

SUPPORTING DEVICE FOR MICROORGANISMS AND
METHOD OF PREPARING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a supporting device for microorganisms used in water treatment and to a method of preparing thereof, and, more particularly, to those employed in the methods of fixed bed process, shaking bed process, fluidized bed process etc.

2. Brief Description of the Prior Art

A method called the biological membrane method in which waste water or clear water is processed by reaction with microorganisms is one of the water processing methods utilizing a supporting device to which necessary microorganisms are supported thereon. The method is noticed as being excellent in increasing the amount of microorganisms per unit water volume.

One of supporting devices for microorganisms used in the biological membrane method has been proposed in Japanese laid-open patent application No. 6-45033 (1994), which is illustrated as the member T in FIGS.10 and 11 of the present specification.

The support member T is prepared, for example, through the following steps of (1) to (3):

(1) Each 50 % of polypropylene fibers (referred to as "PP

fiber" hereinafter) having a melting temperature of 170°C and a denier value of 80 (1 denier = 1 gram (mass) per 9000 meters), and of low-density polyethylene fibers (referred to as "PE fiber" hereinafter) prepared by a high-pressure process having a melting temperature of 110°C and a coarseness of 6 denier are passed through a guard and a layer to form a web W having a width of 3 meters as shown in FIG.10(a);

(2) the obtained web W is fixed by using a needle punching technology to form an elongated nonwoven cloth F₁ having a porosity of 80%, a weight per unit area value of 350 gram/m², a thickness of a 3 mm, a width of 2.7 meters and a length of 50 meters. The cloth F₁ is cut to form an elongated cut nonwoven cloth F₂ having a width of 20 cm as shown in FIG.10(b); and

(3) the produced elongated cut nonwoven cloth F₂ is then wound round and heat-treated at 130°C in a processing device to form a cylindrical nonwoven cloth F₃ as shown in FIG.10(c), which is cut to form each of support members T having a length of 5.5 cm as shown in FIGS.10(d) and 11. By the heat treatment performed in the processing apparatus, the PE fibers are fused to bond the PP fibers with each other of the PP fibers while both side edges of the elongated cut nonwoven cloth F₂ having a cylindrical shape are also bonded by the fused PE fibers.

Although there are some advantages in thus prepared supporting members such as good circulation ability of air and water, a large area for embedding the microorganisms and a good adhering property for the microorganisms, there exist

still two disadvantages mentioned below:

(1) Because thus obtained conventional support member has a structure wherein the PP fibers are supported through the fused PE fibers, the PP fibers in a fluffy state are exposed both on inner and outer surfaces of the member.

Accordingly, due to a possible vibration caused during packaging, conveyance or filling into the water treating tank, or due to a possible flow caused by convection of the water being treated, the adjacent supporting members T are likely to be scrubbed with each other to induce a friction, by which the PP fibers exposed on the outer surface that should contribute to gathering the microorganisms can be removed. The reduced surface area for embedding organisms results in a worsened adherence of organisms to the support member.

(2) Because, during fixing of the web W by the needle punch, both PP and PE fibers constituting the web W are drawn towards a central line located in a longitudinal direction of the web being interacted with each other, which makes the weight per unit area value on the sides of the web relatively heavier compared with that along the central line.

As a result, a large weight dispersion takes place among the devices T produced by processing of the elongated cut nonwoven cloth F₂ resulting in a reduced production yield of the devices T per unit fiber amount.

The afore-mentioned phenomenon is undesirable because the area effective for maintaining microorganisms per unit fiber volume involved in the supporting device is not necessarily increased by an increase in the weight per unit

volume of the supporting device T.

SUMMARY OF THE INVENTION

Accordingly, an object of the invention is to provide a supporting device for microorganisms and a method of preparing thereof wherein the removal of the PP fibers is prevented, the weight dispersion within a group of a plurality of devices is decreased and, consequently, the production yield of the good supporting devices per unit fiber quantity is improved.

The present invention is to provide a supporting device for microorganisms useful for waste water treatment comprising as constituents: a web, which includes first fibers formed of a polyolefin type synthetic resin and second fibers formed of polyolefin type synthetic resin having a melting temperature lower than that of the first fibers, and a nonwoven cloth acting as a base layer, to which the web is fixed by using a needle punch technology and with which the first fibers are bonded by fusing the second fibers as well as with each other of the first fibers (The device prepared above is referred to as a "first supporting device" hereinafter).

The first supporting device is produced, for example, by the following steps (referred to as a "method for manufacturing a first device" hereinafter):

(1) preparing a web out of

first fibers formed of a polyolefin type synthetic resin, and

second fibers formed of a polyolefin type synthetic

resin having a melting temperature lower than that of the first fibers,

(2) stacking the web with a base layer formed of a nonwoven cloth and fixing by means of a needle punch to form a laminate; and

(3) heating the laminate at a temperature lower than the melting temperature of the first fibers and higher than the melting temperature of the second fibers to fuse the second fibers to bond the first fibers with each other of the first fibers as well as with the base layer.

The present invention also provides another supporting device having a structure different from that of the first supporting device (referred to as a "second supporting device" hereinafter). The second device has the first fibers fluffed by needle punching technology utilizing a fluffing needle, which are exposed on a nonwoven cloth surface opposite to the surface that has been fixed to a web.

The second supporting device is produced, for example, by the following steps (referred to as a "method for manufacturing the second device" hereinafter):

(1) preparing a web out of:

first fibers formed of a polyolefin type synthetic resin, and

second fibers formed of a polyolefin type synthetic resin having a melting temperature lower than that of the first fibers;

(2) stacking the web with a base layer formed of a nonwoven cloth and fixing by means of a needle punch to form a

laminate;

(3) treating the obtained laminate by needle punching technology from the web side with a fluffing needle so as to obtain a fluffed layer of the first fibers on the nonwoven cloth surface; and

(4) heating the fluffed laminate at a temperature lower than the melting temperature of the first fibers and higher than the melting temperature of the second fibers to fuse the second fibers to bond the first fibers with each other as well as with the nonwoven cloth.

The web employed in either of the first and second supporting devices together with in the methods to form the first and second devices mentioned above includes from 40 to 80 weight % of the first fibers and from 60 to 20 weight % of the second fibers.

The polyolefin having a higher melting temperature herein is any of polypropylene, high-density polyethylene, ethylene-propylene copolymer or the like while that having a lower melting temperature herein is any of low density polyethylene, ethylene-vinyl acetate copolymer or the like.

The melting temperature of the second fibers may be lower than that of the first fibers by 10 to 100 °C, preferably by 30 to 80°C.

The coarseness between 40 and 400 denier, preferably between 50 and 200 denier, is desirable for the first fibers. The coarseness less than 40 denier provides inferior properties in maintaining configuration and in mechanical strength while that exceeding 400 denier provides a device

having a reduced surface area.

The coarseness of 3 to 20 denier is preferable for the second fibers herein. The other coarseness beside above-mentioned range provides the insufficient bonding strength of the first fibers with each other resulting in supporting devices having a degraded mechanical strength.

The web herein includes 30 to 90, preferably 40 to 80, weight % of the first fibers and 70 to 10, preferably 60 to 20, weight % of the second fibers. In other words, the device that includes less than 30 wt % of the first fibers and exceeding 70 wt % of the second fibers exhibits a poor maintaining ability of the shape and a poor mechanical strength. On the other hand, a constitution rate of the first fibers in the web exceeding 90 % or, accordingly, a constitution rate of the second fibers in the web falling short of 10 % provides an insufficient bonding strength of the first fibers with each other and weakens the mechanical strength of the supporting device.

A weight per unit area value of the nonwoven cloth acting as the base layer should be in a range of about 20 to 600, preferably 40 to 200, gram/m². The weight per unit area value less than 20 gram/m² excessively enhances a breakdown during a needle punching process, making the prevention of shrinkage difficult, while the weight per unit area exceeding 600 gram/m² reduces a round forming feasibility and increases a handling difficulty, resulting in a cost increase.

Although manufacturing technologies used for preparing the nonwoven cloth herein are not limited, the nonwoven cloth

is preferably made by the spun-bond method. The weight per unit area value of the laminate may be 100 to 3000, preferably 200 to 1000, gram/m².

According to the methods of manufacturing the first and the second devices, the first and second fibers constituting the web are fixed to the nonwoven cloth being entangled with each other because the web is stacked with the nonwoven cloth acting as the base layer and fixed by the needle punch method. During the fixing, the web is liable to shrink resulting in a reduced width because the first and second fibers are drawn together toward a center line running in a longitudinal direction of the nonwoven cloth. However, an amount of shrinkage is very little because the movement of web is bound with the nonwoven cloth.

As a result, a laminate having an almost uniform weight per unit area value can be formed of the web and the nonwoven cloth. Conclusively, little weight variance takes place in the first and the second supporting devices formed of this laminate.

The first supporting device has a structure wherein the web including the first and the second fibers is fixed to the nonwoven cloth by needle punching technology and the first fibers are bonded with each other together with the nonwoven cloth layer by fusing the second fibers. The second supporting device has a structure that the web including the first and the second fibers is fixed with the nonwoven cloth by needle punching technology to form the laminate which is provided on the nonwoven cloth surface with the fluffed first

fibers by the needle punching technology from the web side utilizing the fluffing needle, wherein the first fibers are then bonded with each other together with the nonwoven cloth by fusing the second fibers.

Therefore, the connecting strength between the first fibers and the nonwoven layer is enforced in the device formed according to the present invention. As a result, the first fibers which contribute to supporting microorganisms is scarcely removed even when the first and second devices are, for example, allowed to flow in convection of the water being treated and to be scrubbed with other neighboring devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1(a) to FIG.1(e) are illustration of a process of manufacturing a first supporting device for microorganisms of Embodiment 1 according to the present invention;

FIG.2 is a schematic side view of the supporting device shown in FIG.1;

FIG.3 is a longitudinal section view of a processing apparatus used for manufacturing the supporting devices in the preferred embodiments;

FIG.4 is a schematic side view of a modified first supporting device of Embodiment 1;

FIG.5 is a schematic side view of another modified first supporting device of Embodiment 1;

FIG.6 is a schematic side view of still another modified first supporting device of Embodiment 1;

FIG.7(a) to FIG.7(e) are illustration of a process of manufacturing a second supporting device for microorganisms of Embodiment 2;

FIG.8 is a schematic side view of the supporting device for microorganisms shown in FIGS. 7;

FIG.9 is a schematic side view of a modified second supporting device of Embodiment 2;

FIG.10(a) to FIG.10(d) are illustration of a conventional process of preparing a conventional supporting device; and

FIG.11 is a perspective view of the conventional device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter described is the best mode of carrying out the present invention into practice corresponding to the preferred embodiments.

Embodiment 1

A method of preparing a first supporting device or a plurality of devices is detailed sequentially with reference to FIGS. 1 to 3.

(1) 80 denier-coarse polypropylene fibers (referred to as "80dPP" hereinafter) having a melting temperature of 170°C, which constituted first fibers, and 6 denier-coarse high pressure/low density polyethylene fibers (referred to as "6dPE" hereinafter) having a melting temperature of 110°C, which constituted second fibers, were sprayed at a 50 to 50 rate, respectively, onto a rotating metallic net utilizing an air stream to produce a web W_1 having a width of 3 meters as shown in FIG. 1(a).

Incidentally, manufacturing methods of the web according to the present invention were not restricted to the method used in Embodiment 1;

(2) The obtained web W_1 was stacked with a nonwoven cloth f_1 having a thickness of 0.5 mm, a width of 3 meters and a weight per unit area of 50 gram/m², which acts as base layer, as shown in FIG. 1(a) and fixed by means of a needle punch to form a laminate f_2 having a porosity of 87%, a weight per unit area of 350 gram/m², a thickness of 3mm and a width of 2.8

meters as can be seen from FIG. 1(b).

The nonwoven cloth f_1 employed herein was prepared in a manner that spinning threads out of a thermoplastic polypropylene and shaping the spun threads into a sheet-like web were simultaneously proceeded. The threads involved in the sheet-like web were bonded with each other by the use of a solvent to form the nonwoven cloth f_1 .

(3) The obtained laminate f_2 was cut into a plurality of elongated cut laminates f_3 of 20 cm in width as shown in FIG.1(c), which were then helically wound to form wound bodies R having the nonwoven cloth layer positioned outside as shown in FIG. 3.

(4) The elongated cut laminate f_3 extruded from the wounded body R was heat-treated in a processing apparatus Y shown in FIG.3 to produce a cylindrical body f_4 having 5.5cm in diameter and 50 meters in length as shown in FIG.1(d), which was cut into each length of 5.5 cm to produce a plurality of supporting devices T_i as can be seen from FIG.1(e).

The heat treatment and cutting process herein were performed by the use of the processing apparatus Y as follows:

The processing apparatus consists of a heating port 1, a pair of guide members 2 disposed at an inlet side of the heating port 1, a cutting assembly 3 provided on an outlet side of the port 1 and a pair of drawing rolls 4.

The heating port 1 consists both of an outer heating guide cylinder 6, which is heated by surrounding heating means 5, and a cylindrical mandrel 7, which is displaced inside an inner cylindrical surface of the outer cylinder 6. Provided

between the outer guide cylinder 6 and the mandrel 7 is an annular gap 8. The ambient temperature within the gap 8 is decided by the outer cylinder 6 heated at 130°C and by the mandrel 7, which is heated by the ambient temperature of the cylinder 6, so as to maintain the gap 8 at about 130°C. This temperature is actually lower than the melting temperature of the 80dPP fibers and higher than that of the 6dPE fibers mentioned above.

As the processing apparatus Y was constructed as above, the elongated cut laminate f_3 extruded out of the wound body R was introduced via the guide members 2 into the annular gap 8, being bent round with the nonwoven cloth layer exposed as an outer surface. The both side edges were overlapped with each other and heat-treated during passing through the gap 8.

Through such a heat-treatment, the 6dPE fibers were fused to bond 80dPP fibers with each other of 80dPP fibers as well as with the nonwoven cloth f_1 . Simultaneously, both-sided stacked edges of nonwoven cloth f_1 were bonded together making the elongated cut laminate f_3 deformed into a cylindrical body f_4 , which was further cut with the cutting assembly 3 into a plurality of supporting devices T_1 .

FIG.2 shows thus obtained supporting device T_1 wherein the nonwoven cloth f_1 acting as a base layer was exposed on an outside surface of the device while the fluffed 80dPP fibers S were exposed on an inside surface of the device.

The weight per unit area value of thus obtained supporting devices T_1 was substantially uniform as proved by a weight dispersion test to be described hereinafter. A

practical usage of thus obtained supporting devices T₁ which was carried out in a waste water tank indicated that the circulation of water and air was excellent, no coming off of the fluffed 80dPP fiber S was observed and the supporting ability for microorganisms was excellent.

FIG.4 shows a modified first supporting device T₂ wherein the elongated cut laminate f₃ mentioned above was wound so that the nonwoven cloth layer f₁ was placed inside during forming the wounded body and heat-treated in the processing apparatus Y to form a cylindrical body before cutting.

This device T₂ had a structural difference from that of the above-mentioned device T₁ at the points wherein the nonwoven cloth layer f₁ was exposed internally while the fluffed 80dPP fibers S were exposed externally. However, the function thereof was substantially the same as that of the device T₁.

FIG.5 shows another modified first supporting device T₃ formed as follows: A nonwoven cloth f₁ playing a role of the base layer was stacked on each of front and rear surfaces with one of two webs W₁. The stack was then fixed by needle punching technology to form an elongated laminate and cut into a plurality of elongated cut laminates, which were then heat-treated to form a cylindrical body before cutting.

Still another modified first supporting device T₄ shown in FIG.6 was formed as follows: A web W₁ was sandwiched in between two sheets of nonwoven cloth f₁, which acted as base layers, and fixed by needle punching method to form an elongated laminate. The elongated laminated was cut into a plurality of elongated cut laminates and thereafter heat-treated to form cylindrical bodies, which were subjected to the final cutting.

The supporting device T₃ shown in FIG.5 had two fluffed 80dPP fiber layers exposed, respectively, inside and outside the device while the device T₄ shown in FIG.6 is formed so that the 80dPP fiber layer S was enclosed with the nonwoven cloth layers f₁ inbetween. Although the devices T₃ and T₄ had stratified structures different from that of the aforementioned device T₁, their functions were substantially the same as that of the supporting device T₁.

Embodiment 2

A method for manufacturing a second supporting devices will be described sequentially with reference to FIGS.7 and 8.

Incidentally, this fabrication process differs from that of Embodiment 1 because a fluffing process is inserted between Processes (2) and (3) of Embodiment 1.

(1) 80 denier-coarse polypropylene fibers (referred to as "80dPP") having a melting temperature of 170°C, which constituted first fibers, and 6 denier-coarse high pressure/low density polypropylene fibers (referred to as "6dPE") having a melting temperature of 110°C, which

constituted second fibers were, sprayed at a 50 to 50 rate, respectively, onto a rotating metallic net utilizing an air stream to produce a web W_1 having a width of 3 meters as shown in FIG.7(a).

Incidentally, the forming method of the web herein was not limited to the method mentioned above.

(2) The obtained web W_1 was stacked with a nonwoven cloth f_1 having a thickness of 0.5 mm, a width of 3 meters and a weight per unit area of 50 gram/m², which acted as a base layer, as shown in FIG.7(a). The stack was fixed by using a needle punching method to form a laminate f_2 having a porosity of 87%, a weight per unit area of 350 gram/m², a thickness of 3 mm and a width of 2.8 meters, which consisted of the nonwoven cloth f_1 and the web layer W_1 , as shown in FIG.7(b).

The nonwoven cloth f_1 used herein was prepared in a manner that spinning threads out of a thermoplastic polypropylene and shaping the spun threads into a sheet-like web were simultaneously proceeded therefrom. The spun threads involved in the sheet-like web were then adhered to each other by pasting using a solvent to form the nonwoven cloth f_1 .

(3) The obtained laminate f_2 was needle-punched on the web-side surface by using a fork-shaped fluffing needle to provide on the surface of nonwoven cloth f_1 with a plurality of loop-shaped fluffings K made of the 80dPP fibers as can be seen from FIG.7(c);

(4) The laminate f_2 provided with the fluffings K was cut into an elongated cut laminates f_3 having a width of 20 cm as shown in FIG.7(d), which were helically wound to form a wound

body similar to that designated as R in FIG.3. The nonwoven cloth layer f_1 was located inside the wounded body; and

(5) The elongated cut laminate f_6 drawn out of the wound body was heat-treated by the processing apparatus Y shown in FIG.3 to form a cylindrical body f_7 of 5.5 cm in diameter and of 50 meters in length as shown in FIG.7(e), which was cut into the supporting devices T_5 of 5.5 cm in length as shown in FIGS.7(f) and 8.

The heat-treatment and cutting processes herein were performed in the same manner as in Embodiment 1. Namely, the elongated cut laminate f_6 successively drawn out of the wound body was introduced via guide members 2 into the annular gap 8 being bent round with the nonwoven cloth layer f_1 positioned inside. During passing through the gap 8, both side edges thereof were overlapped with each other and heat-treated.

Through such a heat-treatment, the 80dPP fibers were bonded with each other together with the nonwoven cloth f_1 by fusing of the 6dPE fiber material. At the same time, the both side edges of the laminate f_6 were bonded together, which made the elongated cut laminate f_6 transformed into a cylindrical body f_7 . The cylindrical body f_7 was cut into a plurality of supporting devices T_5 by the cutting device 3.

FIG.8 shows thus obtained second supporting devices T_5 having a structure wherein the loop-shaped fluffings K were exposed inside the nonwoven cloth f_1 and the 80dPP fibers in a fluffed state S were exposed outside the nonwoven cloth f_1 .

The weight per unit area value was substantially uniform throughout the produced devices T_5 as proved by the

test to be described hereinafter. The circulation ability of water and air was excellent, the fluffed 80dPP fibers S as well as the loop-shaped fluffings K scarcely came off and the supporting ability for microorganisms was excellent as proved by a practical usage thereof performed in a waste water tank.

FIG.9 shows a modified second supporting device T₆ wherein the elongated cut laminate f₆ was wound so that the nonwoven cloth layer f₁ acting as a base layer was located outside the wound body. The laminate was extruded out of the wound body and subjected to heat treatment in the processing apparatus Y to form a cylindrical body before cutting.

The supporting device T₆ had a structure different from that of afore-mentioned supporting device T₅ because the fluffed 80dPP fibers S were exposed inside the nonwoven while the fluffings K were exposed outside the nonwoven cloth f₁. However, the function thereof was substantially the same as the device T₅.

Table 1 indicates the weight distribution status of the produced supporting devices evaluated by measuring the device weight and compares the weight dispersion between the device T disclosed in Japanese patent application No. 6-45033, the device T₁ of Embodiment 1 and the device T₅ of Embodiment 2. Numerical values shown in the left-hand side column of the Table 1 were weight distribution ranges divided by a mean weight value of a device group. The weight distribution in the conventional device T was exhibited in the next column to the right by the device numbers per each weight range. The weight distributions in devices T₁ and T₅ were tabulated in

the third and the right-hand side columns, respectively.

Herein five samples randomly selected from ten samples in each of the three groups were measured. Inclusively, fifty samples were tested at all.

Table 1

Weight range of device divided by mean value	Supporting device T	Supporting device T ₁	Supporting device T ₅
Less than 0.79	3	0	0
0.80 to 0.84	3	2	1
0.85 to 0.94	9	15	16
0.95 to 1.05	16	18	21
1.06 to 1.15	15	10	9
1.16 to 1.20	2	5	3
Equal to or larger than 1.21	2	0	0

Table 1 clarified that, as to the group of devices T, 32 % thereof stayed within a +5% to -5% range of the mean weight value: in a similar manner, 80 % thereof stayed within a +15% to -15% range of the mean weight value; and 6 % thereof had the weight value less than the mean weight value by 21%.

In contrast, the weight dispersion in the group of devices T₁ was reduced in that, 36 % thereof stayed within the +5% to -5% range of the mean weight value; 80 % thereof stayed within the +15% to -15% range of the mean weight value; and there was no device having the weight value less than the mean value by 21%.

Furthermore, the group of devices T₅ included 42% thereof having the weight deviation less than + and -5% from the mean value, and 92% thereof having the weight deviation less than + and -15%. Also, there was no device having the weight value less than the mean value by 21%.

As a result, in contrast to the large dispersion in the group of devices T, the weight dispersion was decreased in either group of devices T₁ and T₅. This may be attributed to the fact that the draw in of the web toward the central line of the longitudinal direction, which is likely to take place in the manufacturing method disclosed in Patent publication No. 6-45033, is substantially eliminated in producing the devices T₁ and T₅ according to the present invention.

Industrial Utility of the Invention:

The supporting device for microorganisms manufactured according to the present invention includes such a large

number of complex spaces formed by the first fibers in the device that this device can provide microorganisms with excellent living spaces, thereby maintaining a high density of microorganisms. Furthermore, not only those organisms having a less breeding rate are properly caught and enabled to breed rapidly but also hyphomycetes can be caught by the fibers of the device to suspend bulking.

The supporting device of the invention can be extensively used for treatment of the organic waste water from the plants or facilities including industries of food and agricultural materials, spinning and dye products; laundry waste water; wastes from chemical plants, pharmaceuticals, petroleum refining, petrochemicals, paper and pulp industry, alcohol fermentation; municipal waste water, those from agricultural farms, dining facilities, office buildings, or railway station facilities.

Similarly, the supporting device invented is so light in weight, so easily handled and having so sufficient porosity that the hold-up quantity of the treatment chamber using this device is remarkably increased.

Accordingly, the devices are utilized not only in a new installation but also in increasing the treating ability of a biological treatment chamber.

What is claimed is:



1. A supporting device for microorganisms comprising a web and a base layer, said web comprising:

first fibers formed of a polyolefin type synthetic resin, and

second fibers formed of a polyolefin type resin having a melting temperature lower than that of said first fiber material;

said base layer is formed of a nonwoven cloth;

said web is fixed to said nonwoven cloth by means of a needle punch; and

said first fibers are bonded with each other together with said nonwoven cloth by melting of said second fibers.

2. A supporting device for microorganisms according to claim 1, wherein said nonwoven cloth has said first fibers in fluffed state which are provided on a surface opposite to a surface which is bonded to said web.

3. A supporting device for microorganisms according to claim 1 or 2, wherein said web is formed of 40 to 80 weight % of said first fibers and 60 to 20 weight % of said second fibers.

4. A supporting device for microorganisms according to claim 1 or 2, wherein said melting temperature of said second fibers is lower than that of said first fibers by 10 to 100°C.

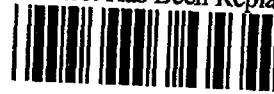
This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



This Sheet Has Been Replaced



5. A method of producing a supporting device for microorganisms comprising the steps of:

- (1) preparing a web out of
first fibers formed of a polyolefin type synthetic resin, and
second fibers formed of a polyolefin type synthetic resin having a melting temperature lower than that of said first fibers;
- (2) stacking said web with a base layer formed of a nonwoven cloth and fixing by means of a needle punch to form a laminate; and
- (3) heating said laminate at a temperature lower than the melting temperature of said first fibers and higher than the melting temperature of said second fibers to fuse said second fibers to bond said first fibers with each other together with said nonwoven cloth.

6. A method of producing a supporting device for microorganisms comprising the steps of:

- (1) preparing a web out of
first fibers formed of a polyolefin type synthetic resin, and
second fibers formed of a polyolefin type synthetic resin having a melting temperature lower than that of said first fiber material;
- (2) stacking said web with a base layer formed of a

THIS SHEET HAS BEEN
REPLACED



nonwoven cloth and fixing by means of a needle punch to form a laminate;

(3) treating said laminate in needle punch process with a fluffing needle from said web side so as to provide said nonwoven cloth surface with fluffings formed of said first fibers; and

(4) heating said fluffed laminate at a temperature lower than the melting temperature of said first fibers and higher than the melting temperature of said second fibers to fuse said second fibers to bond said first fibers with each other together with said nonwoven cloth.

7. A method of producing a supporting device for microorganisms according to claim 5 or 6, wherein said web is formed of 40 to 80 weight % of said first fibers and 60 to 20 weight % of said second fibers.

8. A method of producing a supporting device for microorganisms according to claim 5 or 6, wherein said melting temperature of said second fibers is lower than that of said first fibers by 10 to 100°C.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED