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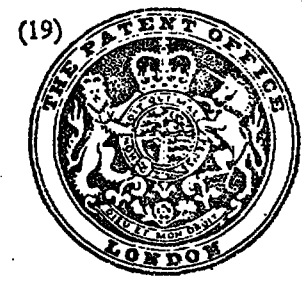
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(54) BONDING COMPOSITION

(71) We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America, of 343 State Street, Rochester, New York 14650, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a bonding composition for bonding together man-made fibres to form them into non-woven articles. The bonding composition is particularly suitable for use with crimped textile tows to be formed into tobacco smoke filter rods. The invention also relates to such tobacco smoke filter rods.

Tobacco smoke filter rods formed from man-made fibres, such as cellulose acetate fibres, are well-known and have been described in a number of patent specifications, such as United States Patent Specifications Nos. 2,794,239 and 3,017,309.

The use of bonding plasticizers to obtain more rigid tobacco smoke filter rods, thus eliminating the collapse of the filter rod when it becomes moist during smoking, is also well-known. For instance, United States Patent Specifications Nos. 3,003,504, 3,008,474 and 3,229,699 disclose plasticizers for this use.

Bonding plasticizers of the prior art may be prepared from esters of glycerol or esters of triethylene glycol. Such plasticizers are externally applied in relatively small quantities to a mass of individual filaments. The surface of the filaments, wherever plasticizer is present, quickly becomes soft and sticky due to the mild solvent action of the plasticizers. At the points where individual filaments touch each other, the softened surfaces merge together in a homogeneous mass. This phenomenon occurs in the first few minutes after the

plasticizer has been applied. As time passes, the plasticizer migrates deeper into the filaments, the surface concentration becomes less and less, and the surface begins to harden or cure. The surface is no longer soft and tacky, but has returned essentially to its original consistency. At those places where filaments contact each other, a strong solid weld has taken place. These welded intersections hold each filament firmly in position relative to adjacent filaments, and an overall rigid structure results. A more rigid internal structure is present in the filter rods produced from the tow, and facilitates further processing of the rods into tips or filter elements for attachment to cigarettes.

Cellulose acetate fibres bonded with a prior art plasticizer, such as glycerol triacetate, have a disadvantage from the standpoint of subsequent disposal after use because the bond is permanent. Filter cigarette butts are discarded in public places where they are unsightly. Filters prepared with prior art bonding plasticizers remain firmly bonded together even after being buried in the ground for one year and exposed to about 40 inches of rainfall. Filter cigarette butts are also discarded in public and private sewage systems where they may block screens and/or pipes in the system. These problems may be alleviated, if not overcome, when the fibres in the filters are not bonded permanently together.

This invention provides certain bonding compositions of thermoplastic water and glycol dispersible polymers mixed in certain glycols, and containing water.

The compositions are effective for bonding together man-made fibres, for instance fibres of cellulose acetate or polyesters used for non-woven articles such as tobacco smoke filter rods. Filter elements severed from the filter rods so bonded and subsequently attached to tobacco columns or cigarettes separate into their individual fibres when the filter

elements come into contact with water from the ground, with rain, or with water in a sewage treatment system.

In accordance with the present invention, there is provided a bonding composition comprising 0.1 to 20% by weight of water, at least one glycol selected from 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,2-butanediol and 1,3-butanediol, and at least one polyester which is dispersible in water and the glycol or glycols, the polyester being present in an amount of from 5% to 50% by weight of the composition, and preferably in the amount of 15% to 35% by weight of the composition, and being selected from polyesters of combinations of isophthalic acid and the sodium, potassium or lithium salt of sulphisophthalic acid reacted with diethylene glycol or triethylene glycol, or terephthalic acid and the sodium, potassium or lithium salt of sulphisophthalic acid reacted with diethylene glycol or triethylene glycol.

When a tow, for instance a cellulose acetate tow, is treated with a water-dispersible polyester-glycol blend in the accordance with the invention, a firm non-tacky tobacco smoke filter rod may be formed in a few minutes. The liquid glycol and water in the bonding composition function as a carrier or dispersion medium for the polymeric adhesive. After the blend is applied to the fibres and the filter rod is formed, the water evaporates and the liquid glycol migrates into the fibres leaving the polymeric adhesive on their surfaces to form bonds at various contact points throughout the filter rod. The liquid glycol is important in the formulation only because it prevents tackiness and premature adhesive action of the formulation, which would otherwise coat the surfaces of the rod making equipment. This would cause the fibres to adhere to the rod making equipment, resulting in severe rod forming problems.

It has been established by a two-step extraction of bonded rods that the polymeric adhesive and liquid glycol have separated. The liquid glycol in the bonded rod was extracted with diethyl ether leaving the polymeric adhesive on the fibres. After the ether extraction the rod remained firmly bonded. Then the polymeric adhesive, which is insoluble in ether, was extracted with water. After this extraction the rod was no longer bonded.

Tobacco smoke filter rods bonded with these compositions will disintegrate in a few minutes in water, or in a few days in moist soil. The fibres separate from their points of bond and the filters no longer retain their original shape. The separated fibres become mixed with organic fibrous

materials on the ground where they add to the natural mulch. In other words, the bond between filaments is formed by the composition employed, and not, as in the prior art, formed by the material of the fibres.

Polymers useful in the bonding composition of the present invention are the thermoplastic water-dispersible polyesters.

Water-dispersible polyesters which are useful include combinations of isophthalic acid and sodiosulphisophthalic acid reacted with diethylene glycol or triethylene glycol. Others are prepared from terephthalic acid and sodiosulphisophthalic acid reacted with diethylene glycol or triethylene glycol. United States Patent Specification No. 3,734,874 describes examples of the preparation of suitable polyesters, which also include combinations of isophthalic acid and the potassium or lithium salts of sulphisophthalic acid reacted with diethylene glycol or triethylene glycol, and combinations of terephthalic acid and the potassium or lithium salts of sulphisophthalic acid reacted with diethylene glycol or triethylene glycol.

These polyesters may be applied to man-made fibres as solutions or dispersions in the glycols in the form of a spray, or by means of centrifugal force from a rotating brush or drum.

The bonding compositions of the present invention may be applied to filamentary tows, such as crimped filamentary tows, prior to their conversion (for instance) into tobacco smoke filter rods. The crimped tow is thereafter pulled into a filter making machine and converted into such filter rods.

The compositions may be applied to unbloomed, crimped, crystalline tow such as polyester tow and packaged into bales or boxes. Later, the tow can be removed, bloomed (i.e. given increased bulk) and converted to filter rods by means of a filter making device equipped with a heated garniture. Crystalline fibres, such as those made from a polyester, need to be heated to achieve bonding.

The amount of bonding composition applied to the filter material can be widely varied, although 5 to 20% by weight of the bonding composition based on the filter material is more generally used.

When the bonding compositions of the present invention are applied to non-crystalline fibres such as cellulose acetate, the glycol diffuses into the fibre at ambient temperature and bonding occurs. Heat may be applied to accelerate the action.

The bonding compositions disclosed may thus be used to bond man-made fibres

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together at their points of contact with each other without a solvent action taking place between adjacent fibres and subsequent hardening of the partially dissolved material to form bonds between the contacting fibres.

The following examples are provided to illustrate the invention.

Example 1

A tow consisting of 12,000 cellulose acetate fibres of 3.3 denier per filament and crimped to 4.7 crimps/cm. was sprayed with a mixture consisting of 70% by weight 1,2-propanediol, 5% by weight water, and 25% by weight of a copolyester composed of 90 mole % isophthalic acid, 10 mole % sodiosulphoisophthalic acid and 100 mole % of diethylene glycol. The tow, which contained 2.5% by weight of the copolyester, was immediately converted to filter rods in a filter rod-making machine.

The rods became firm in approximately 30 minutes, after which they were cut to 20 mm. lengths and attached to cigarettes. The filter cigarettes were smoked on an automatic smoking machine, and the removal of total particulate matter and nicotine from the smoke was determined. The filters had a resistance to draw of 6.6 cm. of water, and they removed 36% of the total particulate matter and nicotine. (Control filters containing glycerol triacetate removed 37% and 35% of the total particulate matter and nicotine, respectively). The filters remained bonded together during smoking. After the smoking test, one of the filters was placed in a 100 ml. beaker containing 50 ml. of water. The mixture was stirred at a medium rate. After 5 minutes, the filter separated into individual filaments, and after 10 minutes no recognizable filter was present in the water.

Filters prepared from other samples of the same 3.3 denier per filament tow bonded with glycerol triacetate retained their original shape after being agitated in water for a period of 24 hours, after which the test was terminated.

The bonding mechanism was investigated as follows:

Ten cellulose acetate filter rods, weighing 10 grams, containing 10% by weight of the bonding composition described in Example 1, were placed in a Soxhlet extractor and extracted with 100 ml. of diethyl ether for 1 hour. The ether extract was then evaporated, leaving a residue identified by infrared spectroscopy as 1,2-propanediol. The weight of the extract was 0.63 gram. The amount of 1,2-propanediol theoretically present in the ten rods was 0.70 gram.

$$\text{Recovery} = \frac{0.63}{0.70} \times 100 = 90\%$$

After the 1,2-propanediol had been extracted from the rods, they still remained firmly bonded, indicating that the polymeric adhesive was still on the fibres. The rods were then extracted with 100 ml of water for 2 hours. The water was evaporated off and the polymeric adhesive which was left was identified by infrared spectroscopy. The weight of the polymeric adhesive recovered was 0.23 gram. The theoretical amount on the filters was 0.25 gram.

$$\text{Recovery} = \frac{0.22}{0.25} \times 100 = 92\%$$

After the polymeric adhesive had been extracted with water, the rods became limp and the fibres separated from each other.

Example 2

Example 1 was repeated, but with the application of 5% by weight of the copolyester to the tow. The resulting filters separated into their individual fibres after 12 minutes in water.

Example 3

Example 1 was repeated with a tow consisting of 10,000 poly(ethylene terephthalate) fibres of 4.0 denier per filament. The tow, which contained 2.5% by weight of the copolyester described in Example 1, was nontacky and was placed in a container for 24 hours. It was nontacky when it was removed from the container, and it was converted to filter rods in a heated filter rod-making device at 100°C for 5 minutes. The rods became firm immediately and were cut to 20 mm. lengths and attached to cigarettes.

Example 4

Example 3 was repeated with a tow consisting of 10,000 poly(hexamethylene adipamide) fibres of 5.0 denier per filament. The fibres were nontacky at ambient temperature, but they bonded immediately when the tow was drawn through a heated filter making device at 100°C. for 5 minutes.

Example 5

Example 1 was repeated, but the thermoplastic polymer was dispersed in 1,4-butanediol instead of 1,2-propanediol.

Example 6

A tow consisting of 30,000 poly(ethylene terephthalate) fibres of 1.6 denier per