue of the biomass is transported by the fluidized medium to the medium regeneration furnace 44. The residue of the biomass is combusted in the medium regeneration furnace 44 to heat the fluidized medium. The heated fluidized medium moves into the pyrolysis furnace 1 and functions as a heat source for the pyrolysis in the pyrolysis furnace 1. The fluidized-bed furnace 40, in which the fluidized medium circulates within the furnace in this manner, is an internal circulating fluidized-bed gasification system.

[0021] The pyrolysis treatment system further includes a solid-gas separator 50 configured to separate particles from the pyrolysis gas discharged from the pyrolysis furnace 1. Specific examples of particles removed by the solid-gas separator 50 include polymeric polymer and coke residue generated during pyrolysis of the biomass, fluidized medium (e.g., fine particles of silica sand), and fine particles of catalyst. An example of the solid-gas separator 50 is a cyclone-type solid-gas separator that separates particles from the pyrolysis gas by centrifugal force.

[0022] The pyrolysis gas discharged from the pyrolysis furnace 1 is delivered to the solid-gas separator 50. The particles removed by the solid-gas separator 50 are returned to the medium regeneration furnace 44. In one embodiment, the particles removed by the solid-gas separator 50 may be returned to the pyrolysis furnace 1. The particles in the pyrolysis gas are removed by the solid-gas separator 50, and as a result, the quality of the oil

recovered in an oil reservoir 12 at the downstream side can be improved.

[0023] The pyrolysis treatment system includes a condenser 7 configured to condense oil component and moisture contained in the pyrolysis gas generated in the pyrolysis furnace 1 to recover an oil-water mixture and light gas separately. The condenser 7 is disposed downstream of the pyrolysis furnace 1. In the embodiment shown in FIG. 1, the condenser 7 is disposed downstream of the solid-gas separator 50. The condenser 7 is configured to cool the pyrolysis gas and condense the oil component and moisture in the pyrolysis gas. Specific examples of the condenser 7 include a heat exchanger (e.g., a multi-tube heat exchanger, a spiral heat exchanger, a plate heat exchanger, etc.), an oil scrubber, a water scrubber, and a combination thereof.

[0024] In one example, the pyrolysis gas is cooled to 40°C by the condenser 7. Thus, in the condenser 7, the oil components and the moisture having boiling points of 40°C or higher are condensed and discharged as the oil-water mixture. The oil-water mixture and the light gas are discharged separately from the condenser 7. The oil-water mixture is delivered to the oil reservoir 12. The oil-water mixture is divided into oil and water in the oil reservoir 12. The oil is recovered as cracked oil or reformed oil, and the water is drained from a bottom of the oil reservoir 12.

[0025] The light gas discharged from the condenser 7 includes, for example, hydrogen (H₂), methane (CH₄), ethane (C₂H₆), liquefied petroleum gas (LPG), carbon monoxide (CO), and carbon dioxide (CO₂).

[0026] The pyrolysis treatment system further includes a gas separator 15 configured to recover the reducing gas containing hydrogen gas from the light gas discharged from the condenser 7, and a reducing-gas transfer line 17 configured to transfer the reducing gas containing the hydrogen gas to the pyrolysis furnace 1.

[0027] The gas separator 15 is disposed downstream of the condenser 7, so that the light gas discharged from the condenser 7 is delivered to the gas separator 15. Specific configuration of the gas separator 15 is not particularly limited. For example, a pressure swing adsorption device (PSA) or a gas separation membrane can be used for the gas

separator 15. The reducing gas separated from the pyrolysis gas by the gas separator 15 is transferred through the reducing-gas transfer line 17 to the pyrolysis furnace 1.

[0028] The gas separator 15 is configured to recover (separate) the reducing gas containing hydrogen gas, methane, ethane, and carbon monoxide gas, which have small
5 molecular weights, from the light gas. The reducing gas containing the hydrogen gas is delivered to the pyrolysis furnace 1, so that generation of coke during the pyrolysis of biomass in the pyrolysis furnace 1 can be suppressed.

[0029] In the pyrolysis furnace 1, the hydrogen gas contained in the reducing gas is added to the pyrolysis gas under a high temperature, so that hydrogenation is performed on the
10 biomass and the pyrolysis gas in the pyrolysis furnace 1. Specifically, oxygen atoms contained in the biomass and the pyrolysis gas react with the hydrogen to form moisture. As a result, the oxygen atoms are removed from the biomass and the pyrolysis gas. Because the pyrolysis gas in the pyrolysis furnace 1 has a high temperature (e.g., 400 to 600°C), the high heat of the pyrolysis gas can be used directly for the hydrogenation of the
15 pyrolysis gas. The condenser 7 cools the pyrolysis gas that has been subjected to the hydrogenation in the pyrolysis furnace 1 and condenses the oil component and moisture contained in the pyrolysis gas. The liquid oil and water are separated, so that the oil can be recovered.

[0030] The hydrogen-gas supply source 10 is coupled to the reducing-gas transfer line 17.
20 The reducing-gas transfer line 17 extends from the gas separator 15 to the pyrolysis furnace 1. Therefore, the hydrogen-gas supply source 10 is coupled to the pyrolysis furnace 1 via the reducing-gas transfer line 17. The hydrogen gas delivered to the pyrolysis furnace 1 also functions as a purge gas within the pyrolysis furnace 1. The purge gas is a gas for discharging the pyrolysis gas remaining in the pyrolysis furnace 1 to a downstream side of
25 the pyrolysis furnace 1, and may be used to adjust a residence time of the pyrolysis gas.

[0031] The hydrogen gas contained in the light gas that has been discharged from the condenser 7 is recovered by the gas separator 15 and used again for the hydrogenation in the pyrolysis furnace 1. Specifically, the hydrogen gas required for the hydrogenation is

consumed while circulating between the pyrolysis furnace 1 and the gas separator 15. According to this embodiment, an amount of hydrogen gas consumed for the hydrogenation can be reduced. Depending on the amount of hydrogen gas required for the hydrogenation in the pyrolysis furnace 1, the hydrogen gas may be supplied from the hydrogen-gas supply source 10 through the reducing-gas transfer line 17 to the pyrolysis furnace 1.

[0032] The pyrolysis treatment system further includes a fuel line 21 configured to supply the light gas, from which the reducing gas has been separated by the gas separator 15, to the medium regeneration furnace 44 of the fluidized-bed furnace 40. The light gas, from which the reducing gas has been separated, includes, for example, liquefied petroleum gas (LPG), such as propane or butane, which has larger molecular weight, and carbon dioxide (CO₂). The light gas is combusted as fuel in the medium regeneration furnace 44. The residue of the biomass pyrolyzed in the pyrolysis furnace 1 is delivered to the medium regeneration furnace 44 and combusted in the medium regeneration furnace 44. The heat generated by the combustion heats the fluidized medium. The heated fluidized medium is delivered to the pyrolysis furnace 1 and used as a heat source for the pyrolysis in the pyrolysis furnace 1.

[0033] FIG. 2 is a block diagram showing another embodiment of a pyrolysis treatment system. Configuration and operation of this embodiment that will not be particularly described are the same as those of the embodiment described with reference to FIG. 1, and therefore duplicated descriptions will be omitted. The pyrolysis treatment system of the embodiment shown in FIG. 2 further includes a hydrocracker 25 coupled to the oil reservoir 12, and a distillation column 28 coupled to the hydrocracker 25.

[0034] A part or all of the oil in the oil reservoir 12 is delivered to the hydrocracker 25 by a pump 30. The hydrocracker 25 is configured to further perform hydrogenation on the oil recovered in the oil reservoir 12 at a high temperature (e.g., 400 to 600°C) and under pressure (e.g., 1 MPa or more). Hydrogen gas used in the hydrogenation in the hydrocracker 25 is supplied from the hydrogen-gas supply source 10. Trace amounts of oxygen atoms, sulfur atoms, nitrogen atoms, etc. contained in the oil are removed by the

hydrogenation in the hydrocracker 25.

[0035] The oil hydrogenated by the hydrocracker 25 is delivered to the distillation tower 28 where the oil is divided into light oil and heavy oil. The hydrogen, hydrogen sulfide, and ammonia discharged from the distillation tower 28 are delivered to the gas separator

5 15. Water condensed and separated in the distillation tower 28 is drained from an auxiliary facility of the distillation tower 28.

[0036] The hydrocracker 25 and distillation column 28 shown in FIG. 2 are appropriately provided based on the quality required for the oil recovered in the oil reservoir 12.

[0037] FIG. 3 is a block diagram showing yet another embodiment of a pyrolysis
10 treatment system. Configuration and operation of this embodiment that will not be particularly described are the same as those of the embodiment described with reference to FIG. 2, and therefore duplicated descriptions will be omitted.

[0038] The pyrolysis treatment system of the embodiment shown in FIG. 3 further includes an oil-water separator 53 disposed between the condenser 7 and the oil reservoir
15 12. The oil-water mixture generated by the condenser 7 is delivered to the oil-water separator 53, which is configured to separate the oil from the water. The specific configuration of the oil-water separator 53 is not particularly limited. For example, a coalescer or a sedimentation tank can be used for the oil-water separator 53. The oil separated by the oil-water separator 53 is delivered to the oil reservoir 12 and stored in the
20 oil reservoir 12. The water separated from the oil by the oil-water separator 53 is drained from the oil-water separator 53.

[0039] FIG. 4 is a block diagram showing yet another embodiment of a pyrolysis treatment system. Configuration and operation of this embodiment that will not be particularly described are the same as those of the embodiment described with reference to
25 FIG. 3, and therefore duplicated descriptions will be omitted.

[0040] The pyrolysis treatment system of the embodiment shown in FIG. 4 further includes a cleaning device 55 disposed between the condenser 7 and the gas separator 15. The cleaning device 55 is configured to scrub the light gas with a scrubbing liquid by

bringing the scrubbing liquid into contact with the light gas passing through an inside of the cleaning device 55. A liquid, such as water, can be used as the scrubbing liquid. The specific configuration of the cleaning device 55 used is not particularly limited, and a known cleaning device, such as a scrubber, can be used. For example, a cleaning tower
5 that includes a tower having a gas passage formed therein and a spray nozzle for spraying water onto the gas flowing through the gas passage can be used as the cleaning device 55.

[0041] The light gas discharged from the condenser 7 is introduced into the cleaning device 55. The hydrogen, the hydrogen sulfide, and the ammonia discharged from the distillation tower 28 are also delivered to the cleaning device 55. Water-soluble
10 substances, such as fine particles and ammonia, are removed from the light gas by the cleaning device 55. The light gas that has passed through the cleaning device 55 is delivered to the gas separator 15.

[0042] FIG. 5 is a block diagram showing yet another embodiment of a pyrolysis treatment system. Configuration and operation of this embodiment that will not be
15 particularly described are the same as those of the embodiment described with reference to FIG. 3, and therefore duplicated descriptions will be omitted.

[0043] In the embodiment shown in FIG. 5, a combination of an oil scrubber 60 and a water scrubber 56 is used as the condenser 7. Specifically, the oil scrubber 60 and the water scrubber 56 as the condenser 7 are configured to cool the hydrogenated pyrolysis gas
20 in two stages to condense oil component and moisture. The oil scrubber 60 is arranged downstream of the pyrolysis furnace 1. In the embodiment shown in FIG. 5, the oil scrubber 60 is arranged downstream of the solid-gas separator 50. The oil scrubber 60 is coupled to the pyrolysis furnace 1, the water scrubber 56, and the oil reservoir 12. The pyrolysis gas hydrogenated in the pyrolysis furnace 1 is introduced to the oil scrubber 60
25 via the solid-gas separator 50.

[0044] The oil scrubber 60 is configured to cool heavy oil recovered on its bottom, and then spray the heavy oil onto the pyrolysis gas to cool the pyrolysis gas and condense gaseous oil component contained in the pyrolysis gas. In one embodiment, oil supplied

from outside, instead of the recovered heavy oil, may be sprayed in the oil scrubber 60.

[0045] In one example, the pyrolysis gas is cooled to 150°C by the oil scrubber 60. Thus, oil component having a boiling point of 150°C or higher is condensed in the oil scrubber 60. The condensed oil and the sprayed oil are discharged from the oil scrubber 60 as heavy oil and stored in the oil reservoir 12. The specific configuration of the oil scrubber 60 is not particularly limited, and a known oil scrubber can be used. For example, a cleaning tower that includes a tower having a gas passage formed therein and a spray nozzle for spraying oil onto a gas flowing through the gas passage can be used as the oil scrubber 60.

[0046] The water scrubber 56 is disposed between the oil scrubber 60 and the gas separator 15. The water scrubber 56 is further coupled to the oil-water separator 53. The water scrubber 56 is configured to bring water into contact with the pyrolysis gas that has passed through the oil scrubber 60, thereby further cooling the pyrolysis gas. In this embodiment, the water scrubber 56 is configured to bring alkaline water into contact with the pyrolysis gas. The pyrolysis gas is cooled by the contact with the water (e.g., alkaline water in this embodiment). For example, the pyrolysis gas is cooled from 150°C to 40°C by the water scrubber 56. Thus, in the water scrubber 56, oil component and moisture having boiling points generally within a range of 150°C to 40°C are condensed. Oil-water mixture is discharged from the water scrubber 56 and delivered to the oil-water separator 53. The oil-water separator 53 is configured to separate oil (e.g., light oil of 40°C) from the alkaline water. The pyrolysis gas from which the oil component and moisture have been removed by the water scrubber 56 is delivered as a light gas to the gas separator 15.

[0047] According to this embodiment, the oil contained in the pyrolysis gas is recovered by the oil scrubber 60 and the water scrubber 56, so that fine particles and water-soluble substance gases in the pyrolysis gas are removed, and an overall oil yield is improved.

[0048] The hydrocracker 25 and the distillation tower 28 shown in FIGS. 2 to 5 may be omitted. The embodiments described with reference to FIGS. 1 to 5 may be combined as appropriate. For example, the condenser 7 constituted of a combination of the oil scrubber

60 and the water scrubber 56 shown in FIG. 5 may be applied to the embodiments described with reference to FIG. 1 or 2.

[0049] The previous description of embodiments is provided to enable a person skilled in the art to make and use the present invention. Moreover, various modifications to these
5 embodiments will be readily apparent to those skilled in the art, and the generic principles and specific examples defined herein may be applied to other embodiments. Therefore, the present invention is not intended to be limited to the embodiments described herein but is to be accorded the widest scope as defined by limitation of the claims.

Industrial Applicability

10 [0050] The present invention is applicable to a pyrolysis treatment system and a pyrolysis treatment method for pyrolyzing treatment object containing oxygen atoms, such as biomass or municipal waste, and recovering oil from the generated pyrolysis gas.

Reference Signs List

[0051]

15	1	pyrolysis furnace
	7	condenser
	10	hydrogen-gas supply source
	12	oil reservoir
	15	gas separator
20	17	reducing-gas transfer line
	21	fuel line
	25	hydrocracker
	28	distillation tower
	40	fluidized-bed furnace
25	44	medium regeneration furnace
	45	partition wall
	50	solid-gas separator
	53	oil-water separator

55	cleaning device
56	water scrubber
60	oil scrubber

CLAIMS

[Claim 1] A pyrolysis treatment system for treating a treatment object containing oxygen atoms, comprising:

5 a fluidized-bed furnace having a pyrolysis furnace configured to generate pyrolysis gas by pyrolyzing the treatment object, and a medium regeneration furnace configured to combust residue of the pyrolyzed treatment object;

a condenser configured to condense oil component and moisture contained in the pyrolysis gas to recover oil-water mixture and light gas separately;

a gas separator configured to recover reducing gas from the light gas;

10 a reducing-gas transfer line configured to transfer the reducing gas, recovered by the gas separator, to the pyrolysis furnace; and

a fuel line configured to transfer the light gas, from which the reducing gas has been separated, to the medium regeneration furnace.

15 [Claim 2] The pyrolysis treatment system according to claim 1, wherein the fluidized-bed furnace is an internal circulating fluidized-bed gasification system in which fluidized medium circulates between the pyrolysis furnace and the medium regeneration furnace.

20 [Claim 3] The pyrolysis treatment system according to claim 1, further comprising a solid-gas separator disposed between the pyrolysis furnace and the condenser, the solid-gas separator being configured to separate particles from the pyrolysis gas discharged from the pyrolysis furnace.

25 [Claim 4] The pyrolysis treatment system according to claim 1, wherein the condenser includes an oil scrubber and a water scrubber.

[Claim 5] The pyrolysis treatment system according to claim 4, further comprising

an oil-water separator configured to divide the oil-water mixture, discharged from the water scrubber, into oil and water.

[Claim 6] The pyrolysis treatment system according to claim 1, further comprising
5 a hydrocracker configured to perform hydrogenation on the oil recovered from the oil-water mixture.

[Claim 7] A pyrolysis treatment method for treating a treatment object containing oxygen atoms, comprising:
10 pyrolyzing the treatment object in a pyrolysis furnace of a fluidized-bed furnace to generate pyrolysis gas;
 condensing oil component and moisture contained in the pyrolysis gas by a condenser to recover oil-water mixture and light gas separately;
 recovering reducing gas from the light gas by a gas separator;
15 transferring the reducing gas, recovered by the gas separator, to the pyrolysis furnace to cause hydrogen, contained in the reducing gas, to perform hydrogenation of the treatment object containing oxygen atoms and the pyrolysis gas in the pyrolysis furnace;
 and
 delivering, as fuel, the light gas from which the reducing gas has been separated
20 to a medium regeneration furnace of the fluidized-bed furnace to combust residue of the pyrolyzed treatment object.

[Claim 8] The pyrolysis treatment method according to claim 7, wherein the fluidized-bed furnace is an internal circulating fluidized-bed gasification system in which
25 fluidized medium circulates between the pyrolysis furnace and the medium regeneration furnace.

[Claim 9] The pyrolysis treatment method according to claim 7, further comprising

separating particles from the pyrolysis gas discharged from the pyrolysis furnace by a solid-gas separator disposed between the pyrolysis furnace and the condenser.

[Claim 10] The pyrolysis treatment method according to claim 7, wherein the
5 condenser includes an oil scrubber and a water scrubber.

[Claim 11] The pyrolysis treatment method according to claim 10, further
 comprising dividing the oil-water mixture, discharged from the water scrubber, into oil and
 water.

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