

DESCRIPTION

METHOD FOR REMOVING COATING LAYER AND DEVICE FOR REMOVING COATING LAYER

5 TECHNICAL FIELD

[0001]

The present invention relates to a method for removing a coating layer and equipment for removing a coating layer.

10 BACKGROUND ART

[0002]

Recently, in order to protect global resources and environment, activities for constructing a recycling-based society through reduction, re-use, recycle, and the like of wastes are being intensified in various fields.

15 As an example, Patent Literature 1 discloses a method for removing a coating film on a resin base material, the method including: putting a resin base material having a coating film on a surface thereof into a washing container; and agitating the resin base material together with an alkaline aqueous solution, an amount of which is fed to have a liquid level higher than an uppermost part of the resin base material
20 deposited in the washing container, at a temperature ranging from 80 to 180 degrees C and at a rotation speed of an end of an agitator impeller ranging from 2 to 100 m/sec.

Another example disclosed in Patent Literature 2 relates to a method for collecting a release film, the method including: immersing a used release film, which
25 includes a release layer provided on at least one side of a base film via a layer of an easily-soluble resin, in a solvent capable for the easily-soluble resin to be dissolved to dissolve the easily-soluble resin in the solvent, thereby separating and removing the release layer on the surface of the film and solely collecting the base film.

30 CITATION LIST

PATENT LITERATURE(S)

[0003]

Patent Literature 1: JP 2004-027072 A

Patent Literature 2: JP 2002-265665 A

SUMMARY OF THE INVENTION

5 PROBLEM(S) TO BE SOLVED BY THE INVENTION

[0004]

The method disclosed in Patent Literature 1 is directed to removing the coating film on the rein base material using an alkaline aqueous solution. The used alkaline aqueous solution, which contains component(s) of the coating film (e.g. a
10 release agent), deteriorates in terms of cleaning performance when being re-used. In addition, it takes a lot of work to purify the alkaline aqueous solution.

The release film disclosed in Patent Literature 2 includes the release layer laminated on at least one side of the base film via the layer of the easily-soluble resin layer (water-soluble resin or water-dispersible resin). According to the method
15 disclosed in Patent Literature 2, the nature of the easily-soluble resin layer (i.e. easily soluble in a solvent) is used to peel the release layer off from the release film.

However, considering the variety of the layer structure of the laminated film, when, for instance, a layer formed on the base film is a water-insoluble resin layer, it is difficult to remove the release layer from the release film according to the method
20 disclosed in Patent Literature 2. In addition, it is possible in the method disclosed in Patent Literature 2 that the easily-soluble resin layer dissolved in the solvent adheres again onto the release film. Furthermore, the solvent is possibly contaminated by the easily-soluble resin layer.

Recent laminated films require a technology for easily removing the film
25 (coating layer) consisting of multiple layers on the base film. As the solvent to be used, an easily re-usable solvent is desired.

[0005]

An object of the invention is to provide a removal method of a coating layer and removal equipment of a coating layer that are capable of easily removing a
30 coating layer from a laminated film including a base film and the coating layer and is delivered in roll-to-roll processing.

MEANS FOR SOLVING THE PROBLEM(S)

[0006]

[1] A method for removing a coating layer, including:

cutting a laminated film including a base film and a coating layer into small

5 pieces;

immersing and agitating the cut laminated film in hot water in an agitator tank to separate the laminated film into the base film and the coating layer;

collecting the separated base film, which is a base-film collection step; and

collecting debris of the separated coating layer, which is a coating-layer

10 collection step, in which

the coating layer includes an intermediate layer and a release agent layer, and

the intermediate layer is interposed between the base film and the release agent layer.

15 [0007]

[2] The method according to the above [1], in which in the cutting of the laminated film into small pieces, the laminated film fed from a roll formed with the wound laminated film is cut into small pieces.

[0008]

20 [3] The method according to the above [1] or [2], in which in the separating of the laminated film into the base film and the coating layer, the separated base film is sunk in the hot water and the debris of the separated coating layer is floated on the hot water.

[0009]

25 [4] The method according to any one of the above [1] to [3], in which in the coating-layer collection step, the debris of the coating layer floating on the hot water is filtrated through a filter detachably provided directly below a water surface in the agitator tank.

[0010]

30 [5] The method according to any one of the above [1] to [3], in which in the coating-layer collection step, the hot water in the agitator tank is overflowed and the debris of the coating layer flowed out together with the overflowed hot water is guided

to an outside of the agitator tank through an upper discharge outlet of the agitator tank and is collected.

[0011]

5 [6] The method according to the above [5], in which in the coating-layer collection step, when the hot water in the agitator tank is overflowed, the debris of the coating layer is guided to the upper discharge outlet and collected while the debris of the coating layer floating on or near the surface of the hot water in the agitator tank is gathered using a raking implement.

[0012]

10 [7] The method according to the above [5] or [6], in which the hot water is overflowed using a water injector having a discharge port, and the discharge port is provided in the agitator tank.

[0013]

15 [8] The method according to any one of the above [3] to [7], in which in the base-film collection step, the base film sunk in the hot water is collected through a discharge outlet provided at a bottom side of the agitator tank, or the base film sunk in the hot water is collected through a discharge pipe connected to the bottom side of the agitator tank.

[0014]

20 [9] The method according to any one of the above [1] to [8], in which the coating-layer collection step is performed after the base-film collection step, the base-film collection step is performed after the coating-layer collection step, or the base-film collection step and the coating-layer collection step are simultaneously performed.

[0015]

25 [10] The method according to any one of the above [1] to [9], in which the base film and the intermediate layer are in direct contact with each other.

[0016]

[11] The method according to any one of the above [1] to [10], in which the intermediate layer is hydrophilic and water-insoluble.

30 [0017]

[12] The method according to any one of the above [1] to [11], in which the laminated film is a laminated film used for manufacturing a ceramic green sheet and

left after the ceramic green sheet is peeled off.

[0018]

[13] Removal equipment configured to remove a coating layer from a laminated film including a base film and the coating layer, the removal equipment including:

5 a cutter unit configured to cut the laminated film into small pieces;

an agitator including an agitator tank and configured to immerse and agitate the cut laminated film in hot water in the agitator tank to separate the laminated film into the base film and the coating layer;

10 a coating-layer collector configured to collect debris of the coating layer separated from the laminated film from an upper side of the agitator tank; and

a base-film collector configured to collect the base film separated from the laminated film from a bottom side of the agitator tank.

[0019]

15 [14] The removal equipment according to the above [13], in which the coating-layer collector is a filter detachably provided directly below the water surface in the agitator.

[0020]

20 [15] The removal equipment according to the above [13], in which the coating-layer collector is a raking implement configured to guide the debris of the coating layer flowed out together with the hot water overflowed out of the agitator tank to an outside of the agitator tank.

[0021]

25 [16] The removal equipment according to any one of the above [13] to [15], in which the base-film collector is a discharge outlet provided at the bottom side of the agitator tank or a discharge pipe connected to the bottom side of the agitator tank.

[0022]

[17] The removal equipment according to any one of the above [13] to [16], in which the laminated film is a laminated film used for manufacturing a ceramic green sheet and left after the ceramic green sheet is peeled off.

30 [0023]

The above aspects of the invention can provide a removal method of a coating layer and removal equipment of a coating layer that are capable of easily

removing a coating layer from a laminated film including a base film and the coating layer.

BRIEF EXPLANATION OF DRAWINGS

5 [0024]

Fig. 1 is an example of a cross-sectional view showing a laminated film usable for a removal method according to a first exemplary embodiment.

Fig. 2 schematically illustrates an example of the removal equipment according to the second exemplary embodiment.

10 Fig. 3A schematically illustrates an example of a coating-layer collector according to a third exemplary embodiment.

Fig. 3B schematically illustrates the example of a coating-layer collector according to the third exemplary embodiment.

15 Fig. 4A schematically illustrates an example of a coating-layer collector according to a fourth exemplary embodiment.

Fig. 4B schematically illustrates the example of a coating-layer collector according to the fourth exemplary embodiment.

20 Fig. 5A is a cross-sectional view of an example of a collector mechanism for collecting a base film and debris of a coating layer according to a fifth exemplary embodiment.

Fig. 5B is a top plan view of the collector mechanism illustrated in Fig. 5A.

DESCRIPTION OF EMBODIMENT(S)

[0025]

25 First Exemplary Embodiment

Method for Removing Coating Layer

30 A method for removing a coating layer according to a first exemplary embodiment (sometimes referred to as a removal method according to the present exemplary embodiment hereinafter) includes: cutting a laminated film including a base film and the coating layer into small pieces (also referred to as a “cutting step” hereinafter); immersing and agitating the cut laminated film in hot water in an agitator tank to separate the laminated film into the base film and the coating layer (also

referred to as a “separation step” hereinafter); collecting the separated base film (base-film collection step); and collecting debris of the separated coating layer (coating-layer collection step).

The coating layer includes an intermediate layer and a release agent layer.

- 5 The intermediate layer is interposed between the base film and the release agent layer.

[0026]

In the removal method according to the present exemplary embodiment, an area of the coating layer to be infiltrated by hot water is increased by cutting the
10 laminated film into small pieces and agitating the pieces of the cut laminated film in hot water. Accordingly, the hot water can more easily infiltrate into an interface between the base film and the intermediate layer. Consequently, the intermediate layer is more easily separated from the base film together with the release agent layer, so that the coating layer can be easily removed from the laminated film.

15 Further, the removal method according to the exemplary embodiment, which employs hot water unlike Patent Literature 1 that uses alkaline aqueous solution, can remove the coating layer from the laminated film irrespective of chemical properties of the coating layer. In other words, the removal method according to the exemplary embodiment is a new removal method the coating layer intended for collecting and
20 recycling the base film (preferably PET film).

Furthermore, the removal method according to the exemplary embodiment produces no remaining foreign matters (mainly blast media) unlike a method for subjecting the coating layer to a blasting process.

In addition, the removal method according to the exemplary embodiment,
25 which can be performed with a use of compactly structured removal equipment (e.g. Fig. 2) before and after removing the coating layer, can reduce the cost for storing and transporting the removal equipment.

[0027]

Fig. 1 is an example of a cross-sectional view showing a laminated film
30 used in the removal method according to the exemplary embodiment.

One of the small pieces of the laminated film after being subjected to the cutting step is shown as the laminated film 50. The laminated film 50 includes a base

film 51 and a coating layer 52. The coating layer 52 includes an intermediate layer 521 and a release agent layer 522. The intermediate layer 521 is interposed between the base film 51 and the release agent layer 522. In other words, the base film 51, the intermediate layer 521, and the release agent layer 522 of the laminated film 50 are laminated in this order.

In Fig. 1, a represents a surface of the intermediate layer 521 close to the base film and b represents a surface of the intermediate layer 521 close to the release agent layer. d represents an outer surface of the release agent layer 522 and c represents a surface of the release agent layer 522 close to the intermediate layer.

In the laminated film according to the exemplary embodiment, it is preferable that the base film and the intermediate layer are in direct contact with each other.

In the example illustrated in Fig. 1, the base film 51 and the intermediate layer 521 are in direct contact with each other and the intermediate layer 521 and the release agent layer 522 are in direct contact with each other.

[0028]

In the laminated film according to the exemplary embodiment, it is preferable that the intermediate layer is hydrophilic and water-insoluble, which will be described with reference to Figs. 1 and 2A.

With the use of hydrophilic intermediate layer, the effect of the exemplary embodiment (i.e. easily removing the coating layer from the laminated film) is more effectively exhibited. Presumably, the reason thereof is as below.

In the laminated film 50, the intermediate layer 521 is closely attached to the base film 51 mainly by hydrogen bonding and anchor effect (Fig. 1). At this time, with the use of the hydrophilic intermediate layer 521, the hot water more easily infiltrates to the interface between the base film 51 and the intermediate layer 521 when the laminated film 50 that has been cut into small pieces is agitated by the hot water in the agitator tank, so that the hydrogen bonding and anchor effect between the intermediate layer 521 and the base film 51 are weakened. Consequently, the intermediate layer 521 is more easily separated from the base film 51 together with the release agent layer 522, so that the coating layer 52 can be more easily removed from the laminated film 50.

[0029]

With the use of the water-insoluble intermediate layer, elution of the component of the intermediate layer 521 into the hot water is restrained. Accordingly, with the intermediate layer 521 being water-insoluble, contamination of the hot water can be prevented, so that the hot water is more easily recycled after being used.

5 As described above, with the use of the hydrophilic and water-insoluble intermediate layer, the coating layer can be more easily removed from the laminated film and the hot water can be more easily reused.

[0030]

Herein, whether the intermediate layer is hydrophilic is determined: the
10 intermediate layer is defined to be “hydrophilic” when the contact angle of water on the base-film-side surface of the intermediate layer is 55 degrees or less.

According to the laminated film 50 illustrated in Fig. 1, when the contact angle of water on the base-film-side surface (represented by “a” in Fig. 1) of the intermediate layer 521 is 55 degrees or less, the intermediate layer 521 is hydrophilic.

15 Further, in order to allow the base film to be more easily separated, the contact angle is preferably 50 degrees or less, more preferably 45 degrees or less. The contact angle is a value determined as follows: after the base film is separated from the laminated film, specifically, after the intermediate layer is brought into contact with water to peel the interface between the base film and the intermediate
20 layer, the contact angle of water on a surface (peeling surface) of the intermediate layer previously contacted with the base film is measured to determine the contact angle.

[0031]

Specifically, the intermediate layer is separated from the base film and the
25 contact angle of water on the base-film-side surface of the intermediate layer is measured according to the method described below. The obtained value is determined to be the contact angle of water on the base-film-side surface of the intermediate layer.

A 50-mm width adhesion tape (manufactured by Nitto Denko Corporation,
30 product name “polyester adhesion tape No. 31B”) is attached to the release-agent-layer surface of the laminated film and then is cut into pieces of 50 mm × 50 mm to prepare test pieces.

Next, 300-ml hot water is put into a glass beaker of 500-ml volume. Each of the test pieces is fully immersed in the hot water at 90 degrees C and is left still for three hours. Subsequently, it is confirmed that each of the test pieces is separated into a laminate and the base film, the laminate being integrated release agent layer and intermediate layer and being carried on the adhesion tape. The adhesion tape carrying the release agent layer and the intermediate layer is taken out of the hot water and dried for 24 hours at room temperature. The contact angle on the surface of the intermediate layer carried on the adhesion tape (i.e. the surface of the intermediate layer that has been in contact with the surface of the base film) is measured. The contact angle is measured using a contact angle gauge (manufactured by Kyowa Interface Science Co., Ltd., product name "DM-701") by sessile drop method according to JIS R3257 (1999). Distilled water is used as liquid droplets.

[0032]

Herein, whether the intermediate layer is water-insoluble is determined: the intermediate layer is defined to be "water-insoluble" when the difference between a contact angle of water on the release-agent-layer surface (represented by "d" in Fig. 1) and the contact angle of water on the base-film-side surface (represented by "a" in Fig. 1) of the intermediate layer is 30 degrees or more. The difference between the contact angles is preferably 40 degrees or more, more preferably 50 degrees or more. If the value of the difference is small, it means that the components forming the intermediate layer have eluted into the water and a partially exposed release agent layer was measured.

The contact angle of water on the release-agent-layer surface, which is not particularly limited, is usually 80 degrees or more, preferably 85 degrees or more, more preferably 90 degrees or more. The upper limit of the contact angle of water on the release-agent-layer surface is usually 150 degrees, preferably 140 degrees, more preferably 130 degrees.

The contact angle of water on the release-agent-layer surface is measured using a contact angle gauge (manufactured by Kyowa Interface Science Co., Ltd., product name "DM-701") by sessile drop method according to JIS R3257 (1999). Distilled water is used as liquid droplets.

[0033]

Details of the base film, the intermediate layer, and the release agent layer will be described later.

[0034]

5 The removal method according to the exemplary embodiment can be performed, for instance, with the use of removal equipment of a coating layer according to a second exemplary embodiment (also referred to as removal equipment according to the second exemplary embodiment hereinafter).

[0035]

10 Second Exemplary Embodiment

Removal Equipment 100 of Coating Layer

Fig. 2 schematically illustrates an example of the coating-layer removal equipment 100 according to the second exemplary embodiment.

15 The removal equipment 100, which is configured to remove the coating layer from the laminated film including the base film and the coating layer, includes: a cutter unit 10 configured to cut the laminated film into small pieces; an agitator 20 including an agitator tank 21C, in which the cut laminated film 50 is immersed in hot water HW and agitated to separate the laminated film 50 into the base film 51 and the coating layer; a coating-layer collector 30 configured to collect debris 52C of the coating layer
20 separated from the laminated film 50 from an upper side of the agitator tank 21C; and a base-film collector 40 configured to collect the base film 51 separated from the laminated film 50 from a bottom side of the agitator tank 21C.

Fig. 2 illustrates a roll 1 formed with the laminated film wound before being cut, a pair of nip rolls 11, a pair of cutter blades 12, and a piece collector 13.

25 [0036]

Cutter Unit 10

30 The cutter unit 10 is configured to cut the laminated film into small pieces. Examples of the cutter unit include a cutting machine having a cutter. Examples of the cutter include a cutter blade, a water-jet cutter, a laser cutter, and an ultrasonic cutter.

In the example illustrated in Fig. 2, the cutter unit 10 includes the pair of nip rolls 11 and the pair of cutter blades 12.

[0037]

Agitator 20

The agitator 20 is configured to immerse and agitate the cut laminated film 50 in the hot water HW to separate the laminated film 50 into the base film 51 and the coating layer.

The agitator 20 includes the agitator tank 21C that stores the hot water HW. The agitator tank 21C includes an agitator shaft 22 including an agitator impeller 22A. The agitator shaft 22 is connected to a motor (not illustrated).

[0038]

10 Base-Film Collector 40

The base-film collector 40 is configured to collect the base film 51 separated from the laminated film 50 from a bottom side of the agitator tank 21C.

The base-film collector is preferably a discharge outlet provided at the bottom side of the agitator tank (also referred to as a “base-film discharge outlet” hereinafter) or a discharge pipe connected to the bottom side of the agitator tank (also referred to as a “base-film discharge pipe” hereinafter).

In the example illustrated in Fig. 2, the base-film collector 40 is a base-film discharge outlet 44 provided at the bottom of the agitator tank 21C. The base-film discharge outlet 44 is openable/closable or is detachable.

20 [0039]

Coating-Layer Collector 30

The coating-layer collector 30 is configured to collect the debris 52C of the coating layer separated from the laminated film 50 through an upper opening 21B (an example of an upper discharge outlet) of the agitator tank 21C.

25 Examples of the coating-layer collector include a reticulated tray (e.g. colander), filter, raking implement (e.g. raking plate, raking blade, and the like), container, pump, and a mechanism including at least one of the above. The container is preferably at least partially reticulated and/or provided with a filter.

In the example illustrated in Fig. 2, the coating-layer collector 30 is a reticulated tray 30a.

[0040]

With the use of the removal equipment 100 according to the second

exemplary embodiment, the removal method according to the first exemplary embodiment is performed, for instance, through steps described below.

[0041]

Cutting Step

5 In the cutting step, the laminated film including the base film and the coating layer is cut into small pieces.

It is preferable that the laminated film, which has been fed from a roll formed with the wound laminated film, is cut into small pieces in the cutting step.

10 In the example illustrated in Fig. 2, the laminated film fed from the roll 1 is cut into small pieces by the pair of cutter blades 12 after passing through between the pair of nip rolls 11. The cut pieces of the laminated film 50 are collected by the piece collector 13.

When the cut pieces of the laminated film 50 are each in a form of a rectangle, the dimension of a side of the rectangular piece of the laminated film 50 is preferably
15 15 cm or less, more preferably 10 cm or less, and still more preferably 5 cm or less. It is preferable that the lower limit of the dimension of the side of the laminated film is 5 mm or more.

For instance, when a part (debris) of the ceramic green sheet remains on the release agent layer of the laminated film without being peeled, the debris of the
20 ceramic green sheet is sometimes peeled off from the coating layer to be sunk into the hot water in the separation step after the cutting step, making it difficult to collect the base film alone. In this case, a filter is optionally provided at the bottom of the agitator tank to separate the base film from the debris of the ceramic green sheet.

The laminated film before being cut is optionally not wound to be roll-shaped.

25 In the cutting step, the laminated film of a predetermined size that is prepared in advance is optionally cut into small pieces.

The laminated film is preferably a laminated film used for manufacturing a ceramic green sheet and left after the ceramic green sheet is peeled off.

[0042]

30 Separation Step

In the separation step, the cut laminated film 50 is immersed and agitated in the hot water HW in the agitator tank 21C to separate the laminated film into the base

film 51 and the coating layer.

In the example illustrated in Fig. 2, the separation step is performed after the laminated film 50 collected by the piece collector 13 is introduced into the agitator tank 21C.

5 It is preferable that the separated base film is submerged in the hot water and the debris of the separated coating layer floats on the hot water in the separation step.

The temperature of the hot water HW is preferably, for instance, 40 degrees C or more, more preferably 60 degrees C or more. Further, the temperature of the
10 hot water HW is preferably less than 100 degrees C, more preferably 98 degrees C or less.

The time for the laminated film 50 to be immersed in the hot water HW is, for instance, in a range from 5 minutes to 120 minutes, from 10 minutes to 100 minutes, or from 15 minutes to 60 minutes.

15 The agitation time is preferably in the same range as the time for the laminated film 50 to be immersed in the hot water HW. The time for the laminated film 50 to be immersed in the hot water HW is, for instance, in a range from 5 minutes to 120 minutes, from 10 minutes to 100 minutes, or from 15 minutes to 60 minutes.

The rotation speed of the agitator impeller 22A is, for instance, in a range
20 from 10 rpm to 1000 rpm, from 15 rpm to 750 rpm, or from 20 rpm to 500 rpm.

[0043]

Base-Film Collection Step

In the base-film collection step, the separated base film 51 is collected.

In the example illustrated in Fig. 2, the base film 51 sunk in the hot water HW
25 is collected from the base-film discharge outlet 44 (an example of the base-film collector) provided at the bottom side of the agitator tank 21C in the base-film collection step.

The base film 51, which easily sinks in the hot water HW, can be easily collected through the base-film discharge outlet 44 by opening or detaching the base-
30 film discharge outlet 44.

Waterdrop on the collected base film 51 is removed by a known method.

[0044]

Coating-Layer Collection Step

In the coating-layer collection step, the debris 52C of the separated coating layer is collected.

5 In the example illustrated in Fig. 2, the debris 52C of the coating layer floating on the surface of the hot water is strained using the reticulated tray 30a through the upper opening 21B (an example of the upper discharge outlet) of the agitator tank 21C in the coating-layer collection step.

10 In the coating-layer collection step, the debris 52C of the coating layer is optionally flowed out of the agitator tank 21C together with the hot water HW that overflows out of the agitator tank 21C to be collected using the above-described coating-layer collector 30.

The debris 52C of the coating layer, which easily floats on the water surface in the agitator tank 21C, can be easily collected through the upper opening 21B of the agitator tank 21C with the use of the coating-layer collector 30.

15 In the removal method according to the second exemplary embodiment, the coating-layer collection step is performed after the base-film collection step, the base-film collection step is performed after the coating-layer collection step, or alternatively, the base-film collection step and the coating-layer collection step are simultaneously performed.

20 [0045]

Third Exemplary Embodiment

Removal equipment of a coating layer according to a third exemplary embodiment is the same as the removal equipment 100 according to the second exemplary embodiment except that the agitator and the coating-layer collector are
25 respectively replaced by an agitator 20A and a coating-layer collector 30A illustrated in Figs. 3A and 3B.

The third exemplary embodiment will be described below, where difference(s) from the second exemplary embodiment will be focused and the same or similar components and features will be, for instance, denoted by the same
30 reference numerals, thereby omitting or simplifying the description thereof.

Figs. 3A and 3B schematically illustrate an example of a the coating-layer collector according to the third exemplary embodiment and describes the coating-

layer collection step.

[0046]

Agitator 20A

The agitator 20A includes the agitator tank 21 having a cut 210 at an upper
5 part thereof. The agitator tank 21 includes the agitator shaft 22 including an agitator
impeller 22B.

[0047]

Coating-Layer Collector 30A

The coating-layer collector 30A according to the third exemplary embodiment
10 includes a container 31 that collects the debris 52C of the coating layer floating on
the water surface through the cut 210 of the agitator tank 21.

The agitator 20A illustrated in Fig. 3B is configured to control the rotation
speed of the agitator impeller 22B so that substantially conical surface is created on
the water surface in accordance with the rotation of the agitator impeller 22B and an
15 outer peripheral portion of the water surface becomes higher than the bottom portion
of the cut 210.

[0048]

With the use of the removal equipment according to the third exemplary
embodiment, the removal method according to the first exemplary embodiment is
20 performed in the same manner as in the second exemplary embodiment except for
the step described below.

[0049]

Coating-Layer Collection Step

In the example illustrated in Figs. 3A and 3B, the debris 52C of the coating
25 layer floating on or near the surface of the hot water HW in the agitator tank 21, which
is gathered to the outer peripheral portion of the water surface (the portion higher
than the bottom portion of the cut 210) in accordance with the rotation of the agitator
impeller 22B, is guided into the container 31 through the cut 210 (an example of the
upper discharge outlet) of the agitator tank 21 and is collected.

30 [0050]

Fourth Exemplary Embodiment

Removal equipment according to a fourth exemplary embodiment is the

same as the removal equipment according to the third exemplary embodiment except that the coating-layer collector is replaced by a coating-layer collector 30B illustrated in Figs. 4A and 4B.

The fourth exemplary embodiment will be described below, where difference(s) from the third exemplary embodiment will be focused and the same or similar components and features will be, for instance, denoted by the same reference numerals, thereby omitting or simplifying the description thereof.

Figs. 4A and 4B schematically illustrate an example of the coating-layer collector according to the fourth exemplary embodiment and describes the coating-layer collection step.

[0051]

Coating-Layer Collector 30B

The coating-layer collector 30B according to a fourth exemplary embodiment includes the container 31 that collects the debris 52C of the coating layer floating on the upper surface of the hot water HW through the cut 210 and a water injector 33 including a discharge port 33a. The water injector 33 is configured to overflow the hot water HW. Figs. 4A and 4B illustrate the water injector 33 in a form of a hose. The water injector 33 is configured to pour water or hot water through the discharge port 33a into the agitator tank 21 to introduce the debris 52C of the coating layer floating on the upper surface of the hot water HW through the cut 210 to an inside of the container 31 provided outside the agitator tank 21.

The means for overflowing the water is not particularly limited. The water injector 33 is configured in any manner as long as being capable of pouring water or hot water. The discharge port of the water injector is optionally provided in the agitator tank 21 or alternatively provided outside the agitator tank 21. It is preferable that the water is overflowed using a water injector provided with the discharge port and the discharge port is provided at the agitator tank.

[0052]

With the use of the removal equipment according to the fourth exemplary embodiment, the removal method according to the first exemplary embodiment is performed in the same manner as in the third exemplary embodiment except for the step described below.

[0053]

Coating-Layer Collection Step

In the coating-layer collection step of the fourth exemplary embodiment, the debris 52C of the coating layer, which flows out together with the hot water HW in the
5 agitator tank 21 overflowed out of the agitation tank 21, is guided to an outside of the agitator tank 21 through the cut 210 (an example of the upper discharge outlet) of the agitator tank 21 and is collected.

In the example illustrated in Figs. 4A and 4B, the hot water HW is poured into the agitator tank 21 through the discharge port 33a of the water injector 33 to overflow
10 the hot water HW in the agitator tank 21. Through the overflow process, the debris 52C of the coating layer is guided through the cut 210 of the agitator tank 21 into the container 31 and is collected.

[0054]

Fifth Exemplary Embodiment

15 Removal equipment according to a fifth exemplary embodiment is the same as the removal equipment 100 according to the second exemplary embodiment except that the coating-layer collector and the base-film collector are replaced by a collector mechanism illustrated in Figs. 5A and 5B.

The fifth exemplary embodiment will be described below, where difference(s)
20 from the second exemplary embodiment will be focused and the same or similar components and features will be, for instance, denoted by the same reference numerals, thereby omitting or simplifying the description thereof.

Fig. 5A is a cross-sectional view of an example of the collector mechanism for collecting the base film and debris of the coating layer according to the fifth
25 exemplary embodiment. Fig. 5B is a top plan view of the collector mechanism illustrated in Fig. 5A. Figs. 5A and 5B describes the base-film collection step and the coating-layer collection step.

[0055]

Collector Mechanism 300

30 A collector mechanism 300 according to the fifth exemplary embodiment includes a base-film collector 40A and a coating-layer collector 30C.

The base-film collector 40A is in a form of a base-film discharge pipe 41

connected to the bottom side of the agitator tank 21A.

The coating-layer collector 30C is in a form of a raking blade 34 (an example of a raking implement) for guiding the debris of the coating layer to be flowed out together with the hot water HW overflowed in the agitator tank 21A to an outside of the agitator tank 21A.

The collector mechanism 300 will be described below.

The collector mechanism 300 includes the agitator tank 21A provided with the agitator shaft 22, the raking blade 34 provided at an upper part of the agitator tank 21A and configured to rotate around the agitator shaft 22, and a cylindrical support member 43 provided along an outer periphery of the upper part of the agitator tank 21A. The agitator shaft 22 is provided with the agitator impeller 22A.

The raking blade 34 includes a tapered portion 34b and a slit 34a at a side opposite the tapered portion 34b. Centrifugal force, which is generated by rotation of the raking blade 34 within the agitator tank 21A, causes the water surface to be lower at an inner side of the agitator tank 21A and higher at an outer side of the agitator tank 21A. The raking blade 34 is substantially triangular to meet the shape of the water surface. Further, the raking blade 34, which extends from near the agitator shaft 22 via the slit 34a to a support wall 43B of the support member 43, is configured to rotate while sliding along the outer periphery of the upper part of the agitator tank 21A at the slit 34a. The raking blade 34 is connected to a motor (not illustrated).

The support member 43 includes: a slanted bottom plate 43A for guiding the debris of the coating layer to the debris discharge outlet 35; and the support wall 43B. An opening 42 is provided in the slanted bottom plate 43A (Fig. 5B). A debris discharge outlet 35 is provided below the opening 42.

The bottom side of the agitator tank 21A is slanted and is connected with the base-film discharge pipe 41 for discharging the base film. The debris discharge outlet 35 and the base-film discharge pipe 41 are slanted in the same direction as the bottom surface in the agitator tank 21A.

[0056]

With the use of the removal equipment according to the fifth exemplary embodiment, the removal method according to the first exemplary embodiment is performed in the same manner as in the second exemplary embodiment except for

the step described below.

[0057]

Coating-Layer Collection Step

5 In the coating-layer collection step of the fifth exemplary embodiment, when the hot water HW in the agitator tank 21A is overflowed out of the agitation tank 21A, the debris of the coating layer floating on or near the surface of the hot water in the agitator tank 21A is gathered using the raking blade 34 to be guided to the debris discharge outlet 35 (an example of the upper discharge outlet) and collected.

10 In the example illustrated in Figs. 5A and 5B, the debris of the coating layer floating near the surface of the hot water HW is guided to the slanted bottom plate 43A by the rotation of the raking blade 34 around the agitator shaft 22. Subsequently, the debris of the coating layer is guided through the opening 42 provided in the slanted bottom plate 43A to the debris discharge outlet 35 and is collected.

[0058]

15 Base-Film Collection Step

In the fifth exemplary embodiment, in the base-film collection step, the base film sunk in the hot water is collected through the base-film discharge pipe 41 (an example of the base-film collector 40A) connected with the bottom side of the agitator tank 21A.

20 In the example illustrated in Figs. 5A and 5B, after being guided to the bottom side of the agitator tank 21A, the base film is guided along the slanted bottom side to the base-film discharge pipe 41 (an example of the base-film collector 40A) connected to the bottom side, and is collected. Waterdrop on the collected base film is removed by a known method.

25 [0059]

Modification of Embodiments

In the coating-layer collection step, it is also preferable to filtrate the debris of the coating layer floating on the hot water through the filter detachably attached directly below the water surface in the agitator tank.

30 The coating-layer collector is also preferably a filter detachably provided directly below the water surface in the agitator tank.

The collector mechanism 300 in the fifth exemplary embodiment is optionally

provided with a detachable filter directly below the water surface in the agitator tank 21A (e.g. the opening 42 and the debris discharge outlet 35).

5 The laminated film 50, which is collected by the piece collector 13 after being cut and then is guided into the agitator tank in the cutting step of the second to fifth exemplary embodiments, is not necessarily processed as in the exemplary embodiments. For instance, the cut laminated film 50 is optionally directly introduced into the agitator tank without passing through the piece collector 13. In other words, the cutting step and the separation step are optionally successively performed.

10 The removal equipment according to the second to fifth exemplary embodiments optionally includes a water injector configured to filtrate the hot water discharged through the base-film discharge outlet of the agitator tank or the base-film discharge pipe using a filter and inject the hot water again into the agitator tank.

15 In the removal equipment according to the second to fifth exemplary embodiments, the agitator tank optionally includes a heater that adjusts the temperature of the hot water to a predetermined temperature. The heater is optionally provided in the agitator tank or alternatively provided outside the agitator tank. Any known heater is usable as the heater.

20 The removal method according to the first exemplary embodiment optionally further includes a step for filtrating the hot water discharged from the agitator tank using a filter and then injecting the hot water again into the agitator tank.

The invention is by no means limited to the above exemplary embodiments. The invention can encompass any modifications, improvements, and the like within the scope of the invention that an object of the invention is achievable.

[0060]

25 The configuration of the laminated film used in the coating-layer removal method according to the first exemplary embodiment and in the equipment for removing the coating layer according to the second to sixth exemplary embodiments will be described.

[0061]

30 Laminated Film

The laminated film used in any of the above exemplary embodiments includes the base film and the coating layer. The coating layer includes the

intermediate layer and the release agent layer. The intermediate layer is interposed between the base film and the release agent layer.

The intermediate layer may be a single layer or a multi-layer formed of two or more intermediate layers of the same or different materials. The release agent
5 layer may be a single layer or a multi-layer formed of two or more release agent layers of the same or different materials.

In order to facilitating removing the coating layer from the laminated film and collecting the remaining base film, the base film and the intermediate layer are preferably directly laminated. Herein, the term "directly laminated" means that, for
10 instance, no layer is interposed between the base film and the intermediate layer, where the base film and the intermediate layer are in direct contact with each other.

In an exemplary arrangement of the laminated film, the base film, the intermediate layer, and the release agent layer that are directly laminated in this order. In other words, the base film, the intermediate layer, and the intermediate layer are
15 directly in contact with each other without including any layer therebetween.

[0062]

Base Film

As the base film, a resin film formed of a resin component planned to be collected is used.

20 Examples of the resin film include: polyester films such as a polyethylene terephthalate film, polybutylene terephthalate film, and polyethylene naphthalate film; polyolefin films such as a polyethylene film and polypropylene film; polyimide film; polyamide film; polycarbonate film; polyacetate film; ethylene-vinyl acetate (EVA) film; ethylene-(meth)acrylic acid copolymer film; ethylene-(meth)acrylate copolymer
25 film; cycloolefin polymer film; polyurethane film; polyphenylene sulfide film; and cellophane.

The density of the base film is preferably larger than the density of water at 40 degrees C, more preferably 1.0 g/cm³ or more. The base film separated from the laminated film is thus easily sunk in the hot water. Accordingly, the base film can be
30 easily collected from the bottom side of the agitator tank.

Among various films usable as the base film, polyester film is preferable in terms of its density larger than the density of water at 40 degrees C and in terms of

excellent heat resistance and strength thereof. In terms of facilitating collecting and recycling of resins, the polyester film is preferably a film whose main component is any of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate.

5 The resin film optionally additionally contains known filler(s), coloring agent(s), antistatic agent(s), antioxidant(s), organic lubricant(s), catalyst(s), and the like. The resin film is optionally transparent, or colored or the like as desired. At least one of the surfaces of the base film is optionally subjected in advance to a surface treatment, for instance, sputtering, corona discharge, flame treatment, ultraviolet
10 irradiation, electron beam irradiation, or etching such as oxidation treatment, as necessary.

[0063]

A thickness of the base film, which is not particularly limited, is preferably in a range from 10 μm to 500 μm , more preferably from 15 μm to 300 μm , and still more
15 preferably from 20 μm to 200 μm in terms of strength, rigidity, and the like.

[0064]

Release Agent Layer

The release agent layer is preferably formed of a release agent composition.

The release agent composition to be used for forming the release agent layer
20 is not particularly limited as long as the release agent composition exhibits releasability. For instance, a release agent composition whose main component is a silicone compound, a fluorine compound, a compound including a long-chain alkyl group, a thermoplastic resin material such as an olefin resin and diene resin is usable. It is also preferable to use a release agent composition whose main component is an
25 energy-ray curable resin or a thermosetting resin. One of the above release agent compositions may be used alone, or two or more of the above may be used in combination.

[0065]

In a release agent composition whose main component is a silicone
30 compound, an example of the silicone compound is a silicone compound including organopolysiloxane as a basic skeleton. Examples of the silicone compound include thermosetting silicone compounds (e.g. addition reaction silicone compounds and

condensation reaction silicone compounds) and energy-ray (e.g. ultraviolet and electron beam) curable silicone compounds.

[0066]

5 In a release agent composition whose main component is a fluorine compound, examples of the fluorine compound include a fluorosilicone compound, a fluoroboron compound, and a compound including a poly(perfluoroalkylene ether) chain.

[0067]

10 In a release agent composition whose main component is a compound including a long-chain alkyl group, examples of the compound including a long-chain alkyl group include polyvinyl carbamate produced by reacting long-chain alkyl isocyanate with a polyvinyl alcohol polymer, alkyl urea derivative produced by reacting long-chain alkyl isocyanate with polyethylene imine, and long-chain alkyl (meth)acrylate copolymer. Additionally, a long-chain alkyl-modified alkyd resin, which
15 is produced by applying a long-chain fatty acid as a modifying agent to an alkyd resin produced by condensation reaction of a polyvalent alcohol and a polybasic acid, is optionally used.

[0068]

20 Preferable example of the release agent composition whose main component is an energy-ray curable resin is a composition containing polyorganosiloxane and an energy-ray curable compound including a reactive functional group selected from a (meth)acryloyl group, alkenyl group, and maleimide group. In the release agent layer formed of the above-described release agent composition that uses energy-ray curable compound and polyorganosiloxane whose
25 molecular structures, polarity, and molecular weights are mutually different, before the release agent layer is cured, the component derived from polyorganosiloxane segregates near an outer surface of the release agent layer to be subsequently cured by an energy beam to immobilize the segregation. As a result, releasability of the release agent layer can be improved. The release agent composition whose main
30 component is an energy-ray curable resin optionally further contains a photoinitiator.

[0069]

Examples of a release agent composition whose main component is a

thermosetting resin include a release agent composition whose main component is a melamine resin and a release agent composition whose main component is an epoxy resin. An example of a release agent composition whose main component is a melamine resin is a composition containing a melamine resin (base compound), an acid catalyst for thermally curing the melamine resin, and polyorganosiloxane that provides releasability for the release agent layer. An example of a release agent composition whose main component is an epoxy resin is a composition containing an epoxy resin (base compound), an acidic or basic thermosetting catalyst for thermally curing the epoxy resin, and polyorganosiloxane that provides releasability for the release agent layer. The component derived from polyorganosiloxane segregates at and near an outer surface of the release agent layer before the release agent layer is cured, and is subsequently cured to immobilize the segregation. As a result, releasability of the release agent layer can be improved.

[0070]

The release agent layer optionally contains additive(s) in addition to the above-described resin components. Examples of the additional additive include an anti-aging agent, light stabilizer, flame retardant, conducting agent, antistatic agent, and plasticizer.

[0071]

A thickness of the release agent layer, which is designed as desired and not particularly limited, is preferably in a range from 0.02 μm to 5 μm , more preferably from 0.03 μm to 2 μm , and still more preferably from 0.05 μm to 1.5 μm .

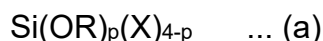
[0072]

Intermediate Layer

The intermediate layer is preferably a layer made of a silane compound that exhibits polycondensability upon being hydrolyzed, from the viewpoint that the intermediate layer exhibits hydrophilicity and water-insolubility and the coating layer is more easily removed from the base-film-side surface of the intermediate layer.

[0073]

The silane compound preferably contains at least one of a tetrafunctional silane compound represented by a formula (a) below or oligomer thereof as a main component.



In the formula (a):

R represents an alkyl group and X represents a halogen atom; when a plurality of R are present, the plurality of R are mutually the same or different; when
5 a plurality of X are present, the plurality of X are mutually the same or different; and p is an integer from 0 to 4.

An alkyl group preferably has 1 to 4 carbon atoms.

It should be noted that the silane compound represented by the formula (a) may be used alone or in combination of two or more thereof.

10 [0074]

Examples of the silane compound represented by the formula (a) preferably includes a silane compound represented by the formula (a) in which p is 4.

The silane compound represented by the formula (a) in which p is 4 (i.e., a tetrafunctional silane compound) is preferably tetraalkoxysilane. More preferable
15 examples of the tetraalkoxysilane include tetramethoxysilane, tetraethoxysilane, tetrapropoxysilane, and tetrabutoxysilane. Among the above, In terms of ease of availability and reactivity of the hydrolysis reaction, at least one of tetramethoxysilane or tetraethoxysilane or a mixture of tetramethoxysilane and tetraethoxysilane is preferable.

20 [0075]

Commercially available products are usable for the hydrolytic polycondensation product of the silane compound. Suitable examples of the commercially available products include "COLCOAT (Registered Trademark) N-103X," "COLCOAT (Registered Trademark) PX," "Methyl Silicate 51" (average
25 tetramer of tetramethoxysilane), "Methyl Silicate 53A" (average heptamer of tetramethoxysilane), "Ethyl Silicate 40" (average pentamer of tetraethoxysilane), "Ethyl Silicate 48" (average decamer of tetraethoxysilane), and "EMS-485" (a mixture of average decamer of tetramethoxysilane and average decamer of tetraethoxysilane) (all manufactured by COLCOAT CO., LTD.).

30 [0076]

In order for water to be easily infiltrated when the intermediate layer is in contact with water, a thickness of the intermediate layer is preferably in a range from

0.01 μm to 1 μm , more preferably from 0.03 μm to 0.5 μm , and still more preferably from 0.05 μm to 0.3 μm .

[0077]

With the use of the laminated film including the hydrophilic and water-insoluble intermediate layer in the exemplary embodiments of the invention, the debris of the removed coating layer has the release-agent-layer surface and the hydrophilic surface of the intermediate layer. When the debris of this structure is immersed in water, the release-agent-layer surface faces the atmosphere by surface tension and the surface of the intermediate layer faces water, so that the debris is stabilized. In other words, the debris of this structure is more likely to be present at the border of water and air than in water. The debris of the coating layer, which is an ultra-thin film, can keep floating on the surface of water due to prevailing buoyant force caused by surface tension even when the density of the debris is slightly large and due to the presence of the water-insoluble intermediate layer.

[0078]

The laminated film used in the exemplary embodiments (laminated film before cutting) is usually usable in order to protect a surface of functional sheets and components usable in specific applications when the functional sheets and components are produced, transported, stored, and the like. After being used for protecting the components and the like, the laminated film are peeled off from the surface and are often disposed. With the use of the laminated film, the coating layer can be easily separated from the base film of the laminated film, thereby greatly contributing to resource protection and environment protection.

EXPLANATION OF CODES

[0079]

1...roll, 10...cutter unit, 11...nip rolls, 12...cutter blades, 13...piece collector, 20, 20A...agitator, 21, 21A, 21C...agitator tank, 21B...upper opening, 22...agitator shaft, 22A, 22B...agitator impeller, 30, 30A, 30B, 30C...coating-layer collector, 30a...tray, 31...container, 33...water injector, 33a...discharge port, 34...raking blade, 34a...slit, 35...debris discharge outlet, 40, 40A...base-film collector, 41...base-film discharge pipe, 42...opening, 43...support member, 43A...slanted bottom plate,

43B...support wall, 44...base-film discharge outlet, 50...laminated film, 51...base film, 52...coating layer, 52C...debris of coating layer, 100...removal equipment, 210...cut, 300...collector mechanism, 521...intermediate layer, 522...release agent layer

CLAIM(S)

[Claim 1]

A method for removing a coating layer, comprising:

cutting a laminated film comprising a base film and a coating layer into small

5 pieces;

immersing and agitating the cut laminated film in hot water in an agitator tank to separate the laminated film into the base film and the coating layer;

collecting the separated base film, which is a base-film collection step; and

collecting debris of the separated coating layer, which is a coating-layer

10 collection step, wherein

the coating layer comprises an intermediate layer and a release agent layer, and

the intermediate layer is interposed between the base film and the release agent layer.

15 [Claim 2]

The method according to claim 1, wherein in the cutting of the laminated film into small pieces, the laminated film fed from a roll formed with the wound laminated film is cut into small pieces.

[Claim 3]

20 The method according to claim 1 or 2, wherein in the separating of the laminated film into the base film and the coating layer, the separated base film is sunk in the hot water and the debris of the separated coating layer is floated on the hot water.

[Claim 4]

25 The method according to claim 1 or 2, wherein in the coating-layer collection step, the debris of the coating layer floating on the hot water is filtrated through a filter detachably provided directly below a water surface in the agitator tank.

[Claim 5]

30 The method according to claim 1 or 2, wherein in the coating-layer collection step, the hot water in the agitator tank is overflowed and the debris of the coating layer flowed out together with the overflowed hot water is guided to an outside of the agitator tank through an upper discharge outlet of the agitator tank and is collected.

[Claim 6]

The method according to claim 5, wherein in the coating-layer collection step, when the hot water in the agitator tank is overflowed, the debris of the coating layer is guided to the upper discharge outlet and collected while the debris of the coating layer floating on or near the surface of the hot water in the agitator tank is gathered using a raking implement.

[Claim 7]

The method according to claim 5, wherein the hot water is overflowed using a water injector comprising a discharge port, and the discharge port is provided in the agitator tank.

[Claim 8]

The method according to claim 3, wherein in the base-film collection step, the base film sunk in the hot water is collected through a discharge outlet provided at a bottom side of the agitator tank, or the base film sunk in the hot water is collected through a discharge pipe connected to the bottom side of the agitator tank.

[Claim 9]

The method according to claim 1 or 2, wherein the coating-layer collection step is performed after the base-film collection step, the base-film collection step is performed after the coating-layer collection step, or the base-film collection step and the coating-layer collection step are simultaneously performed.

[Claim 10]

The method according to claim 1 or 2, wherein the base film and the intermediate layer are in direct contact with each other.

[Claim 11]

The method according to claim 1 or 2, wherein the intermediate layer is hydrophilic and water-insoluble.

[Claim 12]

The method according to claim 1 or 2, wherein the laminated film is a laminated film used for manufacturing a ceramic green sheet and left after the ceramic green sheet is peeled off.

[Claim 13]

Removal equipment configured to remove a coating layer from a laminated film comprising a base film and the coating layer, the removal equipment comprising:

a cutter unit configured to cut the laminated film into small pieces;

an agitator comprising an agitator tank and configured to immerse and
5 agitate the cut laminated film in hot water in the agitator tank to separate the laminated film into the base film and the coating layer;

a coating-layer collector configured to collect debris of the coating layer separated from the laminated film from an upper side of the agitator tank; and

a base-film collector configured to collect the base film separated from the
10 laminated film from a bottom side of the agitator tank.

[Claim 14]

The removal equipment according to claim 13, wherein the coating-layer collector is a filter detachably provided directly below the water surface in the agitator.

[Claim 15]

15 The removal equipment according to claim 13, wherein the coating-layer collector is a raking implement configured to guide the debris of the coating layer flowed out together with the hot water overflowed out of the agitator tank to an outside of the agitator tank.

[Claim 16]

20 The removal equipment according to claim 13 or 14, wherein the base-film collector is a discharge outlet provided at the bottom side of the agitator tank or a discharge pipe connected to the bottom side of the agitator tank.

[Claim 17]

25 The removal equipment according to claim 13 or 14, wherein the laminated film is a laminated film used for manufacturing a ceramic green sheet and left after the ceramic green sheet is peeled off.