

[DESCRIPTION]

[TITLE OF INVENTION]

SOLID FUEL PRODUCTION PLANT AND PRODUCTION METHOD FOR SOLID  
FUEL

5 [Technical Field]

[0001]

The present invention relates to a solid fuel production plant and a production  
method for solid fuel.

[Background Art]

10 [0002]

As a new fuel resource alternative to fossil fuel, fuel originated from biomass  
has come into practical use in recent years. As a specific example of biomass, empty  
fruit bunches (EFBs) of palms generated in a process of refining palm oil can be  
exemplified. In the process of refining palm oil, the amount of the empty fruit bunches  
15 to be discharged also increases in proportional to the oil refining amount. For this  
reason, a technology for recycling a large amount of previously discarded empty fruit  
bunches as resources has been demanded.

As an example of such a technology, the following Patent Literature 1 is known.  
In the technology according to Patent Literature 1, biomass fuel is generated when palm  
20 oil residue (liquid) is mixed with solid material obtained by crushing carbonized coconut  
husks.

[Citation List]

[Patent Literature]

[0003]

25 [Patent Literature 1]

[Summary of Invention]

[Technical Problem]

[0004]

5           However, in the technology disclosed in Patent Literature 1, there is a need to separately prepare dedicated fuel for carbonizing coconut husks. That is, when facilities producing solid fuel using biomass resources are provided in parallel in a plant generating palm oil, there is a need to prepare some other fuel to be used in the solid fuel production facilities in addition to the fuel to be used in the plant. Further, the amount  
10   of available electric power is limited in the palm oil refining plant in many cases. For this reason, there is a need to supply electric power by additional in-house power generators for devices and facilities which consume a large amount of electric power, such as a device crushing coconut husks containing a large amount of moisture or a device carbonizing coconut husks. This technology is not realistic because of the cost  
15   increase. For this reason, there is a concern that efficient plant operation is hindered.

[0005]

          An object of the present invention is to provide a solid fuel production plant which is operable more efficiently and a production method for solid fuel.

[Solution to Problem]

20   [0006]

          According to a first aspect of the present invention, a solid fuel production plant includes: a separation unit which separates oil and water from palm oil mill effluent discharged from an oil refining plant which refines essential oil from fresh fruit bunches containing oil and fat so that fuel oil and treatment water are separated; a heat treatment  
25   unit which performs a heat treatment on empty fruit bunches discharged from the oil

refining plant to generate fuel; and a fuel oil supply line which supplies the fuel oil to the heat treatment unit, and the fuel oil is used as the fuel of the heat treatment unit.

[0007]

According to this configuration, the fuel oil obtained from the palm oil mill effluent discharged from the oil refining plant is used as a heat source when the fuel is generated by the heat treatment unit. Accordingly, the fuel oil can be obtained by reusing the palm oil mill effluent previously discarded. In other words, the fuel can be obtained without fuel or a heat source supplied from the outside.

[0008]

According to a second aspect of the present invention, in the solid fuel production plant according to the first aspect, the heat treatment unit may include a drying treatment unit which dries the empty fruit bunches and a carbonization treatment unit which carbonizes the empty fruit bunches dried by the drying treatment unit.

[0009]

According to this configuration, since the empty fruit bunches are dried by the drying treatment unit and are carbonized by the carbonization treatment unit, the moisture content of the fuel finally obtained can be further decreased. Further, the drying treatment unit serves as a buffer of the entire production plant and hence the carbonization treatment unit can be operated more stably.

[0010]

According to a third aspect of the present invention, the solid fuel production plant according to the first or second aspect may further include: a heating source gas generation unit which is connected to the fuel oil supply line and generates a heating source gas; and a heating source gas supply line which supplies the heating source gas to the carbonization treatment unit and the heating source gas may be used as a heat source

of the carbonization treatment unit.

[0011]

According to this configuration, the heating source gas generated by the heating source gas generation unit is supplied to the carbonization treatment unit through the heating source gas supply line. In the carbonization treatment unit, the heating source gas is used as a heat source. The heating source gas is generated by the combustion of the fuel oil obtained from the palm oil mill effluent. Accordingly, the fuel can be obtained without fuel or a heat source supplied from the outside.

[0012]

According to a fourth aspect of the present invention, the solid fuel production plant according to the third aspect may further include an exhaust gas supply line which supplies an exhaust gas from the carbonization treatment unit to the drying treatment unit and the exhaust gas may be used as a heat source of the drying treatment unit.

[0013]

According to this configuration, the exhaust gas of the carbonization treatment unit is used as the heat source of the drying treatment unit. That is, the drying treatment can be performed without a different heat source provided for the drying treatment unit.

[0014]

According to a fifth aspect of the present invention, the solid fuel production plant according to any one of the first to fourth aspects may further include a crushing treatment unit which crushes the fuel.

[0015]

According to this configuration, the energy necessary for the crushing treatment can be suppressed to be small compared to the configuration of crushing the empty fruit bunches before the heat treatment. Meanwhile, when the crushing treatment is

performed on the empty fruit bunches, much energy is necessary for the crushing treatment because a large amount of moisture is contained in the empty fruit bunches.

[0016]

According to a sixth aspect of the present invention, the solid fuel production plant according to the fifth aspect may further include a pellet molding unit which generates the solid fuel pellets by molding the fuel crushed by the crushing treatment unit.

[0017]

According to this configuration, the pellet molding unit generates the solid fuel pellets by molding the fuel crushed by the crushing treatment unit. Accordingly, the solid fuel pellets which are used more easily as fuel can be obtained.

[0018]

According to a seventh aspect of the present invention, the solid fuel production plant according to any one of the first to sixth aspects may further include a returning unit which returns the fuel oil and the treatment water to the plant.

[0019]

According to this configuration, the fuel oil obtained when the palm oil mill effluent is separated into oil and water can be reused and the treatment water can be also reused in the oil refining plant. Accordingly, the solid fuel can be produced more efficiently and hence the oil refining plant can be operated more efficiently.

[0020]

According to an eighth aspect of the present invention, a production method for solid fuel includes: a separation step of separating oil and water from palm oil mill effluent discharged from an oil refining plant refining essential oil from fresh fruit bunches containing oil and fat so that fuel oil and treatment water are separated; and a

heat treatment step of performing a heat treatment on empty fruit bunches discharged from the oil refining plant to generate fuel, and the fuel oil extracted by the separation step is used as the fuel in the heat treatment step.

[0021]

5           According to this method, the fuel oil obtained from the palm oil mill effluent discharged from the oil refining plant is used as a heat source when the fuel is generated in the heat treatment step. Accordingly, the fuel oil can be obtained by reusing the palm oil mill effluent previously discarded. In other words, the fuel can be obtained by using a solid fuel production heat source obtained without fuel or a heat source supplied from  
10 the outside.

[0022]

          According to a ninth aspect of the present invention, in the production method for solid fuel according to the eighth aspect, the heat treatment step may include a drying treatment step of drying the empty fruit bunches and a carbonization treatment step of  
15 carbonizing the empty fruit bunches dried by the drying treatment step.

[0023]

          According to this method, since the empty fruit bunches are dried by the drying treatment step and are carbonized in the carbonization treatment step, the moisture content of the fuel finally obtained can be further decreased. Further, the drying  
20 treatment unit serves as a buffer of the entire production plant and hence the carbonization treatment unit can be operated more stably.

[0024]

          According to a tenth aspect of the present invention, the production method for solid fuel according to the ninth aspect may further include a gas generation step of  
25 burning the fuel oil to generate a heating source gas after the separation step and the

heating source gas may be used as a heat source in the carbonization treatment step.

[0025]

According to this method, the heating source gas generated in the gas generation step is supplied to the carbonization treatment unit. In the carbonization treatment unit, the heating source gas is used as a heat source. The heating source gas is generated by the combustion of the fuel oil obtained from the palm oil mill effluent. Accordingly, the fuel can be obtained without fuel or a heat source supplied from the outside.

[0026]

According to an eleventh aspect of the present invention, in the production method for solid fuel according to the ninth or tenth aspect, a high-temperature exhaust gas discharged in the carbonization treatment step may be used as a heat source in the drying treatment step.

[0027]

According to this method, the exhaust gas discharged in the carbonization treatment step is used as the heat source in the drying treatment step. That is, in the drying treatment step, the drying treatment can be performed without providing a different heat source.

[0028]

According to a twelfth aspect of the present invention, the production method for solid fuel according to any one of the eighth to eleventh aspects may further include a crushing treatment step of crushing the fuel after the heat treatment step.

[0029]

According to this method, the energy necessary for the crushing treatment can be suppressed to be small compared to the configuration of crushing the empty fruit bunches before the heat treatment. Meanwhile, when the crushing treatment is

performed on the empty fruit bunches, much energy is necessary for the crushing treatment because a large amount of moisture is contained in the empty fruit bunches.

[0030]

According to a thirteenth aspect of the present invention, the production method for solid fuel according to the twelfth aspect may further include a pellet molding step of generating solid fuel pellets by molding the crushed fuel after the crushing treatment step.

[0031]

According to this method, in the pellet molding step, the fuel crushed in the crushing treatment step is molded to generate the solid fuel pellets. Accordingly, the solid fuel pellets which are used more easily as fuel can be obtained.

[0032]

According to a fourteenth aspect of the present invention, the production method for solid fuel may further include a returning step of supplying the fuel oil and the treatment water to the oil refining plant.

[0033]

According to this method, the fuel oil obtained when the palm oil mill effluent is separated into oil and water can be reused and the treatment water can be also reused in the oil refining plant. Accordingly, the solid fuel can be produced more efficiently.

[Advantageous Effects of Invention]

[0034]

According to the present invention, it is possible to provide a solid fuel production plant which is efficiently operable by recycling EFBs and palm oil mill effluent and a production method for solid fuel.

[Brief Description of Drawings]

[0035]

Fig. 1 is a diagram showing the configuration of a combined plant according to an embodiment of the present invention.

Fig. 2 is a diagram showing the configuration of an oil refining facility (an oil refining plant) according to a first embodiment of the present invention.

Fig. 3 is a diagram showing the configuration of a solid fuel production facility (a solid fuel production plant) according to the first embodiment of the present invention.

Fig. 4 is a process diagram showing a production method for solid fuel according to the first embodiment of the present invention.

Fig. 5 is a diagram showing the configuration of a combined plant according to a second embodiment of the present invention.

Fig. 6 is a diagram showing the configuration of an oil refining facility (an oil refining plant) according to the second embodiment of the present invention.

Fig. 7 is a diagram showing the configuration of a solid fuel production facility (a solid fuel production plant) according to the second embodiment of the present invention.

[Description of Embodiments]

[0036]

[First Embodiment]

A first embodiment of the present invention will be described with reference to the drawings. As shown in Fig. 1, a combined plant 100 according to the embodiment includes an oil refining facility 1 (oil refining plant 1 or palm oil production plant 1) which refines essential oil (palm oil) and a solid fuel production facility 2 (solid fuel production plant 2) which produces solid fuel by using the residue generated by the oil refining facility 1.

[0037]

The oil refining facility 1 is a facility which refines palm oil by using fresh fruit bunches containing oil and fat in palms as raw materials. Empty fruit bunches (EFBs) and effluent (as palm oil mill effluent (POME)) containing oil are discharged as residue  
5 generated in a process of refining palm oil from the oil refining facility 1. The solid fuel production facility 2 is a facility which produces solid fuel by using the palm oil mill effluent and the EFBs.

[0038]

Next, the configuration of the oil refining facility 1 will be described with  
10 reference to Fig. 2. The oil refining facility 1 includes a sterilization device 11, a separation device 12, a digestion device 13, and a compression/clarification device 14.

[0039]

The sterilization device 11 is a device which sterilizes the fresh fruit bunches (FFBs) which are carried from the outside and are untreated. Specifically, in the  
15 sterilization device 11, the FFBs are subjected to steam sterilizing by high-temperature steam generated by a boiler B. In the description below, the FFBs subjected to the sterilization treatment will be referred to as sterilized FFBs. The steam used in the sterilizing is naturally liquefied and is discharged to the outside. The effluent (palm oil mill effluent) contains the oil contained in the FFBs. The palm oil mill effluent is  
20 supplied to the solid fuel production facility 2 to be described below.

[0040]

The separation device 12 is a device which separates the sterilized FFBs into fruit bunches containing oil and fat and EFBs which have covered the fruit bunches. The EFBs obtained herein are supplied to the solid fuel production facility 2 similarly to  
25 the palm oil mill effluent.

[0041]

The digestion device 13 is a device which performs a digestion treatment (cooking treatment) on the fruit bunches generated by the treatment of the separation device 12.

5 [0042]

The fruit bunches digested by the digestion device 13 are sent to the compression/clarification device 14. In the compression/clarification device 14, palm oil is extracted by a compression process. Further, a clarification treatment is performed on the extracted palm oil in order to remove impurities therefrom. In the  
10 clarification treatment, the viscosity of the palm oil is decreased by adding water to the palm oil to be treated. Next, fibers and moisture are removed by separation using a centrifugal separator or the like. In this way, the palm oil (palm raw oil) can be obtained.

[0043]

15 Next, the configuration of the solid fuel production facility 2 will be described with reference to Fig. 3. The solid fuel production facility 2 includes a separation unit 21, a heating source gas generation unit 22, a heat treatment unit 23, and a final treatment unit 26.

[0044]

20 The separation unit 21 is a device which separates oil and water from the palm oil mill effluent generated by the sterilization treatment. By this treatment, the palm oil mill effluent is separated into an element containing oil (fuel oil F) and an element containing moisture (treated water W). The fuel oil F is supplied to the heat treatment unit 23 (drying treatment unit 24) through a fuel oil supply line L1. The treated water  
25 W is discharged to the outside. Further, any oil or impurities remaining in the treated

water W are removed by a water treatment device (not shown) before the treated water W is discharged to the outside. The separation unit 21 is connected to the heating source gas generation unit 22 by the fuel oil supply line L1.

[0045]

5 In the heating source gas generation unit 22, the fuel oil F supplied through the fuel oil supply line L1 is mixed with air Af, and a high-temperature heating source gas G is generated by the combustion of the mixture of the fuel oil F and air Af. As an example, the temperature of the heating source gas G is set to 800°C to 1000°C. As the heating source gas generation unit 22, a combustion furnace capable of handling a  
10 relatively low-caloric fuel is preferably used. A heating source gas supply line L2 is connected to the downstream side of the heating source gas generation unit 22. The heating source gas G generated by the heating source gas generation unit 22 is supplied to the heat treatment unit 23 (a carbonization treatment unit 25) through the heating source gas supply line L2.

15 [0046]

The heat treatment unit 23 generates solid fuel by performing a heat treatment on the EFBs discharged from the oil refining facility 1. More specifically, the heat treatment unit 23 includes the drying treatment unit 24 and the carbonization treatment unit 25. As the drying treatment unit 24, a direct heating type rotary kiln furnace is  
20 used appropriately. In the drying treatment unit 24, a drying treatment is performed on the EFBs under a temperature comparatively lower than that of the carbonization treatment unit 25. The EFBs to be treated contain 40 to 60% moisture. The moisture is removed from the EFBs by the drying treatment so that dried EFBs are obtained as an intermediate product Pm. As the carbonization treatment unit 25, an indirect heating  
25 type rotary kiln furnace is used appropriately. In the carbonization treatment unit 25, a

carbonization treatment is performed on the dried EFBs under a temperature comparatively higher than that of the drying treatment unit 24. The dried EFBs become solid fuel through the carbonization treatment. The solid fuel becomes a raw material of solid fuel pellets Pf to be described below. The carbonization treatment unit 25 is connected to the drying treatment unit 24 by an exhaust gas supply line L3. The heating source gas G used in the heating treatment of the carbonization treatment unit 25 is supplied as an exhaust gas E to the drying treatment unit 24 through the exhaust gas supply line L3 and is used as a heat source.

[0047]

Here, in the embodiment, the heating source gas G supplied through the heating source gas supply line L2 is used as the heating fuel source (heat source) of the carbonization treatment unit 25. In the carbonization treatment unit 25, a carbonization treatment is performed by using the heating source gas G under a reducing atmosphere for the dried EFBs. The high-temperature exhaust gas E is discharged from the carbonization treatment unit 25 in accordance with the carbonization treatment. The temperature of the exhaust gas E is lower than that of the heating source gas G. Specifically, the temperature of the exhaust gas E is set to 300°C to 400°C. The exhaust gas E is supplied to the drying treatment unit 24 through the exhaust gas supply line L3. In the drying treatment unit 24, the exhaust gas E is reused as a heat source when the drying treatment is performed on the EFBs. That is, in the embodiment, the fuel oil F obtained from the palm oil mill effluent and mixed with the combustion air in the heating source gas generation unit 22 is burned to be used as the heating heat source of the carbonization treatment unit 25 and the drying heat source of the drying treatment unit 24.

[0048]

In the final treatment unit 26, a crushing treatment and a molding treatment are performed on the solid fuel as the raw material generated by the heat treatment unit 23 (carbonization treatment unit 25). Specifically, the final treatment unit 26 includes a crushing treatment unit 26A which crushes the solid fuel and a pellet molding unit 26B which molds the crushed solid fuel into a pellet shape to generate solid fuel pellets Pf. As the crushing treatment unit 26A, a hammer mill type crusher is used appropriately. The solid fuel pellets Pf molded by the pellet molding unit 26B are used as a fuel source in an external facility.

[0049]

Next, a production method M1 for solid fuel according to the embodiment will be described. As shown in Fig. 4, the production method M1 for solid fuel includes a separation step S1, a gas generation step S2, a heat treatment step S3, and a final treatment step S6.

[0050]

In the separation step S1, oil and moisture are separated from the palm oil mill effluent generated in the oil refining facility 1. By this treatment, the palm oil mill effluent is separated into an element containing oil (fuel oil F) and an element containing moisture (treated water W). In the gas generation step S2, the fuel oil F is mixed with the air (combustion air) and the high-temperature heating source gas G is generated by the combustion of the mixture.

[0051]

In the heat treatment step S3, the heat treatment is performed on the EFBs to generate the solid fuel. Specifically, the heat treatment step S3 includes a drying treatment step S4 of drying the EFBs and a carbonization treatment step S5 of carbonizing the dried EFBs (intermediate product Pm). In the drying treatment step S4,

the drying treatment is performed on the EFBs under a temperature comparatively lower than that in the carbonization treatment step S5. In the carbonization treatment step S5, the carbonization treatment is performed on the EFBs under a temperature comparatively higher than that in the drying treatment step S4. The dried EFBs become the solid fuel through the carbonization treatment step S5. The solid fuel becomes a raw material of the solid fuel pellets Pf to be described below.

[0052]

Here, the heating source gas G is used as a heat source in the carbonization treatment step S5. In the carbonization treatment step S5, the carbonization treatment is performed on the dried EFBs by using the heating source gas G under a reducing atmosphere. The temperature of the exhaust gas E discharged from the carbonization treatment unit 25 is lower than that of the heating source gas G. Specifically, the temperature of the exhaust gas E is set to 300°C to 400°C. The exhaust gas E generated in the carbonization treatment step S5 is reused as a heat source for drying the EFBs in the drying treatment step S4. That is, in the embodiment, the fuel oil F obtained from the palm oil mill effluent is used as the heat source in the gas generation step S2 and the exhaust gas E generated in the carbonization treatment step S5 is used as the heat source in the drying treatment step S4.

[0053]

In the final treatment step S6, the crushing treatment and the molding treatment are performed on the solid fuel as the raw material generated in the heat treatment step S3 (carbonization treatment step S5). Specifically, the final treatment step S6 includes a crushing treatment step S6A of crushing the solid fuel and a pellet molding step S6B of molding the crushed solid fuel into a pellet shape. In the crushing treatment step S6A, a hammer mill type crusher is used appropriately. The solid fuel pellets Pf molded by the

pellet molding step S6B are used as a fuel source in an external facility.

[0054]

As described above, according to the solid fuel production plant 2 (the solid fuel production facility 2) and the production method M1 for solid fuel of the embodiment,  
5 the fuel oil F obtained from the palm oil mill effluent discharged from the oil refining facility 1 is used when the solid fuel is generated by the heat treatment. That is, the fuel oil F can be obtained by reusing the palm oil mill effluent previously discarded. In other words, the solid fuel can be obtained without fuel or a heat source supplied from the outside.

10 [0055]

Moreover, in the aforementioned configuration, the EFBs are dried by the drying treatment unit 24 and is carbonized by the carbonization treatment unit 25, so that the moisture content of the solid fuel (the solid fuel pellets Pf) finally obtained can be further decreased. Further, the drying treatment unit serves as a buffer in the entire production  
15 plant and the carbonization treatment unit can be operated more stably.

[0056]

Further, according to the aforementioned configuration, the heating source gas G generated by the heating source gas generation unit 22 is supplied to the carbonization treatment unit 25 through the heating source gas supply line L2. In the carbonization  
20 treatment unit 25, the heating source gas G is used as a heat source. Here, the heating source gas G is generated by the combustion of the fuel oil F obtained from the palm oil mill effluent. Accordingly, the solid fuel can be obtained without fuel or a heat source supplied from the outside.

[0057]

25 Further, according to the aforementioned configuration, the exhaust gas E

discharged from the carbonization treatment unit 25 is used as the heat source of the drying treatment unit 24. That is, the drying treatment can be performed on the EFBs without providing a different heat source for the drying treatment unit 24.

[0058]

5 Further, according to the aforementioned configuration, the crushing treatment unit 26A performs the crushing treatment on the solid fuel carbonized by the carbonization treatment unit 25. Accordingly, the energy necessary for the crushing treatment can be suppressed to be small compared to the configuration of crushing the EFBs before the carbonization treatment is performed on the EFBs. Meanwhile, when  
10 the crushing treatment is performed on the EFB, much energy is necessary for the crushing treatment because a large amount of moisture is contained in the EFBs. Particularly, since the amount of the available electric power is limited in a general oil refining plant in many cases, the electric power consumption amount can be also decreased when the energy necessary for the crushing treatment is decreased as described  
15 above.

[0059]

Furthermore, in the aforementioned configuration, the solid fuel crushed by the crushing treatment unit 26A is molded in a pellet shape by the pellet molding unit 26B. Accordingly, the solid fuel pellets Pf which are used more easily as fuel can be obtained.

20 [0060]

As described above, the first embodiment of the present invention has been described with reference to the drawings. In addition, the aforementioned configuration can be modified into various forms within the scope of the present invention.

For example, in the aforementioned embodiment, a configuration in which the  
25 heating source gas generation unit 22 is connected in series to the drying treatment unit

24 and the carbonization treatment unit 25 so that the heating source gas G is supplied to the carbonization treatment unit 25 and the exhaust gas E is supplied to the drying treatment unit 24 has been described.

However, the configuration of the heating source gas generation unit 22 is not limited to the aforementioned example, instead, a configuration in which a combustion furnace for supplying fuel to the drying treatment unit 24 and a combustion furnace for supplying fuel to the carbonization treatment unit 25 are provided independently may be employed. Even in this configuration, the residue (palm oil mill effluent and EFBs) of the oil refining facility 1 are used as the raw materials of the fuel.

[0061]

[Second Embodiment]

Next, a second embodiment of the present invention will be described with reference to Figs. 5 to 7. Further, the same reference numerals will be given to the same components as in the first embodiment and the detailed description thereof will not be repeated. As shown in Fig. 5, the combined plant 100 according to the embodiment includes a returning unit 27 which returns a part of the fuel oil F generated by the separation unit 21 and the water (treated water W) generated by the solid fuel production facility 2 to the oil refining facility 1.

[0062]

In the aforementioned first embodiment, the entire fuel oil F generated by the separation unit 21 is supplied to the heating source gas generation unit 22. Further, the treated water W generated by the separation unit 21 is discharged to the outside. Meanwhile, in the solid fuel production plant 2 according to the embodiment, a part of the fuel oil F is extracted by the returning unit 27 and is used as the fuel source of the devices (for example, boiler B) of the oil refining facility 1. The treated water W is

collected by the returning unit 27 and is supplied as a steam generation source to the boiler B (returning step S7).

[0063]

Further, as shown in Fig. 6, the solid fuel production facility 2 according to the embodiment includes a first collection unit 30 which collects dust discharged from the drying treatment unit 24 and supplies the dust to the heating source gas generation unit 22 and a second collection unit 40 which collects dust discharged from the carbonization treatment unit 25 and supplies the dust to the heating source gas generation unit 22. The dust collected by the first collection unit 30 and the second collection unit 40 is burned together with the fuel oil F by the heating source gas generation unit 22. Further, a cyclone-type particle separator is preferably used as the first collection unit 30 and the second collection unit 40.

[0064]

According to the aforementioned configuration, a part of the fuel oil F obtained when the palm oil mill effluent is separated into oil and moisture can be reused as the fuel of the oil refining facility 1 (for example, boiler B) and also, the treated water W can be reused as the steam generation source of the oil refining facility 1 (boiler B). Accordingly, the solid fuel production plant can be operated more efficiently while the amount of the material discharged from the combined plant 100 is further decreased.

[Reference Signs List]

[0065]

- |    |                                                              |
|----|--------------------------------------------------------------|
| 1  | Oil refining facility (oil refining plant)                   |
| 2  | Solid fuel production facility (solid fuel production plant) |
| 11 | Sterilization device                                         |
| 25 | 12 Separation device                                         |

|    |        |                                    |
|----|--------|------------------------------------|
|    | 13     | Digestion device                   |
|    | 14     | Compression/clarification device   |
|    | 21     | Separation unit                    |
|    | 22     | Heating source gas generation unit |
| 5  | 23     | Heat treatment unit                |
|    | 24     | Drying treatment unit              |
|    | 25     | Carbonization treatment unit       |
|    | 26     | Final treatment unit               |
|    | 27     | Returning unit                     |
| 10 | 30     | First collection unit              |
|    | 40     | Second collection unit             |
|    | 100    | Combined plant                     |
|    | B      | Boiler                             |
|    | E      | Exhaust gas                        |
| 15 | F      | Fuel oil                           |
|    | G      | Heating source gas                 |
|    | L1     | Fuel oil supply line               |
|    | L2     | Heating source gas supply line     |
|    | L3     | Exhaust gas supply line            |
| 20 | M1, M2 | Production method for solid fuel   |
|    | Pf     | Solid fuel pellet                  |
|    | Pm     | Intermediate product               |
|    | S1     | Separation step                    |
|    | S2     | Gas generation step                |
| 25 | S3     | Heat treatment step                |

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- S4 Drying treatment step
- S5 Carbonization treatment step
- S6 Final treatment step
- S6A Crushing treatment step
- S6B Pellet molding step
- S7 Returning step
- W Treatment water

5

[Document Type] Drawings

[Fig. 1]

[Fig. 2]

[Fig. 3]

5 [Fig. 4]

[Fig. 5]

[Fig. 6]

[Fig. 7]

## [CLAIMS]

## [Claim 1]

A solid fuel production plant comprising:  
 a separation unit which separates oil and water from palm oil mill effluent discharged from an oil refining plant which refines essential oil from fresh fruit bunches containing oil and fat so that fuel oil and treatment water are separated;  
 a heat treatment unit which performs a heat treatment on empty fruit bunches discharged from the oil refining plant to generate fuel; and  
 a fuel oil supply line which supplies the fuel oil to the heat treatment unit, wherein the fuel oil is used as the fuel of the heat treatment unit, and wherein the heat treatment unit includes:  
 a drying treatment unit which dries the empty fruit bunches; and  
 a carbonization treatment unit which carbonizes the empty fruit bunches dried by the drying treatment unit.

## [Claim 2]

The solid fuel production plant according to claim 1, further comprising:  
 a heating source gas generation unit which is connected to the fuel oil supply line and generates a heating source gas; and  
 a heating source gas supply line which supplies the heating source gas to the carbonization treatment unit, wherein the heating source gas is used as a heat source of the carbonization treatment unit.

## [Claim 3]

The solid fuel production plant according to claim 2, further comprising:  
 an exhaust gas supply line which supplies an exhaust gas from the carbonization treatment unit to the drying treatment unit, wherein the exhaust gas is used as a heat source of the drying treatment unit.

## [Claim 4]

The solid fuel production plant according to any one of claims 1 to 3, further comprising:  
 a crushing treatment unit which crushes the fuel.

## [Claim 5]

The solid fuel production plant according to claim 4, further comprising:  
 a pellet molding unit which molds the fuel crushed by the crushing treatment unit to generate solid fuel pellets.

## [Claim 6]

The solid fuel production plant according to any one of claims 1 to 5, further comprising:  
 a returning unit which returns the fuel oil and the treatment water to the oil refining plant.

## [Claim 7]

A production method for solid fuel comprising:  
 a separation step of separating oil and water from palm oil mill effluent discharged

from an oil refining plant which refines essential oil from fresh fruit bunches containing oil and fat so that fuel oil and treatment water are separated; and

a heat treatment step of performing a heat treatment on empty fruit bunches discharged from the oil refining plant to generate fuel,

wherein the fuel oil extracted by the separation step is used as the fuel in the heat treatment step, and

wherein the heat treatment step includes:

a drying treatment step of drying the empty fruit bunches; and

a carbonization treatment step of carbonizing the empty fruit bunches dried in the drying treatment step.

[Claim 8]

The production method for solid fuel according to claim 7, further comprising:

a gas generation step of burning the fuel oil to generate a heating source gas after the separation step,

wherein the heating source gas is used as a heat source in the carbonization treatment step.

[Claim 9]

The production method for solid fuel according to claim 7 or 8,

wherein a high-temperature exhaust gas discharged in the carbonization treatment step is used as a heat source in the drying treatment step.

[Claim 10]

The production method for solid fuel according to any one of claims 7 to 9, further comprising:

a crushing treatment step of crushing the fuel after the heat treatment step.

[Claim 11]

The production method for solid fuel according to claim 10, further comprising:

a pellet molding step of molding the crushed fuel to generate solid fuel pellets after the crushing treatment step.

[Claim 12]

The production method for solid fuel according to any one of claims 7 to 11, further comprising:

a returning step of supplying the fuel oil and the treatment water to the oil refining plant.