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(54) Manufacture of drawing aprons

(57) Method of manufacture of a drawing apron of an elastomeric material and with a textile reinforcement extending in the circumferential direction, in which the reinforcement, which is made endless and which can shrink in the circumferential direction, is applied onto the mould core of a hollow mould, the reinforcement is pressed against the surface of the core by activation of the shrinking forces, and the remaining space of the hollow mould and the pores of the reinforcement are filled with a liquid reaction mixture of a polyurethane elastomer, which is hardened, and which thereupon makes a firm bond to the reinforcement, so that the drawing apron thereafter can be removed from the hollow mould and be made ready.

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SPECIFICATION
Manufacture of drawing aprons

This invention relates to methods of manufacture of drawing aprons of an elastomeric material and with a textile reinforcement extending in the circumferential direction, in which a hardenable polymeric material is applied to the reinforcement supported on a mould core and thereafter is hardened, so that a bond results between the reinforcement and the elastomeric material.

This method is known from German OS 2 319 111. There the reinforcement consists of a fleece which is at first in flat form, which is impregnated with the solution of an elastomeric material, and which is wound in a plurality of layers onto the mould core, in such a way that the ends overlap each other. In order to reduce to a minimum the variations in the thickness and in the flexibility of the reinforcement in the neighbourhood of the overlapping, extremely light fabric gauzes with a weight per unit area between 10 and 50 g/m² are used as reinforcement, which compels one to undertake a pre-impregnation with a solution of a polymerisable elastomeric compound. However, this separate process step increases the manufacturing costs of the drawing apron to a significant extent, particularly because the solvent must be removed in a costly drying process. During this one cannot exclude the possibility that in particular areas pores remain, which can lead to lamination phenomena within the reinforcement, or between the reinforcement and the coating of the elastomeric material. This danger appears particularly because the drawing apron has altered flexibility in the neighbourhood of the overlapping of the ends of the reinforcement, which can lead to vibrations during the usual high running speeds. Such variations can occur even after a short period of use, because the reinforcements employed are able to contribute only to a restricted amount to increasing the total stability of the drawing apron, by reason of their relatively slight self-stability.

The object underlying the invention is to develop a method which can be simply employed for manufacture of drawing aprons, which produces aprons which are circularly symmetrical, and in which reinforcements of a great mechanical strength can be incorporated.

The object is solved with the present invention in a method of the kind stated above, in which a reinforcement, which is made endless and which can shrink in the circumferential direction, is applied onto the mould core of a hollow mould, the reinforcement is pressed against the surface of the core by activation of the shrinking forces, and the remaining space of the hollow mould and the pores of the reinforcement are filled with a liquid reaction mixture of a polyurethane elastomer, which is hardened, and which thereupon makes a firm bond to the reinforcement, so that the drawing apron thereafter can be removed from the hollow mould and be made ready.

Reinforcements of various constructions can be used within the scope of the present invention. They can, for example consist of natural and/or synthetic staple or continuous filament fibres, while however a diameter range in the order of magnitude of 0.05 mm to 0.1 mm is to be given preference. With such fibres it is a matter of a relatively coarse titre, and therefore a relatively open-pored construction of the reinforcement is made possible, which is advantageous with regard to the penetration with the reaction mixture of the polyurethane elastomer. By reason of availability, with synthetic fibres round fibre cross sections are generally given preference. However, by reasons of the relatively increased surface, fibre sections departing from this are more advantageously employed, for example triangular or elongated-oval thread sections.

Concerning the activation of the shrinking forces conditions are preferably provided such that this is as optimum as possible. In this connection it is a significant feature that the actual shortening of the threads occurring is first extensively hindered by the core on which the reinforcement is threaded, and thereafter by the elastomeric material which surrounds each individual thread of the reinforcement. In consequence there exists in the threads in the finished drawing apron a high internal pre-stress, which opposes in a particularly advantageous degree extension caused during use by reasons of external loading.

According to the kind of shrinking threads employed, various kinds of shrinking conditions must be provided. Many natural fibres, which by reasons of their hygrophilic properties ensure a particularly good bond to the elastomeric material, shrink only under the influence of damp. The exceptional mechanical properties of the finished drawing apron must therefore, with the employment of such fibres, be paid for by an additionally introduced drying step before the actual application of the elastomeric material.

Synthetically manufactured shrinking fibres have on the contrary standardised and hence completely uniform properties, which especially apply to an extraordinarily high shrinkage. For starting the shrinkage a simple heating suffices, and this operation can if desired be combined also with the polymerisation of the elastomeric material. The employment of synthetically manufactured shrinking fibres is therefore given preference within the present invention.

A further advantage can then appear, if bi-component fibres are employed as shrinking fibres, one component of which has a differing shrinkage quality. Upon activation of the shrinking fibre, there results from this a looping of the entire structure, and this contributes to a better anchoring in the hardened elastomeric material.

As regards the polyurethane elastomers which can be employed, alongside their mechanical properties in the hardened condition, the viscosity of the reaction mixture is of especially great significance, in order to ensure good penetration and wetting of all the threads of the reinforcement.

Viscosities in the order of magnitude between 500 and 1000 cP have appeared as advantageous.

From the shrinking of the reinforcement onto the core before the polymerisation of the elastomeric material, there can result an absolutely circularly symmetric embedding of the reinforcement in the finished drawing apron. The shrinking threads producing the reinforcing effect have also in all areas an optimum alignment with reference to the loading of the drawing apron produced by use. The drawing apron has immediately on removal from the hollow mould totally balanced properties around the entire circumference. The necessary finishing treatments consequently need not be concerned with an equalisation of the properties.

As stated above, the activation of the shrinking forces of the reinforcement is fundamentally independent of the chemical polymerisation of the elastomeric material. The reinforcement can in consequence for example be shrunk upon an exchangeable core outside the actual hollow mould, and thereafter inserted together with it in to the hollow mould, which is then filled with a reaction mixture of the polyurethane elastomer, for example one which is cold hardening. However, the qualities of cold-hardening elastomers at present available do not usually satisfy the particularly high requirements which are applied to drawing aprons in practical operation. It is therefore more advantageous to emply hot-hardening polyurethane grades, for example those with a polymerisation temperature in the range of 100 to 130°C. This temperature range lies in the order of magnitude of the optimum shrinking temperature of most synthetically manufactured shrinking fibres. There is therefore the possibility of performing the activation of the shrinking forces of the reinforcement and the polymerisation of the elastomeric material as a single self-contained operating step and by a single heating.

In use, drawing aprons serve to impart to textile threads or fibres a particular transport or drawing speed. For this purpose the threads are clamped between the drawing apron running over a roller, and a rigid counter-roller of metal, and are transported forward by friction. According to the hardness of the thread, this presses more or less firmly into the surface of the drawing apron during this operation, and in conjunction with the high speeds employed there results a great mechanical loading. This has additionally superimposed on it a chemical loading by the dressings which usually are applied to the surface of the threads. Having regard to this specific complex of loading, the employment of a polyurethane elastomer which in the hardened condition has a surface hardness of 60 to 94 Shore A, preferably a hardness of 70 Shore A, and which is composed of an NDI or TDI and polyester or polyether, has especially proved itself as advantageous. Besides sufficient friction, which is necessary for conveying the threads, these grades of elastomer have a particularly high resistance to wear.

As regards the external form of the reinforcement, different constructions can be employed. Particularly suited is a woven hose with shrinking threads extending in the circumferential direction, which are adhered or bound together in the transverse direction by staple threads and/or continuous threads. Here it is possible that the shrinking threads alone, or together with similar or other kinds of fibres, in each case form a strand of comparable width, running circumferentially. Preferably the fibres of different kind, at the temperatures to be used for the activation of the shrinking forces, have no change of length or an irregular one. If the individual strand is composed of a plurality of individual threads, then each of the threads can have a length which is finite or continuous. The threads can be connected together within the strand mechanically or adhesively. If adhesive binders are employed, care should however be taken that the internal molecular structure of the shrinking threads stays unaltered. Solvent adhesives must on this ground be excluded as binders.

A mechanical binding between the various threads can be brought about, in that they are twisted or knitted together. If a knitted structure is employed, then this can be so formed that the shrinking threads are arranged side by side like a warp, while the non-shrinking threads each accompany a respective strand through one row of stitches and transfer sideways to the adjacent strand for the next row, and so on. In this way a reinforcement is obtained which is formed like a woven fabric, with shrinking threads which are absolutely parallel to one another and directed in the circumferential direction, and which have exceptional bond with the matrix of the elastomeric material.

Different fibre types can be employed as synthetic shrinking fibres, for example polyacryl-nitryl or modacryl fibres. However the employment of polyester fibres has appeared as particularly favourable, because these, by reason of their high degree of internal crystallisation following on the shrinking step, are almost totally inert with respect to external influences. Therefore the desired high internal pre-stress remains with the employment of such fibres in a particularly high degree, maintained over a long period. The decomposition temperature of these fibres lies usually above that of the polyurethane elastomers to be employed. Damage to the reinforcement by reason of temperature is preceded in consequence in each case by damage to the outer layer of the polyurethane elastomer, and such damage is in consequence directly recognisable by external inspection. The good wettability of the reaction mixture employed with respect to such fibres leads to a firm bond between the polyurethane elastomer and the polyester firbers. This characteristic is also of great practical significance.

The good properties of the drawing aprons obtained by the method according to the invention result from the combined effect of the high notch and tear strength and the low wear loss of the elastomeric material employed, in conjunction with the fibres of the reinforcement under an internal pre-stress. This acts against the tendency to relaxation of the polyurethane, and significantly increased operating lives are thereby attained. The reinforcement can be made so robust that it significantly contributes to improvement of the mechanical properties, and it is, by reason of the manufacturing method employed, embedded absolutely circularly symmetrically in the wall of the drawing apron. This has in consequence a totally uniform elasticity and flexibility around its entire circumference. Lateral running off from crown-shaped guide rollers is thus not to be feared even after very long running times.

EXAMPLE

In a cylindrically shaped mould tool with an internal diameter of 102 mm and a height of 80 mm there is inserted a cylindrically shaped core with a diameter of 100 mm. All internal surfaces of the mould tool are polished and smoothed to a high finish.

The mould tool has an exactly adjusted temperature of 120°C, and its inner walls are freshly provided with a parting material after each moulding operation.

Onto the cylindrical core there is threaded a woven hose with a length of 80 mm and an internal diamter of 101 mm, the circumferential strands of which consist of highly shrinking threads of polyester with a diameter of 0.102 mm. The strands running across these threads consist of polyamide 66 and they have a diameter of 0.07 mm. The threads running circumferentially and transversely thereto are connected together frictionally. The gaps between the threads running circumferentially amount to about 0.4 mm, and between the threads running transversely to them about 0.6 mm.

By radiant and conducted heat the shrinking forces of the woven hose are activated optimally in the course of 5 minutes, and in consquence the woven hose lies tightly and without folds against the surface of the mould core.

Thereupon a bubble-free polyurethane reaction mixture is prepared in a pouring machine, and is uniformly introduced into the hollow mould. The reaction mixture than uniformly penetrates the pores of the reinforcement, and the threads are embedded fully in the elastomeric material which then forms.

After a reaction period of 15 minutes the elastomeric material is thoroughly firm, so as to be able to accept the pre-stressing of the shrinking fibres, so that de-moulding is possible. Finishing treatment consists of smoothing of the surface by a grinding operation, and cutting off of the aprons to a desired width of 30mm each.

CLAIMS

1. Method of manufacture of a drawing apron of an elastomeric material and with a textile reinforcement extending in the circumferential direction, in which a hardenable polymeric material is applied to the reinforcement supported on a mould core, and thereafter is hardened, so that a bond results between the reinforcement and the elastomeric material, characterised in that a reinforcement, which is made endless and which can shrink in the circumferential direction , is applied onto the mould core of a hollow mould, the reinforcement is pressed against the surface of the core by activation of the shrinking forces, and the remaining space of the hollow mould and the pores of the reinforcement are filled with a liquid reaction mixture of a polyurethane elastomer, which is hardened, and which thereupon makes a firm bond to the reinforcement, so that the drawing apron thereafter can be removed from the hollow mould and be made ready.

2. Method according to claim 1, characterised in that the activation of the shrinking forces of the reinforcement and the polymerisation of the elastomeric material are produced by a single heating.

3. Method according to claims 1 and 2, characterised in that a polyurethane elastomer is used, which in the hardened condition has a surface hardness of 60 to 94 Shore A, preferably a hardness of 70 Shore A.

4. Reinforcement for use in a method according to claims 1 to 3, characterised in that it consists of a woven hose with shrinking threads extending in the circumferential direction, which are adhered or bound together in the transverse direction by staple and/or continuous threads.

5. Reinforcement according to claim 4, characterised in that the shrinking fibres alone, or together with similar or other kinds of fibres, in each case form a strand of comparable width, running circumferentially.

6. Reinforcement according to claim 5, characterised in that the fibres of different kind, at the temperatures to be used for the activation of the shrinking forces, have no change of length or an irregular one.

7. Reinforcement according to claim 6, characterised in that the shrinking fibres and the fibres of different kind are twisted, adhered, or knitted together.

8. Reinforcement according to claims 4 to 6, characterised in that the shrinking fibres are polyacryl-nitrile, modacryl, or polyester fibres.

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