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COVERING SYSTEM AND METHOD FOR MANUFACTURING THE SAME

Description

The invention relates to a cover layer system comprising or consisting of a single-layer or multi-layer cover membrane based on plastics material, such as a roofing membrane, a non-woven layer connected thereto, and a bituminous adhesive layer connected thereto.

In order to protect building surfaces in particular against the effects of weather, corresponding cover layer systems are used, by means of which the building surfaces are sealed. In this case, cover membranes forming roofing membranes can either be provided directly with an adhesive layer, or a layer system is used, which comprises a non-woven fabric and an adhesive layer, the non-woven fabric usually being connected to the roofing membrane by an adhesion-promoting layer.

If the roofing membranes are provided directly with an adhesive layer, butyl-based adhesive materials, acrylate adhesives, or bituminous substances are used.

When a non-woven fabric is used, hot melt pressure sensitive adhesives (HMPSA) are used, which can be rubber-based materials or crosslinked acrylates or UV acrylates.

A sealing layer system is found in EP 1 741 551 B1. The non-woven layer is preferably connected to the cover membrane by an adhesion-promoting layer. The non-woven layer itself consists of an impregnated fibrous material layer which is impregnated with a fluorocarbon resin as a migration-inhibiting agent.

DE 10 2005 039 543 A1 describes a three-layer structure for a roof sealing system which comprises a glass-fiber mat.

DE 10 2016 107 418 A1 relates to a cover laminate comprising at least one barrier layer which prevents migration of oils out of a bituminous hot melt adhesive into the cover layer and of plasticizers out of the cover layer.

DE 295 03 133 U1 discloses a sealing membrane having a three-layer structure which comprises a carrier that is impregnated with bitumen or polymer bitumen and is provided on either side with a cover layer consisting of bitumen or polymer bitumen. In this case, the layer facing a surface is self-adhesive.

An under-roofing material according to US 4,342,804 A comprises a non-woven fabric consisting of polypropylene which is coated with bitumen on one side.

DE 10 2016 107 418 A1 discloses a generic cover laminate or layer system.

DE 295 01 245 U1 discloses a membrane-like insulating material that comprises glass-fiber reinforcement in the form of a glass-fiber mat.

A roof-covering membrane comprising a carrier made of a glass-fiber mat is known from DE 10 2005 039 543 A1.

A roofing membrane according to EP 1 741 551 A1 comprises a migration-inhibiting barrier layer.

WO 2018/210667 A1 discloses a multi-layer sealing membrane comprising a combination carrier insert, which has glass-fiber reinforcement.

The problem addressed by the present invention is to develop a cover layer system and a method for producing the same such that the cover layer system ensures thatdiscoloration or brittleness owing to incompatibilities by migration of bitumen into the cover membrane, such as the roofing membrane, is avoided. Uneven surfaces are also intended to be able to be covered without any difficulty.

The cover membrane is intended to be prevented from detaching from the non-woven layer using simple measures.

To solve the problem, it is substantially proposed that the cover layer system does not comprise a separate barrier film, and that the non-woven layer is or contains at least one non-woven layer from the group including a mechanically bonded non-woven layer based on synthetic fibers or a combination of a mechanically bonded non-woven layer based on synthetic fibers and a glass-fiber non-woven layer or a non-woven layer made up of synthetic fibers and glass fibers, wherein the non-woven layer is connected to the cover membrane by penetration of material of the cover membrane. For this purpose, it is in particular provided that the cover membrane has lower temperature stability or a lower melting point than the non-woven layer.

It has surprisingly been found that, in a corresponding layered structure, migration of a bitumen-containing adhesive layer into the cover layer and of plasticizers out of the cover layer into the adhesive layer is prevented or substantially prevented without requiring a separate barrier layer, as in accordance with DE 10 2016 107 418 A1.

In order to obtain high mechanical resistance, it is in particular provided that the cover layer is multi-layered, but at least three-layered, with one of the layers being a reinforcement layer.

With regard to laying on roof surfaces, self-adhesive membranes are usually laid so as to be exposed, i.e. there is no ballast layer or greenery that covers the cover layer itself. Accordingly, cases of damage from the past, e.g. from 2012, have demonstrated that homogeneous cover layers are susceptible to what is known as “shattering” behavior. In that application, shattering means the glass-like splintering of plastics roofing membranes. In this case, a reinforced layer provides greater reliability in preventing this behavior.

Furthermore, it should be emphasized that the bituminous adhesive layer has a proportion of bitumen of between 60 wt.% and 80 wt.%.

Furthermore, the adhesive layer can contain 5 wt.% to 30 wt.% of branched and/or unbranched copolymers based on styrene and butadiene and/or isoprene. Optionally, it can contain a hydrocarbon resin, but at most up to 15 wt.%. The proportion of hydrocarbon resin can therefore be 0 wt.% or up to a maximum of 15 wt.%.

Mechanically bonded non-woven fabrics can be produced either by needling (known as needle-punched non-woven fabrics), by hydroentanglement (known as hydroentangled non-woven fabrics), and/or by calendering.

In the following, the most common type of mechanically bonded non-woven fabric is meant by “needle-punched non-woven fabric”, but this does not exclude calendered and/or hydroentangled non-woven fabrics, and the properties and advantages set out are also transferable thereto. In this respect, the calendered non-woven fabric, the hydroentangled non-woven fabric, and the needle-punched non-woven fabric are subsumed under the term “mechanically bonded non-woven fabric”.

In particular, the mechanically bonded non-woven layer can also be based on polyethylene (PE), polypropylene (PP), polyacrylonitrile (PAN), viscose, polyamide (PA), copolymers, bicomponents, and types of plastics material that are routine for a person skilled in the art and are possible for use as a non-woven fabric. Combinations of different plastics materials are also possible, e.g. bicomponents made up of polyester (PES) and polypropylene (PP), or fiber mixtures.

Of particular note is a mixture of polyester (PES) and polypropylene (PP). In addition to these plastics fibers, the non-woven layer can also contain glass fibers.

In embodiments, non-woven fabrics can be produced using the dry-laid method, i.e. by air-laying or carding, or spunbonding, i.e. by extrusion from granulates, preferably, which can be finished in further steps by means of mechanical bonding.

A needle-punched non-woven fabric is generally formed by means of mechanical web formation, known as carding. Here, staple fibers are laid out across a width to form a non-woven fabric in machines having rotating cylinders. Directional orientation can be achieved, and an increased thickness or grammage is also possible by applying a plurality of layers (multiple plies). The needling is carried out in a further step. Here, the non-woven fabric is bonded and compacted by being repeatedly pricked by barbed needles. This can achieve the most uniform and structured possible hooking and entanglement of the fibers in a three-dimensional manner without binder (free of binder). During the needling, virtually smooth and line-free surfaces can be produced, as well as structured and patterned surfaces.

In another configuration, non-woven fabrics can also be produced and finished by means of chemical bonding, i.e. by adding binders, and/or by thermal bonding, i.e. by heated rollers or by a hot air flow. In this way, different non-woven fabrics or types of non-woven fabric can be connected to a needle-punched non-woven fabric.

In another configuration, mechanically bonded non-woven fabrics, in particular needle-punched non-woven fabrics, can also be combined with said methods, i.e. chemical and thermal bonding, in order to produce increased strength in the non-woven (fabric) or smoother surfaces or other surface finishes.

Preferably, the material basis of the mechanically bonded non-woven fabric is polyester, due to the following advantages:

- Lowest density of all fibers, at 0.91 g/ccm
- Low thermal conductivity
- High resistance to acids and alkalis
- High abrasion resistance
- Low tendency to soiling
- Low electrostatic charging
- Low moisture absorption
- High resistance to microorganisms

The non-woven layer has the advantage that it fulfills the function of a buffer layer or barrier layer against the bituminous material, meaning that discoloration and brittleness in the cover membrane can be prevented even after many years of service of the cover layer system.

Furthermore, the non-woven layer, when inserted between the adhesive layer and the cover layer, forms a kind of damping layer, which has a positive effect on the resistance behavior in relation to hailstorms or perforation of the cover layer. A punctiform load results in the cover layer being accordingly deformed, and the greatest load arises in the underside of the cover layer. In the event of a hailstorm, exactly this kind of punctiform load occurs. If this punctiform load is greater than the maximum (tensile) strength or maximum elongation of the material used for the cover layer, then cracks develop. These cracks preferably arise on the underside of the cover layer and accordingly cannot be identified by a person or observer standing outside, who can only see and assess the surface of the cover membrane. Accordingly, hailstorm damage caused in this way can only be identified after a few days, weeks, or months, i.e. only when a crack migrates into the upper face of the cover layer due to thermal contraction and alternating elongation on the surface of the cover layer. In this case, an inserted non-woven layer can act as a kind of damping layer by absorbing the majority of the energy of the falling object, e.g. a hailstone, as thermal and deformation energy and reducing the resulting remaining force on the cover layer which results in the deformation of the cover layer. Accordingly, the resistance to hailstorms and perforation is increased or improved.

The non-woven layer also makes it possible for uneven surfaces to be equalized together with the bituminous adhesive layer, i.e. it has the function of a leveling layer, such that the adhesive layer can have a lower weight per unit area. Therefore, it is in particular provided that the bituminous adhesive layer has a grammage G_B of 100 g/m² ≤ G_B ≤ 1000 g/m², in particular 500 g/m² ≤ G_B 750 g/m². The weight per unit area is preferably 600 g/m^2 to 700 g/m^2, in particular between 630 g/m^2 and 670 g/m^2.

The non-woven fabric, in particular the needle-punched non-woven layer, also allows for an adhesive surface for the applied bituminous adhesive. Depending on the pre-treatment, the surface of the non-woven fabric can be more open-pored or more closed. The more open-pored the non-woven fabric, the deeper the adhesive material will penetrate into the non-woven fabric. The deeper the adhesive penetrates, the more adhesive material is required to keep the adhesive properties constant. A smooth, relatively closed surface of the non-woven fabric is preferred to circumvent deep penetration of the adhesive.

Preferably, no more than 300 g/m² adhesive should penetrate the non-woven fabric from an adhesive application weight of 500 g/m². If the effectively available, i.e. the adhesive layer, that is outside the non-woven layer is less than 100 g/m², this is not sufficient for a secure connection to the substrate (roof surface).

In particular, the thickness D_B of the adhesive layer should be between 0.10 mm and 1.00 mm, in particular between 0.50 mm and 0.75 mm.

By using the bituminous adhesive, temperatures in the range between 80°C and 90°C, or in extreme cases even up to 110°C, can act on the cover layer system without problems and without this effect diminishing. The bituminous adhesive material can be reactivated where necessary by the surface being thermally pre-treated.

One advantage of the bituminous adhesive layer is also that, as the material ages, it stiffens or hardens, which increases the strength or cohesion of the adhesive, and as a result the coefficients of adhesion between the surface and the other layers of the cover layer system rise, the layers do not move around, and the connection to the surface is robust, such that reference can be made to protection against wind uplift. Furthermore, the adhesive stiffening also means that the thermal endurance is improved, i.e. that the adhesive will be less likely to slip out of place, even when attached or applied vertically.

In addition, as the temperature of the cover layer system and thus the adhesive rises, the flowability also increases, such that the wetting of the adhesive on the surface or substrate is improved. This essentially means that the adhesive closes or fills any cavities that may be present and evens out or equalizes uneven surfaces or substrates, in order to thus increase the adhesive force to the surface.

Since additional adhesives are not required to connect the non-woven layer and the cover membrane, it can be recycled without difficulty, with it being possible to separate the non-woven layer together with the bituminous adhesive layer from the cover membrane. Therefore, hazardous waste disposal is not required. The bituminous material can thus be used for other bitumen purposes, for example for bitumen membranes.

In a further embodiment, said non-woven fabric can be a laminated non-woven fabric. This means that the non-woven fabric consists of a plurality of layers. By means of preset tensile or peeling force, the failure or peeling of the layers can occur; this means that peeling force resistance or interlaminar adhesion or internal strength of the individual layers has to be overcome so that the layers can be separated. In this structure, various types of bonding (mechanical, chemical, or thermal bonding) can be combined. This method is already known for wallpapers and makes it possible to remove it from a surface when dry in a simple manner. When applied in the sense of a cover system, in the case of renovating or restoring an adhered roof structure, there would be the option of separating the cover membrane including the non-woven fabric, at least the main volume or main thickness thereof, from the adhesive and making it possible to separate the constituents into different sorts or different sorts of material.

Furthermore, in said embodiment, by means of the laminated non-woven fabric, once the cover membrane including the main components of the non-woven fabric or the main thickness of the non-woven fabric has been detached, it would be possible for the remaining non-woven fabric and adhesive or adhesive material affixed to the substrate (surface) to stay there, such that there is a clean, ready-for-laying surface for being relaid. The separated remaining non-woven fabric together with the adhering adhesive affixed to the substrate will stay on the substrate. For a reapplication of adhesive or re-laying, a primer could optionally be applied in order to increase the adhesion, but this is not necessarily required. Depending on its composition, the remaining non-woven fabric would already be able to be used as a separation layer for a subsequent structure.

When using a laminated non-woven fabric, different non-woven materials can also be combined, i.e. primarily synthetic and glass-fiber non-woven fabrics.

In particular, the bituminous adhesive layer consists of or contains:

- bitumen, in particular 500/650 (in accordance with DIN EN 12591), i.e. paving grade bitumen,
- branched and/or unbranched copolymers or block copolymers or thermoplastic elastomers based on styrene and butadiene and/or isoprene, such as styrene butadiene copolymer (SBR), styrene butadiene styrene (SBS), or styrene ethylene butylene styrene (SEBS), styrene isoprene styrene (SIS),
- optionally hydrocarbon resin and/or flux oil.

The proportion of bitumen can be between 60 wt.% and 80 wt.% and/or the proportion of branched and/or unbranched copolymers or block copolymers or thermoplastic elastomers based on styrene and butadiene and/or isoprene is between 5 wt.% and 30 wt.% and/or the proportion of hydrocarbon resin and/or flux oil is between 0 wt.% and 15 wt.%. The proportion of hydrocarbon resin and/or flux oil can also be 0 wt.%.

In further embodiments, the bituminous adhesive material can also consist of or contain (in part) B200 bitumen (previously also called 220/160) and flux oils. Mixtures of above-mentioned components are also possible.

A preferred embodiment of the adhesive layer can also be characterized as follows:

- needle penetration, determined in accordance with DIN EN 1426, achieves values in the range between 60 and 90, with the unit being selected as 1/10 mm,
- softening point, determined in accordance with DIN EN 1427, is in the range between 105°C and 120°C,
- the peel strengths with the substrate, determined in accordance with DIN EN 12316-2, should generally be in the range of ≥ 25 N/5cm (or sometimes indicated as ≥ 5 N/cm).

Owing to the direct connection between the non-woven layer and the cover membrane or roofing membrane, an adhesion-promoting layer is not required, meaning that the cover layer system is more cost-effective than cover layer systems using an adhesion-promoting layer. Irrespective of this, a robust connection is provided, since the cover membrane clings to the non-woven layer by the cover membrane softening and cover membrane material thus being able to penetrate the non-woven layer. A purely mechanical connection or cling is provided between the cover membrane and the non-woven layer.

Therefore, the invention is also characterized in that the cover layer has a lower melting point than the non-woven layer, such that the cover membrane can soften under the effect of heat in order to be connected to the non-woven layer without impairing the stability of the non-woven layer.

In particular, it is provided that the non-woven layer, in particular the mechanically bonded non-woven layer, such as the needle-punched non-woven layer, has a grammage G of $50\ g/m^2 \leq G \leq 300\ g/m^2$, in particular $150\ g/m^2 \leq G \leq 220\ g/m^2$.

It is also in particular provided that the thickness D_V of the non-woven layer, in particular that of the needle-punched non-woven layer, at grammages G of 150

$g/m^2 \leq G \leq 250\ g/m^2$, in particular $150\ g/m^2 \leq G \leq 220\ g/m^2$, is between 1.4 mm and 2.1 mm, in particular between 1.6 mm and 1.9 mm.

These values apply to the non-woven layer in the form of gray cloth. If the non-woven layer is laminated with the adhesive, depending on the pressure resistance of the non-woven layer, the thickness is lower.

The non-woven layer, in particular the needle-punched non-woven layer, is furthermore in particular characterized in that the non-woven layer has a tensile strength [N/50 mm] in the longitudinal direction of greater than 300 and/or in the transverse direction of greater than 350 and/or an elongation ε in the longitudinal direction where $\varepsilon > 45\%$ and/or in the transverse direction where $\varepsilon > 45\%$. The values have been determined in accordance with the EN 29073-3 standard.

In particular, the mechanically bonded non-woven layer also consists of or contains PET (polyethylene terephthalate).

In one embodiment, it is in particular provided that the proportion of PET is greater than 98 wt.%. Furthermore, titanium dioxide (TiO_2) can be contained in a proportion of less than 0.5 wt.% and antimony trioxide (Sb_2O_3) can be contained in a proportion of less than 0.03 wt.%.

In addition, the mechanically bonded non-woven layer can also consist of other known polyester types, polyamides, or glass.

As a rule, the mechanically bonded non-woven layer does not require any special coating or pre-treatment, i.e. no fluorination, plastisol coating, or acrylate coating. Preferably, a resin, usually furan resin, is used as a binder or bonding agent for the individual non-woven fibers and their hydrophobization.

Furthermore, the mechanically bonded non-woven layer can be characterized by the following parameters:

- a melting point of between 250°C and/or 260°C, in particular between 253°C and/or 260°C and/or
- a softening temperature of between 230°C and/or 240°C and/or
- a flash point of between 390°C and/or 410°C and/or

- an ignition point of approx. 530°C and/or
- a density of between 1.36 g/cm³ and/or 1.4 g/cm³ and/or
- insolubility in water and/or
- a glass transition temperature of between 80°C and/or 100°C and/or
- temporary temperature stability of between 200°C and/or 230°C and/or
- continuous temperature resistance up to 90°C.

The cover membrane or roofing membrane consists of or contains at least one material from the group of PVC (polyvinyl chloride), TPE (thermoplastic elastomer), TPO (thermoplastic olefin-based elastomer) or FPO (flexible polyolefin), TPV (thermoplastic vulcanisate), EPDM (ethylene propylene diene rubber), EVA (ethylene vinyl acetate), fluoropolymers, or other standard materials as specified in DIN SPEC 20000-201:2015-08, for example.

Furthermore, it can contain a plasticizer, which can be a polymer or low-molecular-weight plasticizer. It can also contain other additives known from roofing membranes.

In particular, however, it is provided that the cover membrane is colored, in particular anthracite, titanium gray, or black, i.e. in dark hues on the color scale.

It has surprisingly been found that the cover layer system according to the invention can be a dark-colored cover membrane, meaning that the layer system is heated up without the oils, in particular, migrating out of the bituminous adhesive layer. The barrier effect is obtained by the non-woven layer without requiring a separate barrier film.

The cover membrane can be constructed to be multi-layered and can in particular comprise a reinforcement or insert, and combinations thereof. In this case, it is in particular provided that the reinforcement contains a material at least from the group of woven fabric, laid webs, non-woven fabric, meshes, knitted fabric, or any combination thereof.

The reinforcement and/or insert are also referred to as the reinforcement layer.

The reinforcement layer is in particular a reinforcement or insert from the group of woven fabric, laid webs, non-woven fabric, meshes, knitted fabric, or any combination thereof. In this case, the reinforcement layer should be impregnated with a binder, in particular a binder from the group of styrene butadiene, acrylate, PVC, EVA, or any combination thereof. Here, a binder may be obligatory, depending on the reinforcement type. This applies to laid webs, for example. For woven fabric, a binder, e.g. PVC plastisol, can be additionally used.

The reinforcement and/or insert consists of or contains glass fibers and/or synthetic fibers. In this case, the synthetic fibers can be those that are also used for the non-woven layer. In particular, it is provided that the synthetic fibers are bicomponents based on polyester and polypropylene.

The reinforcement insert is intended to have a grammage of between 25 g/m^2 and 75 g/m^2, preferably between 45 g/m^2 and 55 g/m^2.

Textile fabrics or textile spatial formations are usually called knitted fabrics, in which a loop formed by means of yarns is looped into another loop. The stitches produced in this way can be formed using one yarn or a plurality of yarns.

Therefore, knitted fabrics differ from woven fabrics, in which the fabric is produced by interlacing two yarn systems, and from non-woven fabrics, in which a loose fibrous web is bonded, for example by means of heat. In comparison with woven fabrics, knitted fabrics are characterized by higher extensibility, elasticity, and therefore low creasing.

Under knitted fabrics, a distinction is made between weft knitted fabrics and warp knitted fabrics. In this case, knitted fabrics are produced using a single yarn technique (weft knitted fabrics) or in a warp thread technique (multiple-yarn fabrics in the form of warp knitted fabrics).

The reinforcement layer consists of or contains knitted fabrics, and this in turn can contain a combination of warp knitted fabrics and weft knitted fabrics.

The reinforcement layer preferably contains fibers that consist of glass, mineral, polyester, polyamide, polyethylene, or polypropylene fibers, or mixtures thereof.

Those materials based on glass and/or synthetic fibers are possible as materials for the fibers.

A method for producing a cover layer system, in particular of the above-described type, is characterized by the method steps of

- providing a roll of material of a first layer of the cover membrane,
- providing a roll of material of the non-woven layer,
- unrolling the cover membrane material and the non-woven layer material from the rolls,
- guiding both the unrolled cover membrane material and the non-woven layer material through a first gap delimited by two rotating rollers while simultaneously extruding material of a further layer of the cover membrane between the materials of the first layer and the non-woven layer entering the first gap.

In this case, it is in particular provided that, before feeding the first layer of the cover membrane material to the gap, a reinforcement material forming a reinforcement layer is unrolled from a roll and is guided through a second gap delimited by two second rollers while simultaneously extruding the material of the first layer onto the reinforcement material to be drawn through the second gap, wherein, in particular, the extruding is carried out in the direction of the second gap. The unit thus formed by the first layer and the reinforcement layer is then fed to the first gap. Reference is also made to producing a first passage.

Preferably, the invention provides that, after connecting the non-woven layer material to the cover membrane material, the adhesive layer is applied to the non-woven material in particular in a planar manner. The bituminous adhesive can also be applied in a strip-shaped manner. In this respect, irrespective of the production method, the term “adhesive layer” can be understood such that a layer applied in a planar manner or an adhesive applied in a strip-shaped manner can be subsumed under an adhesive layer.

Furthermore, the adhesive can not only be applied over the entire surface or in strips, but also in other structures or forms, such as diamonds, rectangles, offset strips, etc.

Furthermore, the adhesive can also be applied in a punctiform manner.

If the adhesive is evenly applied in other forms or structures across the width of the cover system or non-woven fabric, other application systems, such as roller transfer, and other adhesive application methods that are routine for a person skilled in the art can be used.

If the application is strip-shaped or punctiform, in addition to the air escaping when applying the roofing membrane and providing air-bubble-free application, costs are also reduced due to lower quantities of adhesive being used.

Furthermore, a protective film is intended to be applied to the free surface of the adhesive layer and has siliconization which is coordinated with the adhesive material in order to allow for residue-free removal. This means that the siliconization system is securely anchored to the protective film and is continuously crosslinked such that it is not possible for silicone to be transferred to the adhesive material.

In general, the protective film can be a multi-layer film. In particular, just single-layer polymer films, combinations of polymer layers, as well as thin metal layer films are used here. As an example, this can be a polyolefin protective film, e.g. based on polypropylene (PP), polyethylene (PE), or other polyolefins.

The outer side of the protective film or liner and/or the siliconization applied thereto, or the side thereof facing the adhesive is important here, the siliconization being coordinated with the adhesive. In addition, the liner or protective film can also be foamed (in part). The protective film can be provided to be smooth as well as creped. In this case, the creped variant is preferred in order to prevent any air pockets when applying the layer system. The creped or undulating shape of the protective film is transferred to the adhesive layer here. In this case, “creped” means an undulating shape in cross section in a plane extending perpendicularly to the cover layer system, such that raised portions and indentations result. Therefore, when applying the cover layer system to an underlying surface, air can escape laterally through the channels that are thus formed. Adhesion to the surface first takes place at the raised portions. By applying heat, the adhesive material becomes flowable and adhesion over the entire surface is ensured.

In further embodiments, the protective film or liner can also be siliconized on both sides. Here, attention needs to be paid to the compatibility of the siliconization with the surface of the cover membrane, since, in the rolling process, this means that, because the materials can be packed as rolled materials, the cover membrane is in direct contact with the protective film or liner. In this case, any possible silicone transfer should be prevented as far as possible, in order to avoid any potential later consequences for the application of the roofing membrane, such as difficulties with welding.

In further embodiments, the protective film or liner can also be a smooth film, which, according to the manufacturer, meets the requirements of a barrier film against the migration of volatile constituents of the adhesive. This provides the advantage that, when it is stored as rolled material, even over time there is no transfer of the volatile constituents to the surface of the cover layer resting against the protective film. Otherwise, there would be a negative impact on the aging and/or service life of the roofing membrane and its associated function as a sealing layer.

The thickness distribution of the cover layer system is composed of the thickness of the cover membrane, i.e. the effective thickness, the non-woven layer thickness, i.e. the thickness minimized or compressed by the production process, the adhesive thickness, and the protective film or liner thickness.

The total thickness of the cover layer system including the protective film or liner is between 2.6 mm and 4.2 mm.

The effective thickness of the cover membrane is preferably in the range of between 1.2 mm and 2.5 mm.

In a preferred form of the cover system, the cover membrane forms an effective thickness of 1.2 to 1.8 mm, the cover layer system including the protective film or liner forms a total thickness of 2.7 mm to 3.2 mm, and the weight per unit area should be between 2.5 kg/m² and 2.9 kg/m².

The thicknesses, total thicknesses, effective thicknesses, and weights per unit area are determined and evaluated in accordance with DIN EN 1849-2.

If a glass-fiber mat is used as the insert, the grammage should be between 10 g/m^2 and 500 g/m^2, in particular between 25 g/m^2 and 500 g/m^2, particularly preferably between 25 g/m^2 and 75 g/m^2.

If a polyester non-woven fabric is used as the rear-face non-woven layer or non-woven lamination, the grammage should be between 10 g/m^2 and 500 g/m^2, in particular between 25 g/m^2 and 500 g/m^2, particularly preferably between 180 g/m^2 and 220 g/m^2.

Further details, advantages and features are not only found in the claims in which these features can be found, in isolation and/or in combination, but also in the following description of preferred exemplary embodiments that can be found in the drawings, in which:

Fig. 1 is a schematic view of a detail of a cover layer system,

Fig. 2 shows a sub-method step for producing a multi-layer cover system according to the first embodiment,

Fig. 3 shows a second method step for producing the cover layer system according to a first embodiment,

Fig. 4 shows a first production step for producing a cover layer system according to a second embodiment,

Fig. 5 shows a second method step for producing the cover layer system according to the second embodiment,

Fig. 6 shows a third method step for producing the cover layer system according to the second embodiment,

Fig. 7, 8 show a third embodiment of a production method, and

Fig. 9 shows a fourth embodiment of a production method.

Fig. 1 is a schematic view of a detail of a cover layer system 10, which consists of a cover membrane 12, referred to as a roofing membrane in the following, a non-woven layer 14, and an adhesive layer 16, which can in turn be covered by a protective film 17. The roofing membrane 12 itself is preferably multi-layered, and specifically, in the exemplary embodiment, consists of an outer first layer 18, a reinforcement layer 20 as the inner layer, and a second layer 22, which extends on the non-woven side so as to cover said reinforcement layer and is mechanically connected to the non-woven layer 14.

The layers 18, 22 consist of plastics material.

The non-woven layer 14 is such a mechanically bonded non-woven layer from the group of synthetic fibers, a glass-fiber mat layer, or combinations thereof. In this case, the non-woven layer can be single-layered or multi-layered, and in particular can also be formed as a laminated non-woven fabric. In the following, a needle-punched non-woven fabric is taken as a starting point, without this limiting the invention. “Needle-punched non-woven fabric” means a mechanically bonded non-woven layer which also includes a calendered or hydroentangled non-woven layer.

For the materials set out in the following, it should be noted that these are to be understood to be preferred, but not limiting.

The roofing membrane 12, in this case the layers 18, 22, is based on or contains at least one material from the group of PVC (polyvinyl chloride), TPE (thermoplastic elastomer), TPO (thermoplastic olefin-based elastomer) or FPO (flexible polyolefin), TPV (thermoplastic vulcanisate), EPDM (ethylene propylene diene rubber), EVA (ethylene vinyl acetate), fluoropolymers, or other standard materials as specified in DIN SPEC 20000-201:2015-08, for example.

PVC, in particular flexible PVC, should be mentioned as a preferred material for the layers 18, 22.

The insert, i.e. the reinforcement layer 20, can be a glass-fiber mat, which is connected to the adjacent layers 18, 22 without an additional adhesion-promoting layer by material in the layers 18, 22 penetrating the non-woven layer 20 and material thus clinging to the glass-fiber mat layer 20. This therefore produces a purely mechanical connection.

Furthermore, the roofing membrane 12, in this case the layers 18, 22, can contain a plasticizer, which can be a polymer plasticizer and/or a low-molecular-weight plasticizer.

If the base material of the roofing membrane 12 or its layers 18, 22 is flexible PVC (PVC-P), a plasticizer is required. In other plastics materials listed above, plasticizers are preferred, but not required.

The compositions of the roofing or sealing membrane 12, 18, 22 can also contain further additives such as fillers, pigments, dyes, UV stabilizers, thermostabilizers, fungicides, biocides, processing aids, impact modifiers, acrylates, and additional plasticizers. These additional plasticizers can preferably be low-molecular-weight, monomer plasticizers, such as phthalic acid esters (phthalates). The standard plasticizers known from the prior art that are compatible with PVC can also be used as plasticizers. Typical plasticizers are, for example, derivatives of sylvic acid or acetic acid derivatives, such as cumyl phenyl acetate, derivatives of adipic acid, such as benzyl octyl adipate, dibutyl adipate, diisobutyl adipate, di-(2-ethylhexyl) adipate, diisononyl adipate, derivatives of azelaic acid, benzoic acid derivatives, polyphenyl derivatives, citric acid derivatives, epoxidized fatty derivatives, and glycol derivatives. In addition, biobased plasticizers can also be used, i.e. plasticizers that contain renewable raw materials (at least in part), such as that described in EP 3 156 447 A1, for example.

Furthermore, so-called polymer plasticizers or polyester-based plasticizers and/or thermoplastic polyurethanes (TPU) can also be used. The plasticizers are preferably based on adipic or sebacic acid. In this case, an average molecular weight of 3,000 to 12,000 is particularly preferred.

If plasticizers are contained, the composition preferably contains less than 45 wt.% of plasticizers, particularly preferably less than 37 wt.% and a minimum of 15 wt.%, in particular 30 wt.% to 36 wt.%.

The plasticizer component can not only consist of one of the above-mentioned components, but also of mixtures of the above-mentioned components.

According to one embodiment, the plasticizer can only consist of so-called polymer plasticizers or polyester-based plasticizers and/or thermoplastic polyurethanes (TPU). These are preferably based on adipic or sebacic acid. In this case, an average molecular weight of 3,000 to 12,000 is particularly preferred. The advantage of only using these is their compatibility with bitumen or bitumen constituents. Cover membranes which do not have monomer constituents as plasticizing components are generally less sensitive to being in contact with bituminous materials. This stops and/or slows down the interaction and the associated change in property, which, in the worst case, ultimately causes the roofing membrane to harden or become brittle.

In order to increase the thermal stability of the membranes, Ca/Zn stabilizers can preferably be contained in addition to the thermal stabilizers, such as Ba/Zn stabilizers, known from the prior art. Aside from this, UV stabilizers can additionally be contained, such as oxalanilides, amides, titanium dioxide, carbon black, in particular Tinuvin® and/or Chimasorb® and/or in particular NOR-HALS stabilizers. Usually, the stabilizers are each contained in quantities 0.01 wt.% to 10 wt.%, preferably 0.1 wt.% to 5 wt.%. Usually, the total quantity of stabilizers does not exceed 20 wt.% of the mixture.

In relation to the stabilizers, reference is also preferably made to one-pack stabilizers. In this case, components already mentioned above are combined to ensure better incorporation as well as dispersion and distribution in the mixture. For example, in addition to the main component Ca/Zn, Ca/Zn one-pack stabilizers can also contain hydrotalcite or zeolites (with hydrotalcite being preferred over zeolites owing to its lower water absorption), lubricants, antioxidants, and/or flow aids.

Tinuvin®, preferably Tinuvin XT 833, not only acts as a UV stabilizer, but also as an acid scavenger, meaning that hydrolysis is improved. The stabilizer Tinuvin XT 833 additionally scavenges the hydrochloric acid and improves the aging behavior as well as the hydrolytic stability.

According to the safety data sheet, Tinuvin XT 833 is listed as a product having a proportion of 40 wt.% to 60 wt.% having CAS No.: 25973-55-1, meaning that the chemical name is stored as follows: 2-(2H-benzotriazol-2-yl)-4,6-di-tert-pentylphenol. Accordingly, substances which correspond to the composition of Tinuvin XT 833 but have different product names can also be used.

As fillers, the membranes can contain the standard fillers known from the prior art, such as chalk, talc, silicic acid, or kaolin as fillers. The quantity of fillers is 0 wt.% to 15 wt.%, preferably 1 wt.% to 10 wt.%.

Chalk is preferably used in the form of coated chalk. Kaolin improves both the abrasion resistance and the media resistance.

Kaolin also has an acidic character, which can be described by the pH, for example: in this case, the pH is between 4.5 and 6.5 on average. By comparison, acetic acid has a pH of 4.75. Accordingly, in one application, the use of chalk, particularly coated chalk, is preferred in order to keep the acidic proportion in the recipe low. In addition, neutral kaolin types can also be used, i.e. types which have a pH of 6 to 8.

In general, it is applicable to all the fillers that the proportion of iron (oxide) needs to be kept as low as possible owing to catalytic aging.

Aside from this, further standard ingredients can be contained, such as lubricants, processing aids, gelling aids, UV converters, UV stabilizers, or biocides, such as thiazoline derivatives, tributyltin, or chloroisothiazoline, and isothiazoline derivatives are particularly preferred.

Flame retardants, stabilizers, pigments, co-stabilizers, UV stabilizers, thermostabilizers, or other additives suitable for roofing membranes or other additives used for roofing membranes can be used.

In particular, the weight proportion in each layer 18, 22 in percent is: PVC at least 40%, plasticizer max. 45%, additives max. 20%.

The reinforcement layer 20 is in particular a reinforcement or insert from the group of woven fabric, laid webs, non-woven fabric, meshes, knitted fabric, or any combination thereof. In this case, the reinforcement layer 20 should be impregnated with a binder, in particular a binder from the group of styrene butadiene, acrylate, PVC, EVA, or any combination thereof. Here, a binder may be obligatory, depending on the reinforcement type. This applies to laid webs, for example. For woven fabric, a binder, e.g. PVC plastisol, can be additionally used.

Textile fabrics or textile spatial formations are usually called knitted fabrics, in which a loop formed by means of yarns is looped into another loop. The stitches produced in this way can be formed using one yarn or a plurality of yarns.

Therefore, knitted fabrics differ from woven fabrics, in which the fabric is produced by interlacing two yarn systems, and from non-woven fabrics, in which a loose fibrous web is bonded, for example by means of heat. In comparison with woven fabrics, knitted fabrics are characterized by higher extensibility, elasticity, and therefore low creasing.

Under knitted fabrics, a distinction is made between weft knitted fabrics and warp knitted fabrics. In this case, knitted fabrics are produced using a single yarn technique (weft knitted fabrics) or in a warp thread technique (multiple-yarn fabrics in the form of warp knitted fabrics).

The reinforcement layer 20 consists of or contains knitted fabrics, and this in turn can contain a combination of warp knitted fabrics and weft knitted fabrics.

The reinforcement layer 20 preferably contains fibers that consist of glass, mineral, polyester, polyamide, polyethylene, or polypropylene fibers, or mixtures thereof.

The mechanically bonded non-woven layer 14, in particular in the form of a needle-punched non-woven layer 14, can be based on polyester, in particular PET (polyethylene terephthalate), and is characterized in that it has a grammage G of $150\ g/m^2 < G < 250\ g/m^2$, in particular $180\ g/m^2 < G < 220\ g/m^2$, and/or a thickness D_V of $1.4\ mm < D_V < 2.1\ mm$, in particular $1.6\ mm < D_V < 1.9\ mm$.

The thickness D_V is the thickness of the non-woven layer 14 in the form of gray cloth. If the non-woven layer 14 is connected to the adhesive layer 16, i.e. laminated therewith, the thickness is reduced depending on its pressure resistance.

In this context, it should be noted that the adhesive layer 16 is also understood to mean bituminous adhesive material applied in a strip-shaped manner. In this respect, the term adhesive layer covers both a layer and strips.

It is in particular provided that the non-woven layer 14 has a tensile strength [N/50 mm] in the longitudinal direction of greater than 300 and/or in the transverse direction of greater than 350 and/or an elongation ε in the longitudinal direction where ε > 45% and/or in the transverse direction where ε > 45% (values determined in accordance with the EN 29073-3 standard).

In order to establish a robust connection between the roofing membrane 12 and the non-woven layer 14 without an adhesion-promoting layer being required, a mechanical connection is established in that the roofing membrane material clings to the needle-punched non-woven fabric. To do this, the roofing membrane 12 is softened or heated in order to then allow the molten roofing membrane material to penetrate the non-woven layer 14. So that the dimensional stability of the non-woven layer 14 is not impaired by the process in this regard, the temperature stability of the non-woven layer 14 is greater than that of the roofing membrane 12 or the inner layer 22.

The bituminous layer 16 applied to the non-woven layer 14 consists of or contains bitumen, preferably bitumen 500/650 (in accordance with EN 12591), branched and/or unbranched (block) copolymers based on styrene and butadiene and/or isoprene, and optionally hydrocarbon resins and/or flux oils.

Furthermore, the adhesive layer 16 is in particular characterized in that it has a grammage G_B of 600 g/m^2 < G_B < 800 g/m^2, in particular 650 g/m^2 < G_B < 750 g/m^2, and/or a thickness D_B of 0.60 mm < D_B < 0.75 mm, in particular 0.65 mm < D_B < 0.70 mm.

On the outside, the bituminous layer 16 can be covered with a protective film 17, in order to ensure that it can be handled easily before use without the adhesive layer 16 resulting in any adverse effects.

The total thickness of the cover layer system 10 is in the range of between 2.6 mm and 4.2 mm, without this being intended to limit the teaching according to the invention.

In order to produce the cover layer system 10, methods can preferably be used which are explained on the basis of Fig. 2 to 9.

According to the exemplary embodiment in Fig. 2 and 3, the cover layer system is produced as follows. Material is unrolled from a roll 114 on which a non-woven membrane is rolled up and is guided through under an application system 116, by means of which the bituminous adhesive is applied in a planar manner. Onto the adhesive layer 16 thus produced, protective film material is then unrolled from a roll 118 and applied to the adhesive layer 16.

Very generally, the adhesive can be applied in a direct or indirect coating process. This means that the adhesive material is applied directly to the needle-punched non-woven layer 14, as shown on the basis of Fig. 2 and/or 6, or, in the indirect process, the adhesive material is first applied to the protective film, i.e. the so-called transfer film process is used. The adhesive layer and protective film unit is then provided as rolled material in order to apply the adhesive protective film layer system to the non-woven layer by means of pressure and temperature. It can be heated e.g. by means of IR radiators and/or contact methods by means of heat transfer from a roller/roll system.

In order to connect the thus produced self-adhesive non-woven layer, such as the needle-punched non-woven membrane, consisting of the non-woven layer 14 and the adhesive layer 16, which can also consist of adhesive strips, to a single-layer or multi-layer cover membrane, referred to as a roofing membrane 12 in the following, according to Fig. 3 roofing membrane material is unrolled from a roll 112 and is heated. To do this, for example, one or more infrared radiators 130 or rollers 132, 134 can be used, which are heated and between which the roofing membrane material is guided. The thus softened roofing membrane material is then connected to the self-adhesive non-woven membrane, with material of the roofing membrane penetrating the non-woven material and clinging thereto. To do this, a further roller pair 136, 138 is in particular provided in order to apply the required pressure so that the partial penetration (region 23 in Fig. 1) and thus the mechanical connection can be brought about.

The cover membrane is preferably only heated on the side to which the non-woven material is to be applied. As a result, the thermal endurance or the breakdown of the thermostabilizers, contained in the cover membrane, is prevented.

In accordance with the production method according to Fig. 4 to 6, the following procedure is used:
Therefore, according to Fig. 4, a reinforcement ply is unrolled from a roll 120, which ply forms the reinforcement layer (layer 20) in the roofing membrane 12 and is thus surrounded by the layers 18 and 22. To do this, the membrane-like reinforcement material unrolled from the roll 120 is guided through a gap 143 delimited by rollers 140, 142. At the same time, material of the first layer 18 is extruded (extruder 145) in the direction of the gap and is thus applied to the reinforcement material.

Preferably once it has been rolled up beforehand (roll 146 in Fig. 5), the thus produced layer system is then guided through further rollers 148, 150, 152, with the membrane material preferably being heated, e.g. by means of an infrared radiator 153.

A membrane-like non-woven membrane material, which forms the non-woven layer 14 and is unrolled from a roller 214, is fed to the gap delimited by the rollers 148 and 150. A plastics material forming the second layer 22 of the cover membrane or roofing membrane 12 is extruded (extruder 155) in the direction of the gap which is delimited by the rollers 148, 150 and to which both the non-woven layer material and the membrane-like material formed from the reinforcement material and the material of the first layer 18 are fed.

As a result, at the same time, the desired connection between the non-woven material and the layer 22 of the roofing membrane 12 which is on the inside in the finished cover layer system is produced without a special adhesion-promoting layer.

The roofing membrane material consisting of the roofing membrane 12 comprising the layers 18 and 22 and the reinforcement layer extending therebetween, e.g. the combination carrier insert 20, and the non-woven material connected thereto are then rolled up in order to then be unrolled from a roll 154 and provided on the needle-punched non-woven layer side with an adhesive layer (application apparatus 116), as can be seen in Fig. 6 in principle.

After applying the adhesive layer 16, a protective film 18 is applied, as has been explained in connection with Fig. 2.

Fig. 7 and 8 show a variant of the production method in Fig. 2 and 3 in which identical reference signs are used for identical elements or apparatuses.

For instance, according to Fig. 7, the cover membrane material is unrolled from the roll 112 in order to then mechanically connect the roofing membrane material heated by means of the infrared radiator 130 and/or rollers 132, 134 to non-woven material unrolled from a roll 114. To be laminated, the roofing membrane material and the non-woven material are guided between rollers 136, 138. Beforehand, the non-woven material is deflected by means of a deflection roller 139 in the direction of the rollers 136, 138 or the gap delimited thereby.

The thus produced membrane having laminated non-woven material is rolled up (roll 160) in order to then apply the adhesive layer material thereto according to Fig. 2 after unrolling the membrane and to cover the thus formed adhesive layer 16 with a protective film (release liner) that is unrolled from the roller 118 (Fig. 8). This preferably has a creped or undulating shape. In this case, “creped” means an undulating shape in cross section in a plane extending perpendicularly to the adhesive layer and in the longitudinal direction of the membrane (transport), such that raised portions and indentations result. Therefore, when applying the protective film to the adhesive layer, air can escape laterally, since the undulating shape forms channels. Adhesion to the surface first takes place at the raised portions. By applying heat, the adhesive material becomes flowable and adhesion takes place over the entire surface. A corresponding protective film or release liner can also be used in the above-described method.

The method shown in Fig. 9 is a combination of the method in Fig. 7 and 8 without the cover layer or roofing membrane laminated with the non-woven membrane having been rolled up beforehand. For instance, the multi-layer cover membrane material is in particular unrolled from the roll 112 and is heated in order to laminate the non-woven membrane material therewith. The adhesive material and then the liner, which is unrolled from the roll 118, are then applied to the thus laminated cover membrane by means of the apparatus 116. Cooling apparatuses, such as cooling belts, can be provided under the cover membrane along the membrane to the required extent in order to accelerate the cooling; this is a measure that is also possible in the other above-described methods.

Depending on the membrane length, corresponding portions of the layer system are then cut off and processed into a finished product, whether that is sheet material or rolled material.

In the following exemplary embodiment, two identically structured cover systems, consisting of the following constituents according to Fig. 1, are compared, which have:

– the same recipe composition of the cover membrane 12
– the same PET non-woven material 14 having a grammage of 180 to 220 g/m² The two cover systems have the following modifications:

  - Cover system A: 200 g/m² of an HMPSA, rubber-based, as adhesive material
  - Cover system B: 300 g/m² of a bituminous adhesive material according to the invention

The sample preparation and the substrate preparation took place simultaneously in both cases:

– cleaning the substrate surface by means of acetone and at least 5 minutes' evaporation time,
– removing the protective film or liner and placing the cover system by the adhesive surface onto the previously cleaned substrate,
– pressing down by means of a steel roller of 5 kg.

Both systems are compared in terms of their peel strengths relative to the substrate (stainless steel) under various storage conditions in accordance with DIN EN 12316-2, with the values being indicated in N/5 cm:

Substrate/storage condition	After 24 hours adhesion time at room temperature	Failure pattern	Adhered, after 4 weeks at 80°C, 24 hours at room temperature	Failure pattern
Cover system A	37 N/5 cm	Adhesive	25 N/5 cm	Adhesive
Cover system B	29 N/5 cm	Adhesive	65 N/5 cm	Cohesive

The results explain the results previously explained in the description in that the break or failure pattern for cover system B clearly shifts from an adhesive failure toward a cohesive failure, whereas cover system A remains true to the adhesive failure. In addition, the increase in the peel values after storage at increased temperatures for cover system B underlines the advantage over HMPSA used in cover system A in relation to temperature stability and an increase in the peel values and the stiffening of the adhesive material.

The test after 4 weeks at 80°C in the adhered state is used to artificially accelerate aging or laying of the cover system.

In a second example, two identically structured cover systems, consisting of the following constituents according to Fig. 1, are compared:

- the same recipe composition of the cover membrane 12
- the same cover layer thickness or effective thickness of the cover membrane is in the range of between 1.2 mm and 1.8 mm
- the same glass-fiber mat insert having a weight per unit area between 25 g/m^2 and 75 g/m^2
- the same adhesive recipe and grammage G_B of 600 $g/m^2 < G_B <$ 800 g/m^2

The two cover systems have the following modifications:

- Cover system C: no non-woven layer between adhesive layer and cover layer
- Cover system D: PET non-woven material 14 having a grammage of 180 to 220 g/m^2 according to the invention between the adhesive layer and the cover layer.

The sample preparation and the substrate preparation took place simultaneously in both cases in accordance with DIN EN 13416.

Both systems are tested in terms of their determination of the resistance to abrupt loading in accordance with DIN EN 12691:2018 on a hard support (method A, aluminum plate), with the units each being indicated in mm. In an exaggerated form of the method, the surface is cooled to approx. 0°C by means of ice (an ice plate) and is analyzed in the known perforation test.

Substrate/storage condition	Standard method, hard support, aluminum plate, maximum height withstood [mm]	Surface cooled to 0°C, hard support, aluminum plate, maximum height withstood [mm]
Cover system C	900 mm	1000 mm
Cover system D	1250 mm	1250 mm

The results explain an improved resistance to perforation ≥ 25% for variant D according to the invention. In addition, the positive properties as in cover system A are also provided for that adhesive layer.

In accordance with DIN EN 12691:2018, a height is considered withstood if at least 4 of 5 test specimens pass the tests, i.e. no leaks are identified in the roof sealing membrane.

Cooling the surface to 0°C simulates the behavior when being laid, for example at wintery/spring-like temperatures in which the temperature of the membrane can cool to 0°C in the early hours of the morning.

Patenttivaatimukset

1. Päällystejärjestelmä (10), joka käsittää yksi- tai monikerroksisen päällystekalvon (12), kuten kattokalvon, siihen liitetyn kuitukangaskerroksen (14) sekä siihen liitetyn bitumiliimakerroksen (16), tai koostuu näistä, **tunnettu** siitä, että päällystejärjestelmässä (10) ei ole erillistä sulkukalvoa, ja että kuitukangaskerros (14) on ainakin yksi kuitukangaskerros – tai käsittää sellaisen – seuraavien joukosta: mekaanisesti vahvistettu tekokuitupohjainen kuitukangaskerros tai mekaanisesti vahvistetun tekokuitupohjaisen kuitukangaskerroksen ja lasikuitukangaskerroksen yhdistelmä, tai tekokuituja ja lasikuituja käsittävä kuitukangaskerros, jossa päällystejärjestelmässä kuitukangaskerros on liitetty päällystekalvoon (12) siten, että siihen on tunkeutunut päällystekalvon materiaalia.

2. Patenttivaatimuksen 1 mukainen päällystejärjestelmä, **tunnettu** siitä, että kuitukangaskerroksen (14) neliömassa G on 50 g/m^2 < G < 300 g/m^2, erityisesti 150 g/m^2 < G < 220 g/m^2; erityisesti neulatun kuitukangaskerroksen paksuus Dv neliömassan G ollessa150 g/m^2 ≤ G ≤ 250 g/m^2, erityisesti 150 g/m^2 ≤ G ≤ 220 g/m^2, on 1,4 mm – 2,1 mm, erityisesti 1,6 mm – 1,9 mm.

3. Patenttivaatimuksen 1 tai 2 mukainen päällystejärjestelmä, **tunnettu** siitä, että kuitukangaskerroksen (14) vetolujuus [N/50 mm] pituussuunnassa on yli 300 ja/tai poikittaissuunnassa yli 350, ja/tai venymä ε pituussuunnassa on ε > 45 % ja/tai poikittaissuunnassa ε > 45 %, standardin EN 29073-3 mukaan mitattuna.

4. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että mekaanisesti vahvistettu kuitukangaskerros (14) koostuu polyeteenitereftalaatista (PET) tai sisältää sitä, erityisesti yli 98 p-%, ja edullisesti ainakin yhtä lisäainetta, kuten titaanidioksidia (TiO_2), edullisesti alle 0,5 p-%, ja/tai antimonitrioksidia (Sb_2O_3), edullisesti alle 0,03 p-%, jolloin kuitukangaskerrokseen on järjestetty ainakin yhtä hartsia, kuten furaanihartsia.

5. Ainakin yhden patenttivaatimuksen 1–4 mukainen päällystejärjestelmä, **tunnettu** siitä, että kuitukangaskerroksen (14) pohjana on tai se sisältää tekokuituja, jotka on valmistettu ainakin yhdestä materiaalista seuraavien joukosta: polyesteri (PES), erityisesti polyeteenitereftalaatti (PET), polyeteeni (PE), polypropeeni (PP), polyakryylinitriili (PAN), viskoosi, polyamidi (PA), kopolymeerit, kaksikomponenttikuidut, joiden pohjana ovat polyesteri (PES), polypropeeni

(PP), näiden yhdistelmä ja/tai kuituseokset, jolloin kuitukangaskerros koostuu erityisesti polyesteri- ja polypropeenikuiduista tai sisältää niitä.

6. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että bitumiliima käsittää tai sisältää ainakin standardin DIN EN 12591 mukaista tiebitumia, edullisesti bitumia 500/650 (standardin EN 12591 mukaista), haaratuneita ja/tai haarautumattomia (lohko-)kopolymeerejä, joiden pohjana on styroli ja butadieeni ja/tai isopreeni, sekä valinnaisesti hiilivetyhartsejta ja/tai liuotinöljyjä.

7. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että bitumikerroksen (16) neliöpaino G_B on $100\ g/m^2 < G_B < 1000\ g/m^2$, erityisesti $500\ g/m^2 < G_B < 750\ g/m^2$, ja/tai paksuus D_B on $0{,}10\ mm < D_B < 1{,}00\ mm$, erityisesti $0{,}50\ mm < D_B < 0{,}75\ mm$.

8. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että bitumin osuus on 60 p-% – 80 p-% ja/tai haarautuneiden ja/tai haarautumattomien styreeni- ja butadieenipohjaisten kopolymeerien osuus on 5 p-% – 30 p-% ja/tai hiilivetyhartsin osuus on 0 p-% tai enintään 15 p-%.

9. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että päällystekalvo (12) käsittää tai sisältää ainakin yhtä materiaalia seuraavien joukosta: PVC (polyvinyylikloridi), TPE (termoplastinen elastomeeri), TPO (termoplastinen olefiinipohjainen elastomeeri) tai FPO (joustava polyolefiini), TPV (termoplastinen vulkanisaatti), EPDM (eteeni-propeeni-dieeni-kautsu), EVA (eteenivinyyliasetaatti), fluoripolymeerit, jolloin edullisesti päällystekalvo (12) on värjätty, erityisesti tummilla värisävyillä, kuten antrasiitilla tai titaaniharmaalla tai mustalla.

10. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että päällystekalvo (12) käsittää erityisesti kolme kerrosta, joista erityisesti keskimmäisenä kerroksena on tukikerros (20), kuten vahvike tai tukikappale, joka tukikerros (20) on tai sisältää ainakin yhden vahvikkeen tai tukikappaleen seuraavien joukosta: kudottu kangas, punottu verkko, kuitukangas, verkko, neulos tai näiden mikä tahansa yhdistelmä, jolloin vahvike käsittää tai sisältää kuituja, kuten lasikuituja ja/tai synteettisiä kuituja.

11. Ainakin yhden edellisen patenttivaatimuksen mukainen päällystejärjestelmä, **tunnettu** siitä, että bitumiliimakerroksen (16) päälle on levitetty silikonoitu suojakerros (17), jolla on erityisesti pituussuunnassa ulottuvassa ja päällystejärjestelmään nähden kohtisuorassa tasossa ennen liimakerroksen päälle levittämistä aaltoileva muoto, jossa on kohoumia ja syvennyksiä.

12. Menetelmä päällystejärjestelmän (10) valmistamiseksi, joka päällystejärjestelmä (10) käsittää – erityisesti jonkin patenttivaatimuksen 1–11 mukaisesti – monikerroksisen päällystekalvon (12), kuitukangaskerroksen (14) sekä mahdollisesti juovamaiseksi muodostetun, bitumimateriaalia olevan liimakerroksen (16),
joka menetelmä käsittää ainakin seuraavat menetelmävaiheet:

– järjestetään saataville rulla (146) päällystekalvon (12) ensimmäisen kerroksen (18) materiaalia tai rulla, joka sisältää ensimmäisen kerroksen materiaalia,

– järjestetään saataville rulla (214) kuitukangaskerroksen materiaalia,

– vedetään päällystekalvomateriaalia ja kuitukangaskerrosmateriaalia auki rullilta,

– ohjataan sekä auki vedetty päällystekalvomateriaali että kuitukangaskerrosmateriaali kahden pyörivän telan (148, 150) rajoittaman ensimmäisen raon läpi ja samalla ekstrudoidaan päällystekalvon vielä yhden kerroksen materiaalia ensimmäiseen rakoon menevien ensimmäisen kerroksen ja kuitukangaskerroksen materiaalien väliin.

13. Patenttivaatimuksen 12 mukainen menetelmä, **tunnettu** siitä, että ennen päällystekalvomateriaalin ensimmäisen kerroksen (18) syöttämistä rakoon vedetään rullalta auki tukikerroksen (20) muodostavaa vahvikemateriaalia ja ohjataan se kahden toisen telan (140, 142) rajaaman toisen raon läpi ja samalla ekstrudoidaan ensimmäisen kerroksen materiaali toisen raon läpi vedettävän vahvikemateriaalin päälle, jolloin ekstrudointi tapahtuu erityisesti toisen raon suunnassa.

14. Patenttivaatimuksen 12 tai 13 mukainen menetelmä, **tunnettu** siitä, että sen jälkeen, kun kuitukangasmateriaali on liitetty päällystekalvomateriaaliin, kuitukangasmateriaalin päälle levitetään liimakerros tasaisesti tai raitoina.

15. Menetelmä päällystejärjestelmän (10) valmistamiseksi, joka päällystejärjestelmä (10) käsittää – erityisesti jonkin patenttivaatimuksen 1–11 mukaisesti – monikerroksisen kattokalvon (12), kuitukangaskerroksen (14) sekä mahdollisesti juovamaiseksi muodostetun, bitumimateriaalia olevan liimakerroksen (16),
joka menetelmä käsittää ainakin seuraavat menetelmävaiheet:

– järjestetään saataville rulla (112) kattokalvomateriaalia ja rulla kuitukangaskerrosmateriaalia,

– vedetään päällystekalvomateriaalia ja kuitukangaskerrosmateriaalia auki rullilta,

– laminoidaan kuitukangaskerrosmateriaali kattokalvomateriaalin päälle,

– joko kääritään kuitukangaskerrosmateriaalilla laminoitu kattokalvomateriaali rullalle, myöhemmin vedetään laminoitu kattokalvomateriaali auki rullalta ja levitetään liimakerrosmateriaali ja levitetään näin muodostetun liimakerroksen päälle suojakalvo,

– tai kuitukangaskerroksen laminoinnin jälkeen kuljetetaan laminoitua kattokalvomateriaalia eteenpäin ja tämän jälkeen levitetään liimakerrosmateriaali ja peitetään näin muodostettu liimakerros suojakalvolla.

16. Ainakin jommankumman patenttivaatimuksen 12 tai 15 mukainen menetelmä päällystejärjestelmän valmistamiseksi, **tunnettu** siitä, että liimakerroksen vapaalle pinnalle viedään tai on viety ennen kuitukangaskerroksen päälle viemistä suojakalvo (17), joka erityisesti estää tai ainakin rajoittaa haihtuvien ainesosien kulkeutumista liimakerroksesta (16), jolloin edullisesti käytetään sellaista suojakalvoa, joka liimakerrokseen liitettynä saatetaan sen kanssa kosketukseen ensin pistemäisesti, viivamaisesti ja kaistalemaisesti suojakalvon ja liimakerroksen välissä olevan ilman poistamiseksi puristamalla ja kalvon kiinnittämiseksi sitten koko pinnaltaan liimakerrokseen.

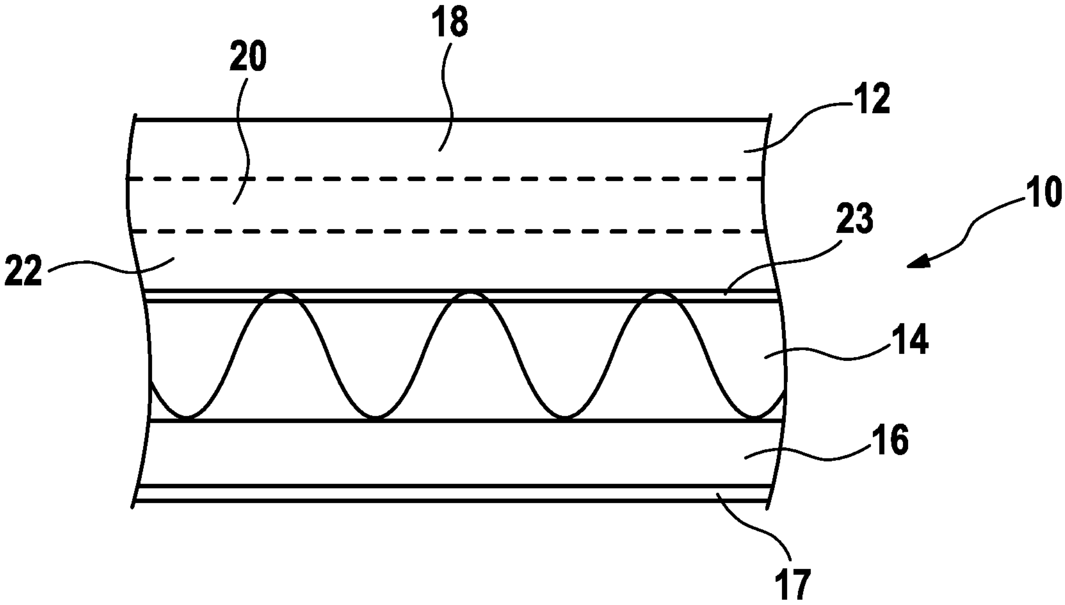

Fig. 1

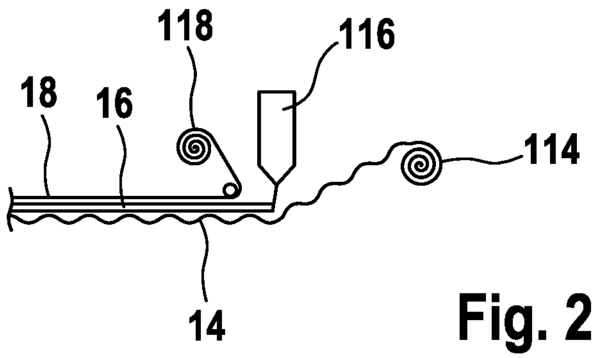

Fig. 2

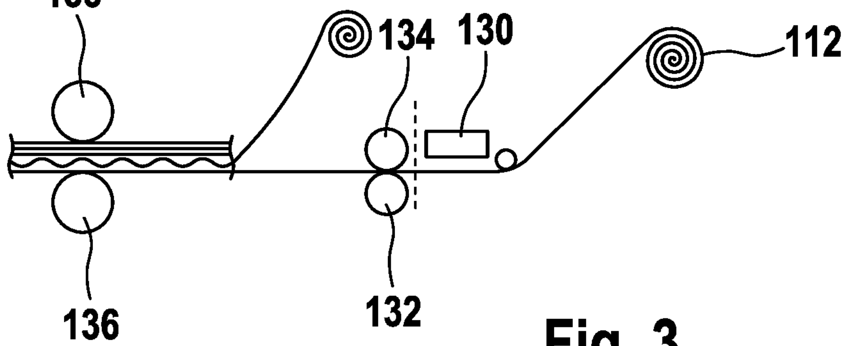

Fig. 3

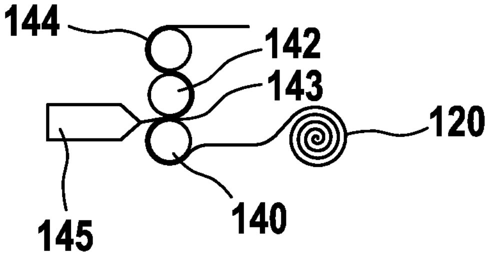

Fig. 4

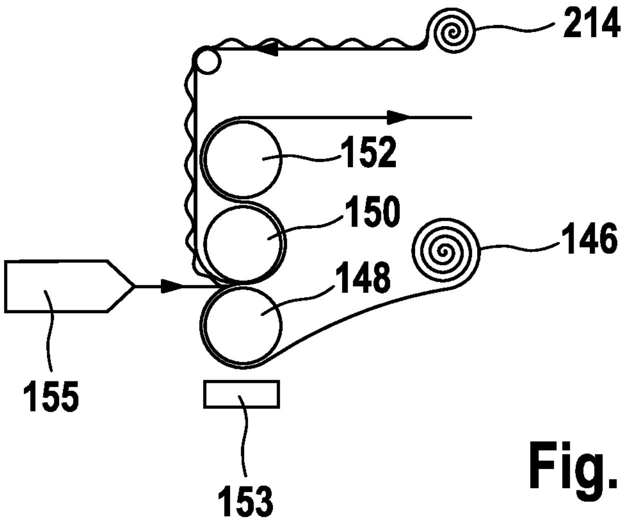

Fig. 5

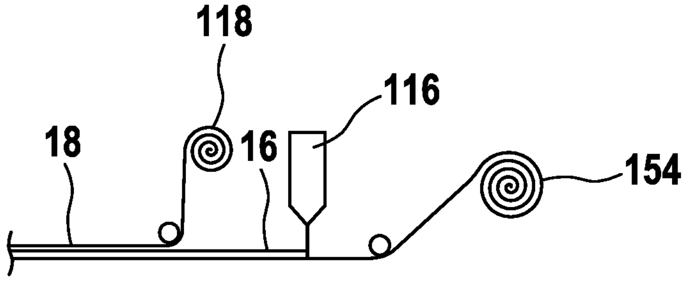

Fig. 6

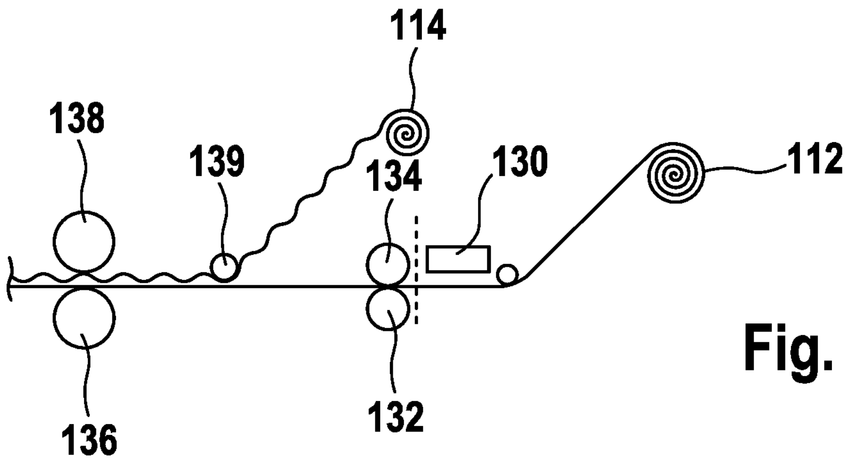

Fig. 7

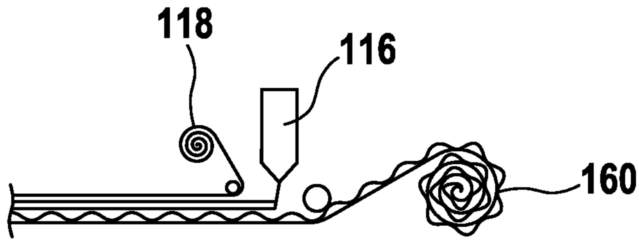

Fig. 8

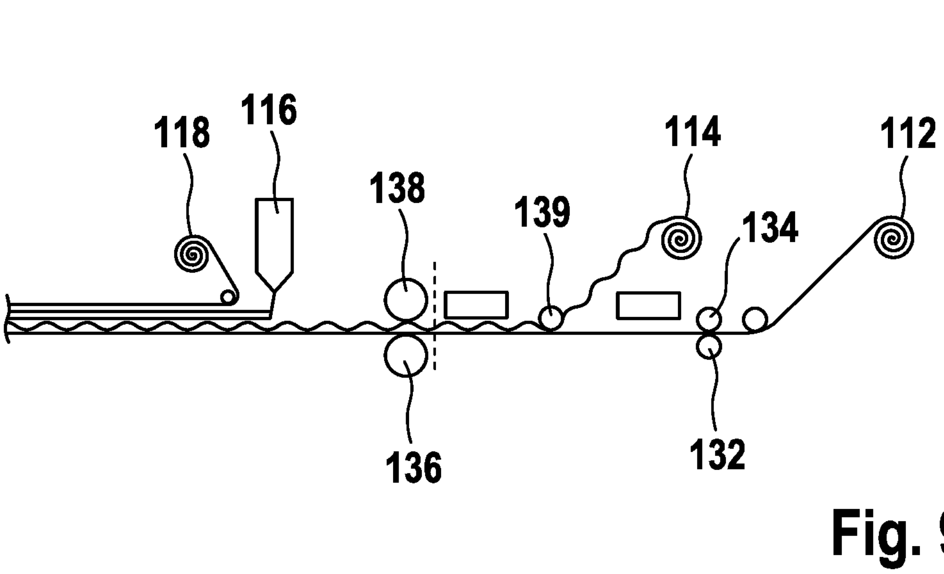

Fig. 9