

METHOD OF PRODUCING A MAT CONSISTING
OF FILAMENT LOOP AGGREGATIONS

Background of the Invention:

This invention relates to a method producing a coarse net-like resilient mat made by entanglement of synthetic resin monofilaments, particularly suitable for a porch mat or a floor mat formed and laid in a long sheet.

Instead of a conventional carpet mat or synthetic resin mat, there is recently provided a three-dimensional net-like mat consisting of synthetic resin monofilaments of high water permeability and quick dryability. Due to such characteristics as the resiliency and weather-proofness, such a three-dimensional net-like mat is used in many indoor and outdoor fields, particularly to such places where water is present as, for example, access to a bath room or a pool side, and is appreciated because it is simple to wash and dry.

Also, as this kind of three-dimensional mat is open-structured, the sand and gravel deposited when it is trodden upon will fall through and will not remain on the surface. As water also will fall through, the surface can be always kept dry. It is thus convenient.

In addition, when a sheet such as a synthetic resin sheet, foam sheet or rubber sheet is adhered to the lower surface of such mat, the cushioning property will be

increased, and the sand and water dropping from the surface will be received by this sheet adhered to the lower surface and the floor will be prevented from being made dirty directly by the dropping sand and the like.

Description of the Prior Art:

As disclosed in Japanese Patent Publication No. 14347/1972, such a three-dimensional net-like mat is formed as a non-woven fabric wherein many monofilaments made of a thermoplastic synthetic resin are fused at their contact points and are cooled until solidified.

Japanese Patent Publication No. 31222/1980 and Japanese Patent laid open No. 85061/1987 disclose means for forming the above mentioned filaments in such non-woven fabric.

Now, in the non-woven fabric formation by the above described conventional means, the resiliency of the filament part is low. The filaments formed by this producing means overlap on each other and collapse and, as a result, as the entangled density of the filaments becomes higher, and the resiliency of the sheet will be lost.

Summary of the Invention:

According to the present invention there is provided a method for producing a mat comprised of filament loop aggregations, comprising extruding a plurality of thermoplastic resin filaments into cooling water, heating

1110

said filaments before entering said cooling water to maintain their temperature close to that at extrusion, maintaining said cooling water at a temperature such that the heat of said filaments causes local boiling at the surface of the cooling water whereby said filaments are caused to form loops on entering the water, and causing said looped filaments to sink into said cooling water at a rate lower than that of extrusion; and conveying a thermoplastic synthetic resin layer into said cooling water, at a rate equal to that at which the filament loop aggregations sink into the cooling water, such that the thermoplastic synthetic resin layer contacts the filament loop aggregations and becomes fused thereto at the points of contact.

Description of the Drawings:

The many advantages and features of the present invention can be best understood and appreciated by reference to the accompanying drawings wherein:

Fig. 1 is a side view of an embodiment of apparatus for carrying out the method of the present invention;

Fig. 2 is a side view of another embodiment for carrying out the method of the present invention; and

Fig. 3 is a block diagram of the production of a sheet using the method of the present invention.

Detailed Description of the Invention:

According to the present invention, a mat is made by overlapping a three-dimensional aggregation of upright entangled loops of synthetic resin filaments and dense synthetic resin layer to develop a cushioning property.

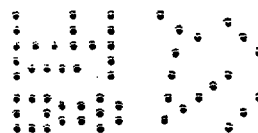
In order to produce such mat, several hot filaments of a thermoplastic synthetic resin are pressed and extruded through die orifices and are made to fall toward a water surface.

The falling hot filaments are heated by such heat sources as ceramic far infrared ray heaters so as not to be cooled by the atmosphere.

Such hot filaments are easily to make coiled loops on the water surface. Unless the filaments are hot, the loops will become large. Further, in the filaments of a reduced temperature, no coiled loop will be formed but only a bent form will be made.

The height from the die mouth end to the water surface is typically 5 to 100 cm. and the heat reduction of the filaments is prevented by making the die mouth end approach the water surface as much as possible.

The orifice diameter of the die is typically 0.3 to 1.5 mm. An element determining the filament diameter is consideration of the shrinkage of the material at the time of hardening after being extruded and molded, so as to retain the resiliency and durability of the formed filaments and



prevent permanent set.

A mat sheet consisting of filament aggregations of respective widths can be made by arranging the numbers of orifices corresponding to the widths of 90, 120 and 150 cm. of intended mat sheets with an orifice arrangement of a die of 2 to 6 longitudinal rows at the intervals of 3 to 5 mm. and a pitch of 3 to 5 mm. in the lateral rows.

That is to say, a hot first filament bundle extruded out of the die of such orifice arrangement is made to fall vertically towards cooling water and is received by submerged rollers rotating at a speed sufficiently slower than the falling speed to limit the falling speed in water and to give the filaments a resistance toward the water surface from the above mentioned rolls. Loops having a peripheral length of the filament length corresponding to the difference between the extruding speed of the respective filaments and the falling speed in water will continuously form a coil-like first filament loop aggregation.

In the same manner, a second filament bundle falling toward a conveyer present on the water surface will be prevented by this conveyer from sinking into water and will form loops on the water surface to form a second filament loop aggregation consisting of over-lapped coiled loops controlled by the conveying speed of the conveyer.

At this time, in order to make it easy to form loops in the first filament loop aggregation and to make bent irregular loops, it is effective to keep boiling the cooling

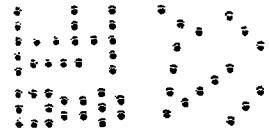
water surface on which the filament bundle falls.

This boiling state vibrates the respective filaments wound on the water surface. As a result, entangled disarranged coiled loops will be induced on the water surface.

In order to make the boiling state on this water surface, it is important to keep the filaments coming out of the die at a high temperature until the liquid level. Generally, when the filaments are in contact with the atmosphere, the filament temperature will quickly reduce. The water surface heated by the falling in water of the filament bundle kept at a filament extruding molding temperature of 200 to 150°C. by the above mentioned heating treatment to prevent air cooling in the filaments coming out of the die will be in the boiling state. Therefore, when the cooling water is kept at a high temperature of 60 to 80°C, this boiling will be maintained.

When the filaments are formed into be coiled loops while kept at a high temperature, the fusing between the loops will be increased. Further, when the cooling water is at a high temperature, in case the molded loops are pulled out into the atmosphere by the guide rolls and are sent to the secondary process, they will be able to be easily dried with cool or hot air.

A filament loop aggregation has its coil density decreased by increasing the rotation (pulling speed in water) of the rolls in water and the conveyer speed synchronized



with it and has its coil density increased by reducing the pulling speed.

On the other hand, even if the width of the hanging first filament bundle is not regulated, a three-dimensional formation of coiled loops will be made but the size of the loops formed on the liquid surface will not be constant. Therefore, a means of regulating the width of the filament bundle functions effectively to form an intended uniform thickness coiled loop aggregation is necessary.

For the second filament loop aggregation fed onto one outside of the first filament loop aggregation, a guide roller is located just below the water surface on the other outside of the first filament loop aggregation to regulate the position of the first filament bundle sinking while describing loops and therefore the thickness width of the filament bundle in the position on the water surface just above the guide roller will be regulated as related with the regulation below the water surface.

Such first and second filament loop aggregations are processed in two parallel places and the above mentioned first aggregation is formed along one side surface of the above mentioned second aggregation.

In such formation, when the above mentioned second aggregation is heated on the side surface to be about the fusing temperature, the filaments on the side surface will soften to make a synthetic resin layer of a high density by the lateral fall of the loops.

Alternatively this synthetic resin layer may be a second filament loop aggregation formed in advance or a synthetic resin backing sheet or net-like sheet.

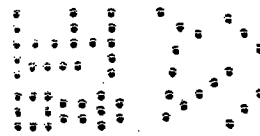
In molding synthetic resins, the general temperature as of the cooling bath is about 50°C. for PE (polyethylene) and PP (polypropylene), about 10 to 40°C. for PVC (polyvinyl chloride) and about 85°C. for PS (polystyrene).

The surface tension of water on PVC (polyvinyl chloride) is so high as to be about 60 to 70 dym./cm. that fine filaments of an outside diameter less than 1mm. will be overlapped in turn above the water surface, the coiled loops formed here will be laminated in several steps and will be cooled in water and therefore the object aggregations coarse in the loop clearances will not be obtained. Therefore, in order to sequentially sink the coiled loops by the filament bundle on the liquid surface, it is effective to add a surface active agent reducing the surface tension of the cooling bath.

Embodiments of the present invention shall be explained in the following:

Embodiments:

Fig. 1 is a side view showing component parts in an optimum apparatus for use in the present invention. Two sets of filaments 2a and 2b fall vertically toward cooling water 5 while being molded in the thickness direction from a die 1 extruding a thermoplastic synthetic resin material under



pressure.

In the lateral direction (front to back direction of the paper surface) of the die in this case, many filaments 2a and 2b are to be molded as arranged at predetermined intervals (pitch of 3 to 5 mm.) in the length zone corresponding to the lateral width of an intended molding.

A conveyer 4 present on the water surface is arranged in the falling zone of the filaments 2b and is driven at a conveying speed equal to the later described comparatively slow water sinking speed of the filament loop aggregation.

On the other hand, in the falling zone of the filaments 2a, bar-like ceramic far infrared ray heaters 3a and 3b are arranged together with reflecting plates 9 so as heat sources.

On the water surface adjacent to where the filaments 2a fall is arranged a guide roller 6 at a predetermined spacing from the delivery end of the above mentioned conveyer 4 so that the bundle of the filaments 2a may fall on the water surface in this clearance and may be led by this roller 6 to sink down.

A pair of feeding submerged rollers 7a and 7b rotated and driven at a constant speed are arranged in water to hold and contract the bundle of the filaments 2a having sunk in the above mentioned water and move it in the cooling water 5. Many engaging pins 8 are erected at intervals on the peripheral surfaces of these submerged rollers 7a and 7b. As the rotating peripheral speed of these rollers 7a and 7b

rotating at a constant speed is set to be lower than the falling speed of the filaments 2a, the filaments 2a falling at a high speed from the die 1 will be decelerated on sinking in water by the above mentioned submerged rollers 7a and 7b and, as a result, will be relaxed by the filament length corresponding to the difference between the falling speed and sinking speed. These relaxations will concentrate in the water surface zone due to the buoyancy of the filaments 2a of a small specific gravity. As a result, the filaments 2a will form loops on the water surface.

That is to say, the filaments 2a extruded out of the die will reach the water surface of the cooling water 5 while being kept near the temperature at the time of molding by heating by the above mentioned heaters 3a and 3b in the falling zone in air. The filaments 2a having sunk in the cooling water 5 will quickly lower in the temperature and will be hardened. However, these hardened filaments 2a will be regulated in the pulling amounts by the submerged rollers 7a and 7b stopped in sliding by the engaging pins 8, therefore the hardened parts in water will be subjected to resistances from the rollers 7a and 7b in water and thereby the soft filaments 2a still at a high temperature just before reaching the water surface will be curved and will be gradually pulled into water while describing loops to form coiled loops.

When the temperature within the bath of this cooling water 5 is kept at 60 to 80°C, the cooling water 5 in the

falling position will be locally boiled by heating by the filaments 2a reaching the water surface while at a high temperature. By this boiling, the water surface of that part will be waved and greatly rocked and therefore the filaments 2a describing loops on this water surface will be waved and disarranged in response to the rocking of the water surface.

Therefore, the total surface contact between the adjacent loops overlapped on the water surface will be obstructed by the concavo-convexes by this disarrangement of the disarranged form loops and the contact point parts will be comparatively many.

In such contact part, the loops will be fused with each other between them and will be cooled to be hardened. Therefore, coiled loops having comparatively many fused parts between the adjacent loops will be continuously formed in turn and a filament loop aggregation A in which coiled loops a_1 are cross-linked longitudinally and laterally with loop edges overlapping between adjacent filaments 2a will be formed.

On the other hand, the other corresponding filaments 2b will form, on the water surface 1 loops with a filament length corresponding to the difference between the extruding, molding and falling speed and the conveying speed of the conveyer 4 being equal to the sinking speed of the filament loop aggregation A regulated by the above mentioned submerged rollers 7a and 7b and will be transmitted toward the falling zone of the above mentioned filaments 2a while being

laminated in turn to be coiled on the conveyer 4. A filament loop aggregation B high in the filament density will be formed by being fused in the coiled loop overlapping parts by heating by the above mentioned heater 3b while the filaments 2b on this conveyer 4 are conveyed, will be well softened on the surface, will be conveyed to the delivery end of the conveyer 4 and will sink into the cooling water 5.

The sinking zone in water of this aggregation B is located on one side of the falling zone of the above mentioned filaments 2a. The filaments 2a falling between the aggregation B and the guide roller 6 on the opposite side will be regulated in the thickness width by the aggregation B and guide roller 6. Therefore, the size of the loops will be formed to be substantially constant and the softened surface of the above mentioned aggregation B and the loops on one side of the aggregation A will be fused together.

Thereby, there is formed a mat material wherein the second filament aggregation B of higher density is laminated to one side surface of the first filament aggregation A.

By the way, as another embodiment, the above mentioned high density second filament aggregation B need not always be formed simultaneously with the aggregation A. As shown in Fig. 2, an aggregation B formed in advance may be fed onto the conveyer 4. A backing sheet made of a synthetic resin film or net-like sheet made of synthetic resin may be fed instead of this aggregation B. In the embodiment shown in the above mentioned Fig. 2, the same mechanism parts as in

the embodiment shown in the above mentioned Fig. 1 bear respectively common reference numerals.

In these respective embodiments, the conveyer 4 has its conveying surface set to be substantially flush with the water surface but may be arranged to have its conveying surface somewhat inclined to be submerged at the delivery side tip.

By the way, in order to pull the coiled loops formed on the cooling water surface into water without disturbing their form, a surface active agent is added into cooling water 4.

Amounts of addition of the surface active agents per 100 parts of water:

Anion system: Alkylbenzenesulfonate 1 to 0.2 part

Dialkylsulfosuccinate 1 to 0.05 "

Nonionic system: Polyoxyethylene nonylphenol ether

1 to 0.1 "

It is effective to add 0.05 to 0.2% dialkylsulfosuccinate which is high in the capacity of reducing the surface tension and in the connecting effect with a slight amount.

Now, in this kind of apparatus, in order to keep the cooling bath level constant, cooling water is circulated with a pump while being overflowed. In such case, many bubbles will be generated in an auxiliary tank level detecting electrode and cooling bath and will be disadvantageous in molding. In this respect, at the above mentioned effective component concentration of the dialkylsulfosuccinate, many

bubbles tend to be generated. Therefore, it can be said to be optimum to add and use preferably 0.05 to 0.2% dialkylsulfosuccinate.

The mat material consisting of the thus formed filament loop aggregations A and B may be coated with a plastisol made of the same material mixture as of the filament to improve the bonding strength between the two sets of filament loop aggregations A and B and permanently set the two aggregations in place.

The apparatus therefor is shown in Fig. 3. An aggregation A pulled up from a bath 10 of the above mentioned cooling water 5 is fed into a primary dryer 12 by a feeding roller and is dried at a low temperature. In this drying, the aggregation A is still about 70°C due to the high temperature of the cooling water 5. Therefore, the water can be comparatively easily and positively removed by blowing warm air or the like.

The dried aggregation is fed into a surface coating process part 13. The above mentioned plastisol, is applied in the part 13 by such means as blowing, painting or dipping. It is then fused by high temperature drying in a secondary dryer 14 and is wound up on a winder 15. A backing sheet consisting of a resin sheet, foamed sheet, rubber sheet or net-sheet may be used for bonding to the back surface of this aggregation A in response to the object of use of the mat or sheet.

Formation Example 1

Polyvinyl chloride (PVC)(P-1300)	100 parts
Plasticizer DOP Dioctyl phthalate	50 "
Stabilizer Dibutyl tin laurate	2 "
" Cadmium stearate	0.6 part
" Barium stearate	0.4 "
Coloring agent	0.1 "

A compound material of the above mentioned mixture is molded as filaments by an extruding molder.

The distance between the conveyer 4 below the cooling water surface and the guide roller 6 is set to be 15 mm. The distance between the guide roller 6 and submerged roller 7a is 9 mm. The filament molding orifice diameter of the die 1 is 0.8 mm. The die orifice arrangement is of four longitudinal rows. The clearance between the filament 2b orifice and filament 2a orifice is 50 mm. The clearance between the filaments 2a and 4 mm. Their lateral orifice pitch is 5 mm. the distance between the die cooling water surface is 5 cm.

The die temperature is 185°C. The die pressure is 90 kg./cm². The extruding pressure is 190 Kg./cm². The cooling water temperature is 60 to 80°C. The guide panel temperature is 120°C. Two ceramic far infrared ray heaters of 2.5 KW each are used. At a molding linear speed of 2m. per minute, loops at a speed of 40 cm. per minute can be made.

In this formation, by only holding the filament bundle in its thickness width direction with the guide rollers, the front and back surfaces of the aggregations can be made uniform and a mat of a filament diameter of 1 mm., loop size of 5 to 10 mm. and thickness of 14 mm. is obtained and is made a product through drying and bonding steps.

Formation Example II

When, in the conditions of Formation Example I,
the filaments 2b are in two rows at a spacing of 4 mm.,
the filaments 2a are in two rows at a spacing of 4 mm.,
and

the distance between the filaments 2 and 2b is 45 mm,
a thickness mat of the above mentioned second
aggregation layer B part of a filament diameter of 1 mm.,
loop size of 5 to 10 mm. and thickness of 14 mm. is obtained.

Formation Example III

When, in the conditions of Formation Example I,
the filaments 2b are in two rows at a spacing of 4 mm.,
the filaments 2a are in two rows at a spacing of 4 mm.,
the distance between the filaments 2a and 2b is 45 mm.
and

the distance between the conveyer 4 and guide roller 6
is 17 mm.,

a thick mat of a filament diameter of 1 mm., loop size of 5 to 10 mm. and thickness of 16 mm. is obtained.

Effects of the Invention

In the method of the present invention, since there is formed an aggregation of irregular coil-like loops, the individual closed loops will develop resiliency. They are of such irregular form as a wavy form and therefore high in the degree of contact fusing between the adjacent continuous coiled loops and between the loop forming filaments arranged longitudinally and laterally. In the aggregation part in which such loops are formed in the upright direction, in addition to the resiliency of the above mentioned loops themselves, a stiff mat resiliency can be obtained by the strength of the bonded degree between these loops. The high density thermoplastic synthetic resin layer is high in strength, particularly, in the tensile strength. Therefore, according to the method of the present invention, there can be obtained a mat material high in both resiliency and tensile strength and as such is suitable as a porch mat or floor sheet.

In the method of the present invention, the filaments are lowered onto the water surface while near the molding temperature and, when this water surface is waved by boiling, the loops formed on the water surface will be able to be in such irregular forms as wavy forms and to be contact-fused in the loop intersecting parts and between the loops.

When the second filament loop aggregation is made a high density thermoplastic synthetic resin layer simultaneously in parallel with the formation of the above described first filament aggregation low in the filament density, the above mentioned long mat material can be continuously formed. However, alternatively, the above mentioned second aggregation or back sheet material formed in advance or a net-sheet may be used.

In addition, there are auxiliary effects that, when the filament bundle falling toward the cooling water surface is regulated in width the sizes of the respective loops formed of these filaments will be uniform and, when the width is so controlled, the combining of the above described upright directed loops and laterally fallen loops can be easily made.

If the distance from the die to the cooling water surface is long, the filament temperature will be reduced by air cooling between them. Therefore, it is desirable to set the distance to be as short as possible. However, if they are too close, the loop formation on the water surface will be disturbed. Therefore, this distance of 5 to 10 cm. is effective.

By keeping the temperature of the cooling water at a comparatively high temperature of 60 to 80°C., a local boiling state in which the water surface on which the filaments fall is properly waved by heating the filaments submerging into water can be automatically obtained. In order to smoothly sink the filaments to prevent the loop

1949

forms being disturbed, it is effective to add a surface active agent.

CLAIMS:

1. A method for producing a mat comprised of filament loop aggregations, comprising extruding a plurality of thermoplastic resin filaments into cooling water, heating said filaments before entering said cooling water to maintain their temperature close to that at extrusion, maintaining said cooling water at a temperature such that the heat of said filaments causes local boiling at the surface of the cooling water whereby said filaments are caused to form loops on entering the water, and causing said looped filaments to sink into said cooling water at a rate lower than that of extrusion; and conveying a thermoplastic synthetic resin layer into said cooling water, at a rate equal to that at which the filament loop aggregations sink into the cooling water, such that the thermoplastic synthetic resin layer contacts the filament loop aggregations and becomes fused thereto at the points of contact.

2. A method according to Claim 1 wherein said thermoplastic synthetic resin layer is a second filament loop aggregation, of higher filament density than that of the first filament loop aggregation, formed by extruding a second plurality of synthetic resin filaments in parallel with said first filaments while obstructing the sinking of said second filaments by a conveyor present on the cooling water surface.



3. A method according to Claim 1 wherein said thermoplastic synthetic resin layer is a preformed second filament loop aggregation of higher filament density than that of the first filament loop aggregation.

4. A method according to Claim 1 wherein said thermoplastic synthetic resin layer is a preformed synthetic resin backing sheet or net-like sheet.

5. A method according to any one of claims 1 to 4 wherein the width of said first filament loop aggregation is regulated by the thermoplastic synthetic resin layer led by said conveyer on its falling water surface and a guide roller present on the opposite side.

6. A method according to any one of claims 1 to 5 wherein the distance from the lower surface of the die to the water surface is 5 to 10 cm.

7. A method according to any one of claims 1 to 6 wherein the cooling water is held at a temperature of 60 to 80°C.

8. A method according to any one of claims 1 to 7 wherein 0.05 to 0.2% surface active agent dialkylsulfosuccinate is added into the cooling water.

9. A method according to Claim 1 substantially as described



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- 22 -

herein with reference to Fig. 1 or Fig. 2 of the accompanying drawings.

