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(54) Title: TECHNICAL TEXTILE FABRIC

(57) Abstract: A technical textile fabric, woven fabric and knitted fabric in particular, containing continuous carbon fibres where at least some roving or folded yarn of the basalt continuous filament with a fineness of 50 to 700 tex is used in at least one part of the weaving system, whereas at least one more part of the system contains some yarns or roving of the carbon fibres.

Technical textile fabric

Field of the invention

The invention is related to a technical textile fabric, woven fabric or knitted fabric in particular, containing continuous carbon filament.

Prior art

Industrial or technical textie fabrics containing both organic and inorganic continuous filament are known. The most important inorganic filaments are glass, ceramics, basalt, carbon and metals. The organic materials with the widest usability in the production of the technical fabrics are polyester, aromatic polyamides, polyarylesters, polyethylene, and polypropylene. The existing constructions of the technical woven fabrics produced from such materials include rovings, little tows or slivers. These linear shapes form continual bundles of individual, mainly continuous filaments with the diameter ranging from tens to units of micrometers. A roving is made up of hundreds or tens of thousands of the individual filaments that are either unfolded or folded with up to 200 twists per metre. The rovings provided with a twist are technically referred to as yarns, folded yarns or threads. The rovings created by unification of a larger number of slivers tend to be called multi-end rovings.

The current technical woven fabrics are produced from the above mentioned materials by common weaving processes, mainly on air-jet or projectile weaving machines. The weaving methods include various, mostly smooth types of weaves, such as plain weave, twill or satin weave. In comparison with the similar classic textiles the roving texture is distinctly thinner, which is caused by the flat section of the used rovings or yarns with a small twist.

The technical knitted fabrics are usually made of folded materials with a sufficient number of twists that ensure a good compactness of the continuous filaments passing through the knitting loop.

The roving textiles made of carbon fibres with a different number of filaments or the knitted fabrics made of folded materials are mainly used for the production of sturdy and relatively light laminate base constructions. The production of these textiles or knitted fabrics usually starts with a sliver of e.g. 3 000 individual fibres (but the number can be as high as 24 000) with a protective twisting of up to 20 twist per metre. The fabrics are widely utilized in aviation, in the production of sports requisites and other numerous fields.

The producers of the roving woven fabric and knitted fabrics of folded materials on the basis of carbon fibres often combine different materials in the warp, weft or individual threads in order to achieve the best possible indexes. The surface shapes are often referred to as hybrid. There are hybrid woven fabrics containing glass or aramide fibres (yarns or rovings) with carbon fibres that are used to lead away the electric charge, see e.g. the document RU 2092634 published on 10.10.1997. The combinations of air-formed glass yarns and carbon are used for their benefits in the fire protection, see e.g. the document EP 0 223 664 published 27.05.1987.

The lamination technologies use regularly the combinations of glass rovings or yarns and carbon fibres in the form of woven fabrics or knitted fabrics.

The use of carbon fibres in such materials has, however, its disadvantages. Firstly, it is the high price of the used material, secondly, the low resistance of the carbon fibres against fire and oxidation, which significantly reduces its usability mainly in the military sphere.

The materials combining glass fibres with carbon fibres are less expensive due to the use of the cheaper yet technically less advanced glass roving. The lower price is, however, outweighed by a lower aesthetic value of the produced fabric. The use of the glass material additionally lowers the resistance of these compounds against oxidation and alkali agents to the level that is usually regarded as insufficient.

Essence of the invention

The above mentioned disadvantages can be nearly removed by the invention the substance of which consists in that at least some roving or folded yarn of the basalt continuous filament with a fineness of 50 to 700 tex is used in at least one part of the weaving system, whereas at least one more part of the weawing system contains yarns or roving of the carbon fibres.

For the usability of the technical textile fabric according to the invention it is important that the basalt continuous filaments are in the form of the multi-end roving.

In production terms it is further recommendable to use the basalt continuous filament as the weft and the roving of the carbon fibres as the warp.

The requested qualities can be achieved more easily if at least one more part of the weaving system contains both the yarns or roving of the carbon fibres and the roving or folded yarn of the basalt continuous filament.

Examples of the invention

The weaving systems of the innovated technical textile fabric are essentially composed of rovings or yarns of the carbon fibres and continuous filaments which are created by melting and spinning of natural

basalts. These continuous basalt filaments are widely known and marketed in the form of rovings, i.e. bundles of continuous filaments and tissues. Among the manufacturers of this material are e.g. Sudaglas, Russia or TZI, Ukraine. The properties of this material can be compared to the properties of the glass fibre. Having said that, the glass fibre does not have such a good chemical persistence and, what is more, its coefficient of elasticity, particularly in very low temperatures, is sometimes lower. Both the innovated material and the glass fibre are inflammable and resistant to high temperatures. Their dark colour is similar to the colour of the carbon fibres. The combination of the material with the carbon fibres ensures surprisingly better characteristics.

The rovings or basalt fibre yarns can be used to produce hybrid textiles or knitted fabrics with better aesthetic qualities than those associated with the usual combinations of glass yarns and carbon rovings. This innovation brings about a significant increase in the resistance of the new material to thermal and chemical oxidation, and, last but not least, considerable costs saving. These properties make it possible to use the material in places where an exposure to thermal and chemical influences is to be considered, e.g. in carbon filters.

The weaving of the hybrid roving fabrics on the basis of the basalt continuous filament in combination with the rovings of the carbon fibres is relatively difficult, and can only be facilitated by using more costly folded materials. From the economical point of view, the best structure to start with is the one with a carbon component placed in the warp and the basalt fibre in the weft. This combination referred to as a one-way fabric has proved to be most suitable for a range of uses of hybrid textiles combining basalt roving or yarn with carbon materials both in laminates and other applications such as in odour filters or filters used against the penetration of

greasy vapours. It is also possible to use the cheapest non-folded multi-end basalt roving in picking. This is important as the warp work with the basalt fibres in the form of roving poses certain difficulties, especially if the roving is used in its multi-end form. The problems are down to the loose protuberant fibres of the rovings that hamper the weaving of close-mashed materials by disrupting the adjacent warp threads, and reducing thus the overall strength of the woven material.

Be way of example there are five specific applications of the innovated material:

Example 1

A textile with a plain weave has been woven on a projectile weaving machine. It contains a five-fold carbon roving TENAX HTA 5131 200 tex within 1 cm of the warp length (produced by Teijin, Japan) containing 3000 individual fibres, and a five-fold basalt multi-end roving 320 tex (supplied by TZI Ukraine) within 1 cm of the weft length. The manufactured textile has a warp strength of 4 000 N and weft strength of 2 000 N (ČSN EN ISO 13934-1) at the basis weight of 260 g/m^2. The fabric is used for laminating canoes with the same effect as any purely carbon textile, reducing the cost of the laminated reinforcement by ca 30 % and producing an aesthetically highly valued surface appearance.

Example 2

A textile with a twill weave has been woven on a projectile weaving machine. It contains a six-fold multi-end basalt roving 80 tex x 2 x 2 (produced by Sudaglas, Russia) within the warp and six roving slivers of the carbon fibres TENAX 5131 200 tex within 1 cm of the weft length. The warp strength of the textile is 2 200 N, weft strength 4 200 N (ČSN EN ISO 13934-1). The textile has been exposed to a ten-fold disinfection (5 % sodium hypochlorite, 60 °C) without any effect on its properties. A similar

absence of any qualitative changes was stated even after a ten-fold immersion of the cloth in liquid nitrogen.

Example 3

A textile with a plain weave has been woven on an air-jet weaving machine. It contains a five-fold carbon roving TENAX HTA 5131 (6 000 filament) 400 tex in the warp with a protective twisting of 10 twists per 1 metre, and a five-fold basalt multi-end roving 320 tex in the weft. The basis weight is 250 g/m^2, the warp strength 5 000 N and the weft strength 2 000 N. The fabric has been used in 10 layers as a filter element retaining greasy vapours. A ten-fold washing using a common washing powder at 60 °C has changed neither the appearance nor the performance or mechanical properties of the product.

Example 4

A textile with a plain weave has been woven on an air-jet weaving machine. In the warp it contains alternately a folded basalt 80 tex x 2 x 2 (ca 80 twists per metre) and carbon roving TENAX HTA 5131 200 tex (6 threads per 1 cm) and in the warp there is a basalt multi-end roving (6 threads 300 tex, produced by Kameny Vek, Russia). The basis weight is 275 g/m^2, the warp strength 2 200 N and the weft strength 2 000 N. The material has been immersed ten times in liquid nitrogen without causing any changes in its mechanical properties. The textile is used as a protection surface to shield electromagnetic radiation. It is laid out in a single layer with the carbon fibres lying in parallel and the individual carbon threads in the warp interconnected and grounded by means of a metal bar.

Example 5

A knitted fabric with a pulled-in weft has been woven on a circular knitting machine containing alternately a carbon thread of the total of 134 tex (2x TENAX 5241 67 tex, 15 twists per metre) and a folded basalt

thread of the total of 160 tex (80 tex x 2. 80 twists per metre). The knitted hose created in this way has a diameter of 40 cm. The knitted fabric is used in a multi-layer laminate structure as an inside piece. While meeting all ISO 14 130 requirements, the shear strength of the innovated laminated material is 10 % higher than the shear strength of an analogous knitted fabric combining glass fibres and carbon fibres.

From an expert perspective it is clear that both the basalt and carbon fibres can be applied in the technical fabric with a different form, fineness and roving pick count. At any rate, the above mentioned basic rule must be followed, i.e. at least some roving or folded yarn of the basalt continuous filament with a fineness of 50 to 700 tex must be used in at least one part of the weaving system, whereas at least one more part of the weaving system must contain some folded yarn or roving of the carbon fibres. As far as the technical woven fabric is concerned, the two parts in question can be the weft system and the warp system respectively. In the case of the technical knitted fabric produced e.g. on a warp knitting machine, the part of the knitted fabric that is formed by some knitting systems can present the "one part", whereas the other knitting systems or, where appropriate, a part of them can be used as "one more part" (see above).

Many advantages are connected with the technical woven fabric where the roving of the basalt continuous filament in the form of the multi-end roving is picked, whereas the roving of the carbon fibres creates the warp.

A similar effect can be achieved if the reverse is done, i.e. the roving of the basalt continuous filament in the form of the multi-end roving creates the warp, whereas the roving of the carbon fibres creates the weft. The basis weight of the technical fabric may then vary considerably depending on its actual intended use.

Industrial applicability

The products made in compliance with the invention have a wide usability in places where the aesthetic qualities and a high thermal, chemical and mechanical resistance of the material are required. These characteristics make the fabric an ideal option not only for the production of laminates in combination with various resins but also for the construction of odour filters with a regenerative capacity.

CLAIMS

1. A technical textile fabric, the woven fabric and knitted fabric in particular, containing continuous carbon fibres, **characterized in that** at least some roving or folded yarn of the basalt continuous filament with a fineness of 50 to 700 tex is used in at least one part of the weaving system, whereas at least one more part of the weawing system contains yarns or roving of the carbon fibres.

2. A technical textile fabric according to claim 1, **characterized in that** the basalt continuous filaments are in the form of the multi-end roving.

3. A technical textile fabric according to claim 1 or 2, **characterized in that** the basalt continuous filament creates the weft, whereas the roving of the carbon fibres creates the warp.

4. A technical textile fabric according to claim 1 or 2, **characterized in that** at least one more part of the weaving system contains both yarns or roving of the carbon fibres and the roving or folded yarn of the basalt continuous filament.
