

5 Description

Sealing Web

10 The invention is for a multi-layer sealing web for a region of a structure, such as a roof, cladding, cellar or tanks¹; the sealing web features outer layers which contain a base polymer such as polyvinyl chloride or a polychloride-copolymer, and a plasticiser, as well as a combination carrier insert which is located between the outer layers and features a glass nonwoven and glass reinforcement.

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A similar sealing web can be found under WO 2009/138314 A1. To achieve ease of application, high impact strength at low temperatures and high weather resistance, the plasticiser is to be a polymer plasticiser in the form of an adipic acid polyester with a mean molecular weight of 3,000
20 to 12,000. However, polymer plasticisers have considerable disadvantages in terms of application and cost.

The invention at hand is based on the task of further developing a sealing web of the type mentioned above in such a way that it can be produced cost-effectively, has high

dimensional stability and low shrinkage characteristics. A problem-free mechanical attachment should be made possible.

5 A further aspect is that the sealing web should have an extremely smooth or slightly embossed surface.

Also, recycling should be better or easier compared to webs with polyester reinforcement.

10 In order to solve one or more of the abovementioned aspects, the invention essentially proposes a multi-layer sealing web for a region of a structure, such as a roof, cladding, cellar or tanksⁱⁱ; the sealing web features outer layers which contain a base polymer such as polyvinyl chloride or a polychloride-copolymer, and a plasticiser, as well as a combination carrier insert located
15 between the outer layers which features a glass nonwoven and a knitted fabric. The combination carrier insert is attached to the outer layers preferably by a binding agent containing a proportion by weight in particular between 5 % and 50 % of the total weight of binding agent and combination carrier insert.

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Knitted fabrics are commonly referred to as textile fabrics or textile structures, where one loop which has been formed by yarn is intermeshed through another loop. The stitches which are produced as a result can be formed using one or more yarns.

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Knitted fabrics differ from woven fabrics, where the structure is produced by crossing two sets of threads, they also differ from nonwoven fabrics, where a loose fibre pile is bonded by heat for example. Compared to woven fabrics, knitted fabrics are characterised by higher stretchability,
30 elasticity and, as a result, less creasing.

Knitted fabric is divided into weft-knitted and warp-knitted fabric. The knitted fabric is produced using the single-yarn technique (knitted and weft-knitted fabrics) or the warp-yarn technique (multi-yarn fabrics as chain-link warp knit or chain-link warp-knitted fabrics).

The glass reinforcement according to this invention consists of, or contains, knitted fabric,

5 although this may be made up of a combination of warp-knitted fabric and weft-knitted fabric.

In particular, the invention solves this task independently through a multi-layer sealing web for a region of a structures such as a roof, cladding, cellar or tanksⁱⁱⁱ the outer layers of which

10 contain a base polymer such as polyvinyl chloride or a polychloride-copolymer as well as a low-molecular-weight plasticiser, it also has a combination carrier insert featuring a glass nonwoven and a knitted fabric with stitches running in a lengthwise/longitudinal and crosswise/transverse direction - also called warp yarns and weft yarns. The lengthwise yarns form

15 a first layer and the crosswise yarns form a second layer, the lengthwise yarns and the crosswise yarns are connected by first and second linking yarns, which in turn extend fixedly from the lengthwise threads. At the cross points between the lengthwise yarns and crosswise yarns, the first linking yarns are passed exclusively above and the second linking yarns are passed exclusively below the cross points in their areas in such a way that the cross points are in-between the first and second linking yarns.

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The combination carrier insert can also be referred to as a knitted fabric-nonwoven composite or knitted-nonwoven composite.

Knitted fabrics are produced through a knitting process. This process can use three different yarns
25 to create a fabric or a mesh structure. There are warp yarns (running in the direction of the machine) and/or weft yarns, as well as at least one linking yarn which is used to connect the warp and/or weft yarns. In a further version, the fabric or mesh can be additionally coated with a binding agent.

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Knitted fabrics can be arranged and prepared uniaxially or biaxially. With biaxial structures, the warp and weft yarns can be positioned at different angles, preferably 0° and 90° or 45°.

There are two varieties of knitted fabrics: warp knits and weft knits. Weft knitting is produced with a single yarn whereas warp knitting is produced with a large number of parallel yarns. This means that when weft knitting, one loop is interlinked with the next until a row is formed. With warp knitting, on the other hand, many loops are interlinked through each other so that a complete
5 parallel structure is formed. Warp knits are also referred to as (chain-link) warp knitting or Raschel (warp) knitting.

Knitted fabric is divided into weft-knitted and warp-knitted fabric. The knitted fabric is produced using a single-yarn technique (knitted and weft-knitted fabrics) or the warp-yarn technique (multi
10 yarn fabrics as chain-link warp knit or chain-link warp-knitted fabrics).

The knitted fabrics referred to are those in which the individual yarns are combined with the support of technology which helps to form the stitches allowing a structure to be produced with dimensional stability.
15 Production methods used to form the knitted fabric are very complex and difficult to describe. As a rule, the knitted fabrics can be grouped together with the single yarn warp knits and weft knits as well as with the with chain-link warp knits. It is important to note that in the case of single-yarn warp-knitted fabrics and single-yarn weft-knitted fabrics, stitches positioned next to each other are produced by one yarn running in the crosswise direction, whereas in the case of chain-link
20 warp-knitted fabrics, the yarn runs through the warp-knitted fabric in the lengthwise direction.

A single loop (bight), is the structural element of knitted fabric. It is a yarn loop that is intertwined in four positions by other yarn loops. The structure is produced one knitted row after another. Several loops arranged side by side form a row of loops and several loops arranged one
25 above the other form a loop wale.

A warp knitting machine produces knitted fabric with the help of a system of needles as well as supporting components, by moving all the needles simultaneously and producing a row of loops at the same time from one or more yarns. Knitted fabrics created from a single yarn are produced
30 on a weft knitting machine (also known as a cotton machine), whereby a distinction is made between flat and tubular weft machines.

Chains made from several (as many as more than 10,000) yarns are made on warp knitting machines. These can be produced using three different methods:

- Automatic warp knitting machines
- Raschel knitting machine
- Double-needle bar Raschel machine
- Crochet gallon machines
- Tricot machine

10 If a knitted fabric is produced on a Raschel machine, then an expert in this industry would call this raschel fabric. The Raschel machine or Raschel (also called a pile machine) is a specialised warp knitting machine. On a Raschel, the direction the fabric is drawn off the machine (downwards) differs from other normal warp knitting machines (upwards). The basic construction is derived from the warp knitting machine. However, the Raschel is equipped with several additional features
15 which allow an almost unlimited patterning of knitwear. Knitting elements of a Raschel machine with Jacquard device, machines are equipped with latch or slide needles. The basic equipment includes two needle systems (single needle and guide bar) with tongue needle block, laying-in and cast-off combs (sinkers), two guide bars with latch needles. The machines can be equipped with
20 a multi-digit number of guide bars, jacquard guide bars and so-called fall-plates, double bars (for weft or pile yarn).

According to the invention, a sealing web is proposed which is constructed in several layers, whereby an inner layer is formed by the combination carrier insert. As this consists of a glass
25 nonwoven and a glass reinforcement which consists of or contains a knitted fabric, a warp knit and/or weft knit or a combination thereof, a problem-free, secure mechanical attachment is achieved. At the same time, sufficient dimensional stability is given. Shrinkage due to ageing is reduced in comparison to known sealing webs.

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A desirable strength is achieved or ensured by the alignment of the bonding surfaces and the connection with the lengthwise or crosswise threads. At the same time, a smooth surface is obtained.

The invention also envisages that the glass reinforcement will be attached to the glass nonwoven in particular by using specifically using styrene-butadiene.

It is also an option to attach the glass reinforcement to the glass nonwoven using at least one
5 binding agent from the group acrylate, EVA or PVC-based variants such as PVC dispersions and PVC plastisol.

It is also an option to attach the glass reinforcement to the glass nonwoven using a combination
of at least two binding agents from the group styrene-butadiene, acrylate, EVA, PVC
10 dispersions or PVC plastisol.

Furthermore, it is an option that the glass reinforcement is not attached to the glass nonwoven,
which means that no binding agent is used as a medium of adhesion.

15 A factor influencing the ability of the individual layers of the sealing web to sufficiently bond to
each other i.e. the upper outer layer (PVC layer) (top layer), the combination carrier insert and the
lower outer layer (PVC layer) (bottom layer), depends on the extent to which the upper and lower
PVC layers penetrate the structure of the combination carrier insert. It has been observed, that
20 how the binding agent has been distributed on the surface and the amount used has an impact on
the quality of adhesion between the layers of the sealing web.

In particular, it is envisaged that that proportion of binding agent used is between 5 wt.% and 50
wt.%, preferably between 15 – 35 %.

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The proportion of binding agent applied to the reinforcement is determined after production using
the Loss On Ignition method – which is described in more detail in the DIN EN 13820 standard.

30 A further factor determining the content and distribution of the binding agent, is the air
permeability of the reinforcement, i.e. the airflow through a selected and defined area of the
reinforcement sample and resulting pressure drop across the sample. There are two different
methods of measurement. In the first variant, the drop in pressure is kept constant and the flow
rate is measured.

In the second variant, the flow rate is kept constant and the pressure drop is measured.

- 5 Air permeability is measured in $\text{l/m}^2\text{s}$ at a pressure of 200 Pa. The values are around 4000 – 12000 $\text{l/m}^2\text{s}$, preferably between 5000 – 8000 $\text{l/m}^2\text{s}$.

- For knitted fabrics, it is preferable if the linking yarn or yarns have a degree of fineness between 2 tex and 20 tex, preferably between 4 tex and 10 tex. By definition: 1 dtex (decitex) = 0.1 tex or
10 gram per 10,000 metres or 1 tex = 10 dtex.

A combination of linking yarn or yarns and binding agents is possible.

- 15 It is preferable if the linking yarn is based on the following materials: polyester, polypropylene, polyamide and glass.

- When comparing woven with knitted fabric, woven fabric involves a crosswise interlacing of two groups of thread (warp and weft) with different weave - e.g. plain weave (weft thread crosses
20 only one warp thread) or basket weave (weft thread crosses two warp threads each time). With knitted fabric, however, warp knitting and weft knitting form a surface structure of loops made of yarn which are interlinked with each other.

- 25 The preferred knitted structures are generally known to experts in this industry and can be divided into "single guide bar" and "two guide bars". Experts are also familiar with the term "double bar" knitted fabric.

- 30 Preferred stitches or patterns can be taken from the following list:

- "Full Tricot" or "Double Tricot"
- "Half Tricot"
- "Locknit"
- "Sharkskin"

In order to differentiate between the variants "Half Tricot" and "Full Tricot" the following description offers more detail:

- 5 - "Half Tricot": is the basic form of chain-link warp knitting and warp-knitted fabrics. In the first step, the guide bar guides the yarn/thread/threads onto a needle then moves sideways and in the second step feeds the yarn/thread/threads onto the adjacent needle. The procedure is
- 10 repeated accordingly. All chain-link warp knitting and warp-knitted fabrics are formed similarly with the exception that there may be more guide bars, more repetition of steps or different underlaps and different directions of guide bar movement (right-left; "shogging").
- 15 - "Full Tricot": this structure knits two "Half Tricots" together with two guide bars that move in opposite directions. This is a well-balanced structure, both warp-yarns are overlapped in opposite directions (the so-called "overlap"). This leads to perfect upright loops in the fabric surface.

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Furthermore, the standard DIN EN ISO 8388 "Knitted fabrics - type designations - terminology" lists preferred knitted fabrics or knitted materials that can be used in accordance with inventions.

- 25 In addition, in contrast to previously known sealing webs, a low-molecular-weight plasticiser, i.e. a monomeric plasticiser, can be used as a plasticiser in the outer layers. This is particularly preferable. The proportion of low-molecular-weight plasticiser used in the outer layers containing the base polymer should be between 25 wt.% to 45 wt.%, in particular between 25 wt.% and 37
- 30 wt.%, preferably between 27 wt.% to 35 wt.%.

This results in high dimensional stability, low shrinkage and, in particular, the desired smooth outer structure. If there is only one outer layer running along each side of the combination carrier insert, this means that,

particularly on the side not being affixed to the surface being constructed, there is a middle layer creating the following order starting at the surface being constructed: outer-layer, combination carrier insert, middle layer, outer layer.

- 5 The outer layer which runs along the structure or area of the structure it is being affixed to, refers to the installation of the sealing web, that one side of the outer layer faces directly towards the building and the combination carrier insert runs along the other side. Accordingly, the outer layer facing away from the structure or area of the structure means that the combination carrier insert runs along its inner side.

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The composition of the middle layer is very similar to that of the outer layers. Differences may arise as a result of different additives, particularly with regards to UV stability and colour pigments, however, the middle layer may contain fewer additives than the adjacent outer layer.

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It is preferable if the low-molecular-weight plasticiser is a phthalate-based plasticiser, in particular, a plasticiser from the group DPHP (Dipropyl heptyl phthalate), DINP (Diisonyl phthalate), DIDP (Diisodecyl phthalate). The plasticiser can also be a phthalate-free plasticiser, a biobased

- 20 plasticiser or a partially bio-based plasticiser as described in EP 3 156 447 A, for example, the disclosure of which is the subject of the present invention. A combination of the above plasticisers may also be an option in a further embodiment of the invention.

- 25 A special characteristic of the invention is that each layer contains or consists of wt. %:

low-molecular-weight plasticiser	25 - 45, in particular, 27 - 37
Processing additives	0 – 1.9, in particular, 0.1 – 1.50
Filler	0 - 20, in particular, 0 - 15
PVC	45 – 57, in particular, 46 - 56
Antioxidants	0 – 0.2, in particular, 0.1 – 0.2
UV stabiliser	0 – 0.23, in particular, 0.1 – 0.23
Other stabilisers	1.5 – 1.8

Colour pigments except TiO ₂	0 – 0.14, in particular, 0.005 – 0.10
Titanium dioxide	1.0 – 12, in particular, 1 – 8
Flame retardant additives	0 – 20, in particular, 0 – 12

According to an embodiment worthy of emphasis, the other stabilisers could consist of organic thermo-stabilisers. The use of such stabilisers has the advantage that ESO or ESBO

5 (epoxidized soybean oil) is no longer required in the composition as a co-stabiliser.

The combination carrier insert is impregnated with the binding agent which ensures its connectivity to the adjacent outer layers or rather outer and middle layers. It is preferable, that the binding agent is based on at least one substance from the group: styrene-butadiene, acrylate,
 10 EVA and PVC or combinations thereof. The PVC variant is particularly suitable as a dispersion or plastisol.

In particular, styrene-butadiene is recommended as a binding agent, which despite absorbing plasticisers, does not display any adverse effects on the sealing web, not even in the area of the
 15 nodes of the intersecting glass fibres. Also, the mineral properties make it easier to recycle compared to polyester.

The use of EVA, PVC and acrylate provides the advantage of exceptionally high adhesive strength
 20 between the combination carrier insert and the adjacent layers.

Using the combination carrier insert as reinforcement has, as mentioned, surprisingly resulted in the sealing web having an extremely smooth surface.

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In addition, by using the aforementioned combination carrier insert, tensile stresses were able to be eliminated in the end product. This leads to stable thickness tolerances of the individual layers, enabling the manufacturer to achieve tighter thickness tolerances between the individual layers.

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Exceptionally high strength and easy attachment can be achieved when the glass nonwoven has a weight per unit area between 20 g/m² and 90 g/m² and/or the glass fibres of the glass nonwoven have a thickness between 10 µm and 20µm.

- 5 The strand spacing, yarn width or thread structure of the glass reinforcement fibres such as knitted fabric, weft knit, warp knit or a combination thereof, should be between 2x2 and 6x6, although it would be preferable to select 3x3 - 4x4. 2x2 means that per cm, two glass strands are laid both in the same direction as well as in a direction transverse to this. Warp strand is the name given to fibres going in a lengthwise direction and weft/fill strand for fibres going in a crosswise direction.
- 10 The same applies to 3x3, 4x4, 5x5 and 6x6.

The structure or construction or strand spacing, or yarn width can be symmetrical, square, rectangular or asymmetrical. The following examples are intended to illustrate the various

15 structures:

- a square structure e.g. 2x2, i.e. 2 strands/cm in lengthwise and crosswise direction, 2 warp strands/cm and 2 weft strands/cm
- a rectangular structure would be for example 2x1, i.e. 1 strand/cm in lengthwise and 2 strands/cm in crosswise direction, which means 1 warp strand/cm and 2 weft strands/cm or

20 vice versa.

- an asymmetrical structure, for example, would be 2x2 ER (edge reinforcement), i.e. 2 strands/cm in both lengthwise and crosswise direction, whereby the edge area of the mesh in the crosswise direction has 4 instead of 2 strands/cm, which means 2 warp strands/cm and 2 weft strands/cm although in the edge area there would be 4 warp strands instead of 2 warp strands/cm.

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In addition, warp strands may be arranged double or in multiples, although the weft strands do not need to reflect the same amount.

Furthermore, different strand dimensions can be used between the weft and warp strands, this

- 30 includes using different diameters or different substance groups e.g. polyester and glass, however, at least one of the two strands should be based on glass.

In yet another version, the glass nonwoven is placed in edge/margin areas or middle areas of the glass nonwoven width with reinforcing strands – which are preferably also based on glass strands

or PES (polyester) strands i.e. in particular arranged in a lengthwise direction of the roofing membrane. This type of design is preferable in areas of high wind, i.e. particularly in coastal areas where greater wind force or force transmission points enter into the sealing web.

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The edge/margin area is fixed at 1 cm to 20 cm from the outer edge of the lengthwise direction of the membrane, whereby the preferred width is no more than approximately 6 cm. In addition, between 4 and 20, preferably between 4 and 10 reinforcing fibres can be arranged with a maximum spacing of 50 mm, however, preferably between 5 mm to 10 mm apart. The spacing is

10 chosen so that the fastening plates, which are interspersed with screws or nails allow the roofing membrane to be attached to the substrate or base. At least 3 reinforcement fibres run along the substrate or base to ensure mechanical reinforcement.

15 The total weight per unit area of the combination carrier insert should be between 80 g/m² and 200 g/m², however, a weight of between 100 g/m² and 120 g/m² is preferred.

The sealing web itself should have a basis weight of between 1.4 kg/m² and 2.6 kg/m², however, the preferred weight is between 1.5 kg/m² and 1.9 kg/m².

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The preferred thickness of the sealing web is between 1.0 mm and 2.5 mm, however of particular preference would be between 1.2 mm and 2.0 mm.

The sealing web invention is characterised among other things, however in particular by its tensile

25 strength [N/50 mm] in lengthwise direction where it measures at least 1000, preferably at least 1150, but of particular preference would be 1150 to 1250 and/or in the crosswise direction at least 800, preferably a minimum of 1000, but of particular preference would be 1100 to 1200, according to EN 12311-2.

30 In addition, the tear propagation strength [N] in the lengthwise direction shall be measured between 170 and 250, and in the crosswise direction between 210 and 300, measured according to EN 12310-2.

During manufacture, the sealing web is transported in lengthwise direction. Crosswise is the direction perpendicular to this.

To prevent the connecting points of the knitted fabric, weft knit and/or warp-knit from forming elevations on the edges of the sealing web, the invention prefers that the glass nonwoven is to run along the outside surface of the glass reinforcement which is not being affixed to the construction surface.

However, the invention also covers positioning the glass nonwoven along the outer side of the glass reinforcement facing the building.

10 In the case of alternative roofing membrane products known to those in the industry containing a mesh reinforcement or inserts, the connecting points can come to the surface of the roofing membrane causing a structural change. This does not apply to this invention as it contains a combination carrier insert. However, for professionals, the structural change in alternative roofing membranes can cause channels, sinkholes, or puddles allowing dirt, water, algae, insects, etc.

15 to accumulate. When these substances or organisms which have collected interact with the roofing membrane or the components contained in the roofing membrane, e.g. the plasticiser, this can lead to accelerated ageing, especially around the areas where these reservoirs or channels have formed, which in turn results in a shorter lifespan of the roofing membrane.

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This effect is avoided by the invention's use of the combination carrier insert, as this structural change in the surface can no longer occur.

25 By using a combination carrier insert, this results in improved fire resistance of the reinforcement or insert or the roofing membrane or the complete roof structure, which can be demonstrated in accordance with CEN/TS 1187:2012 "External fire exposure to roofing materials".

30 Another positive aspect to mention is the improved sealing properties of the roofing membrane. This is due, in particular, to the smooth and wave-free nature of the roofing membrane. When welding with automatic welding machines, this results in fewer imperfections, i.e. imperfections which have to be subsequently sealed by hand using hot air hand tools and the same materials as an additional workload.

This enables better handling and faster laying time of the roofing membrane.

Furthermore, it is intended that the sealing web contains one or more additives or additives
5 from the group of fillers, pigments, colour additives, UV stabilisers, thermo-stabilisers, biocides, flame retardants.

Additives in the layers should differ in their proportions according to the desired effect. For example, in the outer layer or outer layers that run above the combination carrier insert when the
10 roofing membrane is laid, the proportion of UV stabilisers and/or thermo-stabilisers and/or fungicides should be greater than in the layer or layers running below the combination carrier insert.

Preferably the intention is that one or two layers containing the base polymer and the monomer
15 plasticiser run above the combination carrier insert and one layer below the combination carrier insert, i.e. on the building side, whereby the proportion of additives in the individual layers can vary as mentioned above.

20 In terms of processing, the innovative roofing membrane can be produced by (co-)extrusion or the calendering process using one or more stacks of calenders. The combination carrier insert can be produced in a preceding step or can be added to the process as a separate glass nonwoven and glass reinforcement.

25 Further details, advantages and characteristics of the invention result not only from the claims, the characteristics to be inferred from them, for themselves and/or in combination but also from the following description of preferred examples of use.

30 It shows:

Fig. 1 A section of the sealing web

Fig. 2 A stack of calenders for manufacturing the sealing web as per Fig. 1,

Fig. 3 a section of warp knitting and

Fig. 4 a cross-section of the warp knitting in Fig. 3

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Fig. 5 a combination of two calenders used for manufacturing the sealing web as per Fig. 1

Fig. 6 a section of biaxial weft-knitted fabric

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Fig. 7 a section of biaxial warp-knitted fabric

Fig. 8 a section of "Half Tricot warp-knitted fabric"

15 Fig. 9 a section of "Full Tricot warp-knitted fabric"

Fig. 10 a section showing an adhesion problem due to the binding agent used.

20 Fig. 1 shows a section of the innovative sealing web 10, which is used in the construction sector, e.g. for sealing roofs, cladding facades, lining tanks or lining cellars.

In the example, the sealing web 10 runs along a roof 12 and consists of a lower layer 14, which
 25 once the sealing web 10 is installed, runs along the roof side i.e. along the side facing the building structure. On the lower layer 14, there is a combination carrier insert 16, which in turn consists of a glass reinforcement running along the roof side and consisting of or containing a knitted fabric 18 and, facing away from the roof, a glass nonwoven 20. The knitted fabric is a weft-knitted fabric, warp-knitted fabric or a combination thereof.

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Two layers 22, 24 are then arranged on the free side of the combination carrier insert 16, which, like the lower layer 14, contain or consist of soft PVC (polyvinyl chloride) and a monomer plasticiser as well as one or more additives such as filling agents, pigments,

UV stabilisers, thermo-stabilisers and biocides. The proportion by weight of the monomer softener in the respective layers 14, 22, 24 is between 25 wt.% and 40 wt.%, preferably between 25 wt.% and 37 wt.%, however in particular between 27 wt.% and 35 wt.%.

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Consequently, layers 22 and 24 run on the side of the combination carrier insert 16, which faces away from the roof 12 or the structure when the sealing web 10 is installed.

The use of a phthalate-based monomer plasticiser is preferred, in particular, a plasticiser from the group DPHP (Dipropyl heptyl phthalate), DINP (diisononyl phthalate), DIDP (diisodecyl phthalate). The plasticiser can also be a phthalate-free plasticiser, a biobased plasticiser or a partially bio-based plasticiser.

A special characteristic of the invention is that each layer 14, 22, 24 contains wt.%:

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Low-molecular-weight plasticiser	25 - 45, in particular, 27 - 37
Processing additives	0 – 1.9, in particular, 0.1 – 1.50
Filling agents	0 - 20, in particular, 0 - 15
PVC	45 – 57, in particular, 46 - 56
Antioxidants	0 – 0.2, in particular, 0.1 – 0.2
UV stabiliser	0 – 0.23, in particular, 0.1 – 0.23
Other stabilisers	1.5 – 1.8
Colour pigments except TiO ₂	0 – 0.14, in particular, 0.005 – 0.10
Titanium dioxide	1.0 – 12, in particular, 1 – 8
Flame retardant additives	0 – 20, in particular, 0 – 12

In particular, it is intended that the proportion of titanium dioxide in the upper layer 24 is greater than that in the middle layer 22. The titanium dioxide content of the lower layer 12 is in turn, less than that of the middle layer 22.

In addition, both the middle layer 22 and the lower layer 12, do not need to contain antioxidants and stabilisers this includes UV stabilisers.

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The proportion of calcium carbonate in the lower layer 14 can be greater than in the middle layer 22, and the latter in turn can be greater than in the upper layer 24.

The glass nonwoven 20 of the combination carrier insert 16 has a basis weight of
5 between 30 g/m² and 90 g/m².

The glass fibres of the glass nonwoven should have a thickness of between 13 µm and 18 µm. The
glass fibres of the glass reinforcement, which consists of a knitted fabric, a weft-knitted fabric,
10 warp-knitted fabric or a combination thereof, are characterised by a weight of 60 tex to 80 tex.

In addition, the strand spacing or yarn width or fibre construction of the glass reinforcement, which
consists of a knitted fabric, a weft-knitted fabric, warp-knitted fabric or a combination thereof
should be 3x3 to 4x4.
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The surface weight of the sealing web 10 should be between 1.4 kg/m² and 2.6 kg/m², with a
preferred thickness of 1.2 mm to 2.0 mm.

20 The layers 14, on the one hand, and 22, 24 on the other hand, will be attached to the combination
carrier insert 16, in particular, by calendering, brushing or by extrusion.

In particular, it is intended that the layers 22 and 24 will be produced by co-extrusion and the layer
14 can be produced by extrusion with a single-channel nozzle.
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The co-extruded layers 22 and 24 and the layer 14 are then attached to the combination carrier
insert 16 which runs between them, using a single stack of calenders – also known as a calender
unit or roll calender machine. The various steps in this process are pictured with a single stack of
calenders.

30 The glass nonwoven 20 and the glass reinforcement, which consists of or contains a knitted fabric
18, are impregnated with a binding agent, which consists of or contains at least one substance
from the group styrene-butadiene, acrylate, PVC, EVA.

This binding agent is then used to attach the combination carrier insert to the adjacent layers 14, 22.

Sealing webs 10 produced in this manner, have a tensile strength in N/50 mm of the lengthwise direction of at least 1000, preferably of approximately 1150 to 1180 and in the crosswise direction of at least 800, but preferably approximately 1080 to 1100, with the measurement being in accordance with EN 12311-2.

The maximum tensile elongation in the lengthwise and crosswise direction is approximately 2 - 10 5% also measured in accordance with EN 12311-2.

The tear resistance according to EN 12310-2 is approx. 220 N in the lengthwise direction and approx. 270 N in the crosswise direction.

15 The nail tear resistance according to EN 12310-1 is approx. 300 N in the lengthwise direction and approx. 375 N in the crosswise direction.

With regard to dimensional stability, according to EN 1107-2 the values were given in lengthwise direction -0.07% and crosswise direction -0.07%.

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Fig. 2 shows a calender 100, although purely the principle behind it, with which the innovative sealing web 10 can be produced using the extrusion or calendering process.

25 The calender 100 is made up of a lower roller or drum 102, a middle roller or drum 104, and an upper roller or drum 106. In addition, two cooling rollers 108, 110 are shown in the example.

Furthermore, the calender 100 has a co-extrusion nozzle 112 and a single channel extrusion nozzle 30 114 which are each connected to a corresponding extruder.

To produce the roofing membrane 10, the combination carrier insert 16 is drawn off a winder and guided through the rollers or drums 102, 104, 106.

In the area of the lower and middle roller 102 and 104, and prior to the combination carrier insert 16 being passed between the rollers 104 and 106, the middle layer 22 and outer layer 24 are applied via the co-extrusion nozzle as a unit to the middle roller 104. The combination carrier insert 16 is then bonded with the exposed surface.

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After passing between the lower and middle rollers 102, 104 heat is applied with an IR radiant heater 105. Warmth is then applied in the direction of the middle roller 104. The lower layer 14 is applied to the upper roller 106 using an extrusion nozzle 114. The combination carrier insert 16 is bonded to the free surface of the lower layer 14 prior to the gap between the middle roller 104 and the upper roller 106 as it passes through. The roofing membrane 10 which is produced in this way, is passed around the upper roller 106 and finally through the cooling rollers 108 and 110.

15 Figs. 3 and 4 show views of the knitted glass fabric 18, which consists of intersecting lengthwise threads 30, 32 and crosswise threads 34, 36, 38, 40. The threads each run in a separate layer so that the lengthwise threads 30, 32 are situated in a first layer 33 and the crosswise threads 34, 36, 38, 40 in a second layer 41. The respective threads form layers.

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The lengthwise and crosswise threads 30, 32, 34, 36, 38, 40 are connected via the linking yarns 42 and 44, whereby in the area of the cross points 54, 56, 58, 60 between the lengthwise and crosswise threads 30, 32, 34, 36, 38, 40, the first linking yarn 42 runs solely above and the second linking yarn 44 runs solely below the cross points 54, 56, 58, 60, so that the intersecting points 54, 56, 58, 60

25 are located between the first and second linking yarns 42, 44, as can be self-explanatory when comparing the plan view according to Fig. 3 and the cross-section view according to Fig. 4. Furthermore, the figures show in principle that the linking yarns 42, 44 are connected with the lengthwise threads 30, 32 at an almost equal point 44, 46, 48, 50.

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Along each lengthwise thread 30, 32 there are thus two linking yarns, one of which runs in sections above layer 41 and the other in sections below layer 33, to ensure the connection between the lengthwise and crosswise threads 30, 32, 34, 36, 38, 40.

The strength of the linking yarns 42, 44 also influences the strength of the combination carrier insert 16 and thus of the sealing web 10.

By using the combination carrier insert 16, the two other already extruded layers - middle layer 22 and the outer layer 24 - are protected from very high heat input during the extrusion of the lower layer 14. This has a positive effect on the ageing of the middle layer 22 and the upper layer 24. This can be proven by the Yellowness Index.

10 Figure 5 shows the procedure involving two stacks of calenders.

In the case of a combination carrier insert according to the invention 216 when coming from a winder (point A) over deflection rollers 218, 220, 222, it is then guided past heat sources such as IR radiant heaters 224, 226 to then be guided between rollers 228, 230, 232. A layer is applied 15 between rollers 228, 230 via a single-channel nozzle 234, forming layer 14 as shown in Fig. 1, which in the finished sealing web 10, when covering a structure or a section or area of such a structure, is thus facing or resting on it.

20 The rollers 228, 230, 232 form the first stack of calender 200. From calender 200, the combination carrier insert 216 with the applied layer is fed via deflection rollers 236, 238, 204, 242 to a second calender 300. Prior to this, it is reheated by a heat source such as an IR radiant heater 324. Following this it is guided through rollers 328, 330, 332, also to be referred to as lower, middle and upper rollers. Between the lower roller 328 and the upper roller 330, a co-extrusion nozzle 334 is used

25 to apply the middle layer 22 and the outer layer, i.e. layer 24 of the finished sealing web, which faces away from the structure being constructed and corresponds to layers 22, 24 as shown in Fig.

1. As the roofing membrane is guided from the calender 300 it is fed via the deflection roller 334 e.g. cooling roller not displayed (Area B). Further processing can take place, especially winding or 30 cutting to length. The roller 332 can already be used as the cooling roller – just like the deflector roller 334.

In Figs. 6 to 9 preferred design forms of the knitted fabric i.e. in particular, the biaxial knitted fabric are shown. Biaxial in this case means that the lengthwise or crosswise yarns or weft and warp

yarns are arranged at an angle of 90° or 45° to each other.

Fig. 6 shows a weft-knitted fabric, whereby the inserted warp or weft threads are arranged at 0°
5 or 90° angles.

Fig. 7 shows a warp-knitted fabric, known to specialists in this industry as "Half Tricot". In this
design, the woven-in warp or weft threads are arranged at an angle to 0° or 90° each other.
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Fig. 8 also shows a warp-knitted fabric, which as previously mentioned with regards to Fig. 7, is
known to specialists in this industry as "Half Tricot". However, the number of stitches arranged
between the weft and warp threads differ.

15 Fig. 9 shows another example of a warp-knitted fabric, known to specialists in this industry as a
"Full Tricot". In this case, the structure is composed of two "Half Tricots" structures, whereby two
guide rails are used during production and these move in opposite directions. This means that a
balanced structure is created. The two warp threads are overlapped in opposite directions (known
20 as "overlap"). This leads to perfect upright loops in the surface.

In Fig. 10 for example, two surfaces are shown to illustrate the principle of adhesion between the
outer layers including the combination carrier insert. For example, Area A shows an area which
25 does not provide sufficient adhesion strength of the individual outer layers with the combination
carrier insert. Area B, on the other hand, indicates an area with good adhesion properties. This is
indicated by the fact that the upper and lower outer layers are coloured differently. During the
30 production process, the substances of the outer layers must fill or penetrate the open pores or
open areas of the combination carrier insert so that the outer layers touch each other. Since both
outer layers are heated and based on the same polymer base material, a high adhesion strength

can be achieved between both layers. A binder can be used to improve the adhesion to the combination carrier insert.

Thus the poor adhesion of Area A can be linked to two possibilities: a non-homogeneous or poor
5 permeability of the combination carrier insert by the substances of the outer layers or, where applicable, the outer layer running along the side being constructed and the middle layer (layer 22 in Fig. 1) and/or an insufficient quantity or insufficient surface distribution of the binding agent

Claims

Sealing Web

1. A multi-layer sealing web (10) for a region of a structure, such as a roof, cladding, cellar or tanks^{iv}, the outer layers (14, 22, 24) of which contain a base polymer such as polyvinyl chloride or a polychloride-copolymer, and a plasticiser, as well as combination carrier insert (16) between the outer layers, which has a glass nonwoven (20) and a glass reinforcement (18) which consists of or contains a knitted fabric.
2. Multi-layer sealing web according to Claim 1,
c h a r a c t e r i s e d i n t h a t ,
the combination carrier insert (16) is connected to the outer layers (14, 22, 24) by means of a binding agent, which has a weight percentage in particular between 5 and 50 based on the sum of the weights of the binding agent and the combination carrier insert.
3. Multi-layer sealing web according to Claim 1 or 2
c h a r a c t e r i s e d i n t h a t ,
the threads of the knitted fabric (18) have threads running lengthwise and crosswise (30, 32, 34, 36, 38, 40), which are connected by linking yarns (42, 44).
4. Multi-layer sealing web according to Claim 1 or 2
c h a r a c t e r i s e d i n t h a t ,
the knitted fabric (18) is a weft-knitted fabric or a warp-knitted fabric or a combination thereof.
5. Multi-layer sealing web according to at least one of the preceding claims,
c h a r a c t e r i s e d i n t h a t ,

in that the lengthwise threads (30, 32) form a first layer (33) and the crosswise threads (34, 36, 38, 40) form a second layer (41), the lengthwise threads and the crosswise threads are connected by first and second linking yarns (42, 44), which in turn extend fixedly from the lengthwise threads, and that in the region of the cross points (54, 56, 58, 60) between the lengthwise threads and crosswise threads, the first linking yarns (42) run solely above and the second linking yarns (44) solely below the cross points in their regions in such a way that the cross points run between the first and second linking yarns.

6. Multi-layer sealing web according to at least claim 5,
characterised in that,
the linking yarns (42, 44) are connected to the lengthwise threads (30, 32) at or almost at the same points (44, 46, 48, 50).
7. Multi-layer sealing web according to at least one of the previous claims,
characterised in that,
the glass reinforcement is attached to the glass nonwoven (20) by means of at least one binding agent from the group styrene-butadiene, acrylate, EVA (ethylene-vinyl acetate), PVC-based variants like PVC dispersions and PVC plastisol.
8. Multi-layer sealing web according to at least one of the previous claims,
characterised in that,
the linking yarns (42, 44) and/or threads (30, 32, 34, 36, 38, 40) of the knitted fabric (18) have a degree of fineness between 2 tex and 20 tex, in particular 4 tex and 10 tex.
9. Multi-layer sealing web according to at least one of the previous claims,
characterised in that,

the linking yarns (42, 44) or threads (30, 32, 34, 36, 38, 40), consist of a material from the group, polyester, polypropylene, polyamide, glass.

10. Sealing web according to at least one of the previous claims,
characterised in that,
the glass nonwoven (20) has a surface weight between 30 g/m² and 90 g/m² and/or the glass fibres of the glass nonwoven have a thickness of between 13 µm and 18 µm.
11. Sealing web according to at least one of the previous claims,
characterised in that,
the fibres of the weft and warp threads (30, 32, 34, 36, 38, 40) of the knitted fabric (18) which intersect at a right angle have a strand spacing of 2x2 to 6x6, in particular 3x3 to 4x4.
12. Sealing web according to at least one of the previous claims,
characterised in that,
the degree of fineness of the weft and warp threads (30, 32, 34, 36, 38, 40) of the knitted fabric (18) is 60 tex to 80 tex.
13. Sealing web according to at least one of the previous claims,
characterised in that,
the plasticiser is a low-molecular-weight plasticiser.
14. Sealing web according to at least Claim 13,
characterised in that,
the proportion of low-molecular-weight plasticiser in the outer layers (14, 22, 24) which contain a base polymer is between 25 wt. % and 45 wt.%.
15. Sealing web according to at least one of Claims
13 or 14, characterised in that,

the proportion of low-molecular-weight plasticiser is between 25wt. % and 37 wt.%, in particular, between 27 wt. % and 35 wt.%.

16. Sealing web according to at least one of Claims 13 to 15, characterised in that, the low-molecular-weight plasticiser is a phthalate-based plasticiser, in particular, from the group DPHP (Dipropyl heptyl phthalate) DINP (Diisonyl phthalate), DIDP (Diisodecyl phthalate) or a phthalate-free plasticiser or plasticiser at least (partially) bio-based.
17. Sealing web according to at least one of the previous claims, characterised in that, the combination carrier insert (16) is impregnated with the binding agent based on at least one substance from the group: styrene-butadiene, acrylate, PVC, EVA in particular styrene-butadiene.
18. Sealing web according to at least one of the previous claims, characterised in that, the sealing web (10) has a surface weight of between 1.4 kg/m² and 2.6 kg/m², however, in particular between 1.5 kg/m² and 1.9 kg/m².
19. Sealing web according to at least one of the previous claims, characterised in that, the thickness of the sealing web (10) is between 1.0 mm and 2.5 mm, in particular between 1.2 mm and 2.0 mm.
20. Sealing web according to at least one of the previous claims, characterised in that, the sealing web (10) has a tensile strength in N/50 mm of at least 800 in the lengthwise direction, preferably of at least 1000 but of particular preference would be 1150 to 1250, and/or in the crosswise direction at least 800, preferably 1100 to 1200.

21. Sealing web according to at least one of the previous claims,
characterised in that,
the sealing web (10) has a tear resistance in N of between 170 and 250 in the lengthwise direction and of between 210 and 300 in the crosswise direction.
22. Sealing web according to at least one of the previous claims,
characterised in that,
the glass nonwoven (20) runs along the outer side of the knitted fabric (18) of the side which is not being attached to the surface being constructed.
23. Sealing web according to at least one of the previous claims,
characterised in that,
the sealing web (10) contains one or more additives from the group: filling agents, pigments, colour additives, UV stabilisers, thermo-stabilisers, biocide.
24. Sealing web according to at least one of the previous claims,
characterised in that,
the sealing web (10) consists of a first outer layer (14) which runs along the side to be attached to the construction surface, it also consists of a combination carrier insert (16), as well as at least one outer layer (22, 24) which runs along the side of the combination carrier insert which is not being attached to the construction surface.
25. Sealing web according to at least one of the previous claims,
characterised in that,
the side of the combination carrier insert (16) which is not being attached to the construction area has two layers, a middle layer (22) and an outer layer (24).

26. Sealing web according to at least one of the previous claims, characterised in that,
- the outer layer (26) which faces away from the surface being constructed and/or the middle layer (22) and/or the layer (14) which runs along the side facing toward the surface being constructed, in particular, each layer (14, 22, 24) consists of or contains, in % by weight

low-molecular-weight plasticiser preferably phthalate-based	25 - 45, in particular, 27 - 37
Processing additives like lubricants	0 – 1.9, in particular, 0.1 – 1.9
Filling agents like calcium carbonate	0 -20, in particular, 0 - 15
PVC	45 – 57, in particular, 46 - 56
Antioxidant such as antioxidants	0 – 0.2, in particular, 0.1 – 0.2
UV stabiliser	0 – 0.23, in particular, 0.1 – 0.23
other stabilisers	1.5 – 1.8
Colour pigments except TiO ₂	0 – 0.14, in particular, 0.905 – 0.10
Titanium dioxide	1.0 – 12, in particular, 1 – 8

27. Process for producing a sealing web (10) according to at least one of the previous claims, characterised in that,
- the outer layers (14, 24) are produced by extrusion, and are then joined to the combination carrier insert (16).
28. Process for producing a sealing web (10) according to at least one of the claims 1 to 27, characterised in that,
- the sealing web's (10) layers (22, 34) which run along the side of the combination carrier insert (16) facing away from the surface being constructed, are produced by co-extrusion, also that the coextruded layers, the combination carrier insert and layer (14) which was produced by extrusion and runs along the side being attached to the surface being constructed, are all joined to together by a single stack of calenders.

29. Process for producing a sealing web (10) according to at least one of the claims 1 to 27, characterised in that, the combination carrier insert (16) is fed into a first stack of calenders (200) which then by means of extrusion applies the outer layer (14) to the external side of the sealing web (10) that will run along the surface of building structure being constructed, that the combination carrier insert with the outer layer is then fed to a second stack of calenders (300) which then by means of co-extrusion applies the middle and outer layers (22, 24) to the external side of the sealing web which does not run along the surface of the building structure being constructed.
30. Equipment for producing a sealing web (10) preferably according to at least one of the claims 1 to 29, characterised in that, the equipment features a lower roller (102), a middle roller (104) and an upper roller (106), which are arranged with a gap between them, in that a first extrusion nozzle (112) for extruding at least one layer (22, 24) is arranged on the middle roller (104) upstream of the gap with respect to its direction of rotation, one outer side of which contacts the middle roller and the other outer side of which makes contact with the combination carrier insert which is also guided through the gap, that the middle roller is assigned a heating device (105) which applies heat radiation in the direction of the middle roller, in that a second extrusion nozzle (114) is arranged in the direction of rotation of the middle roller upstream of the gap existing between the middle roller and the upper roller, for extruding a second layer (14), which makes contact both with the upper roller and with the outer surface of the combination carrier insert passing through the gap.

31. Equipment according to Claim 30,
characterised in that,
cooling rollers (108, 110) with a limited gap are arranged downstream of the upper roller (106), once the sealing web (10) consisting of at least one first layer, the combination carrier insert and at least a second layer, has been drawn off the upper roller it is guided through the cooling rollers.
32. Equipment according to Claim 30,
characterised in that,
the extrusion nozzle (112) is a co-extrusion nozzle.
33. Equipment according to one of the claims 30 to 32, characterised in that,
the equipment is one single stack of calenders.
34. Equipment for producing a sealing web (10) preferably according to at least one of the claims 1 to 27,
characterised in that,
the equipment features two stacks of calenders (200, 300), the first stack of calenders (200) applies the first outer layer (14) containing a base polymer and a plasticiser to a combination carrier insert (16) containing at least glass threads, by means of an extrusion nozzle (234), that the second stack of calenders (300) arranged to follow after the first stack of calenders, applies the outer layers (22, 24) which contain a base polymer and a plasticiser, to the side of the combination carrier insert which was not covered by the first outer layer, by means of a co-extrusion nozzle (334) which is assigned to the second stack of calenders.