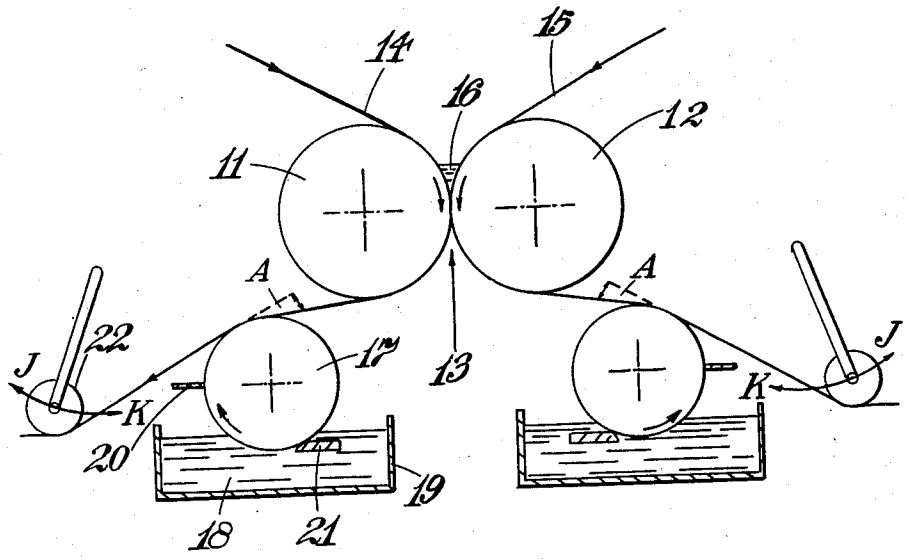
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PRODUCTION OF MOISTUREPROOF SHEET WRAPPING MATERIALS

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PRODUCTION OF MOISTUREPROOF SHEET WRAPPING MATERIALS

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This invention is for improvements in or relating to the production of moistureproof sheet wrapping materials.

It is known to produce moistureproof sheet wrapping materials by applying a moistureproof layer of vinylidene chloride copolymer to the surface of a solid film of water-sensitive, organic, non-fibrous material from an aqueous dispersion of the copolymer. Thus, for example, a process for applying a moistureproof layer of vinylidene chloride/acrylonitrile copolymer to the surface of a solid film or films of water-sensitive, organic, non-fibrous material is described in United States Patent No. 2,618,575. That process comprises introducing into a nip formed between two surfaces of the film or films to be coated an aqueous dispersion of the said copolymer and separating the two surfaces, each with its coating, in a time less than the time of imbibition of water from the aqueous dispersion of the said copolymer through either of the two surfaces. Moreover a method is described in British Patent No. 756,851 whereby solid film of water-sensitive, organic, non-fibrous material is coated on each of its opposite sides with an aqueous dispersion of a polymer formed from a readily polymerisable compound containing the group >C=C< or of a copolymer formed from a polymerisable mixture of two or more such readily polymerisable compounds, by one or the other of two co-directional applicator rolls, but wherein the film passes round the lower half of the periphery of a roll mounted horizontally and arranged vertically above each horizontal applicator roll, either roll of each pair of superposed rolls being mounted to allow movement towards and away from the other.

It has been found, however, that as regards the processes described in Patent No. 2,618,575 and in British Patent No. 756,851, although these known aqueous copolymer dispersion coating processes yield a satisfactory result when operated at relatively low coating speeds, difficulties arise, particularly as regards accurate control of the thickness of the coating, when attempts are made in practice to operate these processes at the higher speeds which are commercially desirable. The coated film, in these circumstances, for example, becomes marred by undesirable streaks and lines running in the direction of travel of the film through the machine. Thus, in the process described in Patent No. 2,618,575, using a base film of regenerated cellulose 0.00115" in thickness, two parallel rollers, each 6" in diameter, rotating about horizontal axes to support the nip formed by the film surfaces, an aqueous vinylidene chloride/acrylonitrile dispersion having a viscosity of 4 centipoises at the coating temperature of 25° C., and a gap of 2.75 thousandths of an inch between the rollers at the nip, it has been found that such streaks and lines tend to appear when the speed of travel of the film to be coated through the coating machine reaches about 28 to 30 metres/minute. The presence of the streaks and lines renders the finished coated film so unsightly as to render it unacceptable for use as sheet wrapping material in the packaging industry. Thus, although these earlier procedures represent a great advance there is still room for improvement.

The operating speed at which the streaks and lines first appear depends upon a number of factors, among which may be mentioned the diameter of the rollers supporting the film at the nip, the viscosity of the aqueous copolymer dispersion employed, and the width of the gap between the rollers at the nip. Thus, the operating speed at which the streaks and lines first appear is raised by (*a*) decreasing the diameter of the rollers, (*b*) decreasing the viscosity of the aqueous copolymer dispersion, and/or (*c*) increasing the width of the gap between the rollers at the nip, but in normal cases the maximum speed at which the process can be operated is about 28 to 30 metres/minute for the reason that (i) the diameter of the rollers cannot be decreased unduly owing to loss of the necessary mechanical strength, (ii) any material decrease in the viscosity of the aqueous copolymer is practically impossible, and (iii) the width of the gap between the rollers at the nip, being determined by the coating thickness required, is capable of but little variation. With regard to (iii) above, it may be noted that if a more dilute dispersion was applied, with the object of permitting the use of a greater width of nip for the same coating thickness, a correspondingly greater drying capacity would be required.

One of the objects of the present invention is to provide a process for applying a moistureproof layer of vinylidene chloride copolymer to the surface of a solid film of water-sensitive, organic, non-fibrous material from an aqueous dispersion of the copolymer, in which the development of unsightly streaks and lines in the finished coated film is avoided even at desirably high coating speeds.

Accordingly, the invention provides a process for forming a smooth continuous coating of a synthetic organic film-forming polymer on the surface of a travelling base sheet of water-sensitive material which process comprises applying to the base sheet a thin coating of a liquid aqueous dispersion of the polymer and while the coating is still wet, bringing the coated surface of the sheet into contact with the barrel of a water-wet smoothing roller rotating in such a direction that at the zone of contact with the coated surface, the barrel of the roller is moving in a direction opposite to the direction of travel of the coated sheet.

The invention also includes a base sheet of water-sensitive material, coated with a smooth, continuous coating of a synthetic organic polymer, when produced by the process in accordance with the present invention.

The coated film of the invention is free from unsightly streaks and lines, even when the coating operation has been carried out at desirably high speeds.

Water-sensitive sheets are characterized in that they absorb water when they are brought into contact with water or water-vapour; in so doing they tend to change their dimensions.

The smoothing roller, which may advantageously have a diameter of between 1½" and 6", and preferably between 2" and 4", may be made of stainless steel or other corrosion-resistant material, and may be driven from one end by any suitable means to cause it to revolve in the required direction.

The smoothing roller may be wetted with water in any suitable known way, for example by partial immersion of the roller in a water-bath, or by contact with a furnish roller, itself partially immersed in a water-bath. The temperature of the water is not critical, and may be between 5° and 50° C.; water at the usual temperature of about 15° C. is quite suitable. Any excess of water applied to the smoothing roller may be removed by means of a doctor blade. A stationary pad of fibrous material, such as felt, may be mounted in contact with the roller

below the surface of the water of the bath to facilitate removal of any deposited polymer.

If the smoothing roller is used dry, the streaks and lines are not entirely removed, as they are when the roller is used water-wet in the process of the present invention. Moreover, dry polymer tends to build upon the dry roller.

The base sheet of water-sensitive material may consist of a web of fibrous material such as paper or may be a film of an organic non-fibrous material such as a smooth, dense, substantially non-porous film of regenerated cellulose produced from viscose, cuprammonium cellulose, or any other aqueous solutions or dispersions of cellulose. Films of alginic acid derivatives, or of protein such as of gelatine or casein, or of lowly substituted cellulose ether or of lowly substituted cellulose ester, or of polyvinyl alcohol, may alternatively be employed.

Various types of synthetic organic film-forming polymers may be employed in the process of this invention. Vinylidene chloride polymer and copolymers are preferred. Among such copolymers may be mentioned (1) copolymers obtained by polymerisation of a mixture comprising (*a*) 35% to 98% by weight of monomeric vinylidene chloride and (*b*) 65% to 2% by weight of monomeric acrylonitrile, the mixture including no other constituent copolymerisable with the monomeric vinylidene chloride and no acidic ethylenic compound, viz. itaconic acid or itaconic anhydride, or citraconic acid or citraconic anhydride, or mesaconic acid, the proportions being selected to total 100%; (2) copolymers obtained by polymerisation of a mixture comprising (*a*) 35% to 96% by weight of monomeric vinylidene chloride (*b*) 65% to 4% by weight of one or a mixture of two or more of the following compounds containing a vinyl group or substituted vinyl group, viz. monomeric methacrylonitrile, a monomeric alkyl ester of acrylic or methacrylic acid, having from 1 to 5 carbon atoms in the alkyl group, monomeric vinyl chloride, monomeric vinyl acetate or monomeric styrene, with or without (*c*) 0.5% to 10% by weight of an acidic ethylenic compound or a mixture of two or more acidic ethylenic compounds, viz. itaconic acid or itaconic anhydride, or citraconic acid or citraconic anhydride, or mesaconic acid, and with or without monomeric acrylonitrile in addition to the vinyl or substituted vinyl compound or compounds, or in substitution for one of the vinyl or substituted vinyl compounds when another is included in the mixture, the proportions being selected to total 100%; (3) copolymers obtained by polymerisation of a mixture comprising (*a*) 35% to 96% by weight of monomeric vinylidene chloride, (*b*) 65% to 4% by weight of monomeric acrylonitrile, and (*c*) 0.5% to 10% by weight of an acidic ethylenic compound or a mixture of two or more acidic ethylenic compounds, viz. itaconic acid or itaconic anhydride, or citraconic acid or citraconic anhydride, or mesaconic acid, the mixture including no other vinyl or substituted vinyl compound, and the proportions being selected to total 100% by weight.

Among other synthetic organic film-forming polymers, mention may be made of polyvinyl chloride and copolymers of vinyl chloride and vinyl acetate. The production of liquid aqueous colloidal dispersions of these polymers is known in the art.

It is not, of course, necessary to coat both sides of the sheet in order to obtain a water-vapour barrier, but it is desirable to do so in order to prevent curling.

The sheet of water-sensitive material may be in the form of cut sheets or of continuous webs.

The liquid aqueous colloidal dispersion of the polymer should be applied to the base sheet in a layer of such thinness that the water thereof is wholly absorbed by the base sheet and the dispersed polymer thereof coalesces to form a smooth, transparent, surface coating. The absorbed water may then be removed from the coated sheet by evaporation by heat, and the coating or coatings may then be subjected to heat at a temperature sufficiently high to consolidate the particles of polymer deposited from the dispersion.

Following is an example, by way of illustration, of the carrying out of the process in accordance with the invention by means of apparatus shown diagrammatically by way of example in the accompanying drawing.

The drawing shows the arrangement of a pair of rollers for applying to each of two base films of regenerated cellulose a thin coating of a liquid aqueous dispersion of the polymer, and of water-wet rotatable smoothing rollers, for forming a smooth continuous coating of a synthetic organic film-forming polymer on a surface of each of the two films in accordance with the process of the invention.

Parts and proportions referred to throughout this specification are parts and proportions by weight unless otherwise stated.

Example

Referring to the drawing, two brass rollers **11** and **12**, each 12" in length and 6" in diameter, are mounted with their axes horizontal and parallel. The gap **13** between the rollers **11** and **12** is adjusted to a width of 0.0022". Two sheets of commercial "plain" (as differentiated from further treated, e.g. moistureproofed) regenerated cellulose film (which is water-sensitive, organic and non-fibrous) **14** and **15**, each 0.00085" thick and 10" wide, are fed through the nip, and the rollers **11** and **12** are caused to rotate in a clockwise and an anticlockwise direction respectively at equal speeds. An aqueous dispersion containing, in colloidal dispersion, 45% of vinylidene chloride/acrylonitrile copolymer (85:15) is fed into the nip at a rate of 0.001 cu. inch for each inch of travel of the roller peripheries, and by means of air-jets (not shown) directed at points ¼ inch from the edges of the sheets the dispersion is retained in a small pool or reservoir **16**, 9½ inches wide and not more than ¼ inch deep.

The distance of contact of the surfaces of the sheets with the dispersion before separation of the surfaces is about ½", and the peripheral speed of the rollers is 93 feet per minute. The time of imbibition of water from the aqueous dispersion of the copolymer through either of the two film surfaces was 1½ seconds.

On emerging from the nip, the two sheets are separated. Sheet **14** passes over, and with its coated surface in contact with a water-wet rotatable smoothing roller **17** driven by means not shown in the direction indicated. Roller **17** is made of stainless steel, and has a diameter of 3". The roller **17** is partially immersed in water **18** contained in the bath **19**.

The roller **17** is mounted at a distance of 12 inches from the nip, and thus at such a distance from the nip that, at the speed of travel of sheet **14**, it is less than the distance travelled by the coated sheet during the time of imbibition of water from the aqueous dispersion of the copolymer through the surface of the sheet **14**, so that, while the aqueous dispersion of the coating applied to sheet **14** is still liquid, the surface of the coating is smoothed by contact thereof with the roller **17**.

Doctor blade **20** is arranged to remove any excess water from the surface of roller **17**, and to leave only a thin layer thereon. The water in bath **19** may be replenished by any known means (not shown). The pad **21** of fibrous material is arranged to press against the surface of the roller **17** below the surface of the water **18** in bath **19**, to clean the surface of the roller **17**.

The coated sheet **14** is deflected in its path, so as to make contact with the roller **17**, by passage under jockey-roller **22**, which contacts the uncoated surface of sheet **14**. The amount of contact which sheet **14** makes with roller **17** has but little effect on the efficiency with which the streaks and lines are eliminated. Thus if the sheet **14** has perfect characteristics, a substantially tangential contact with roller **17** is sufficient. If, however, sheet

14 shows the defect of "droop," arising from the sheet having a greater length at the edges than at the centre, the angle of contact of the sheet **14** with the roller should be increased, until the sheet **14** is in contact over its whole width with the roller **17**. Thus the position of the roller **22** may be adjusted along the arc JK. However, the angle A, which is a measure of the deflection of the coated sheet **14** from its path, should not exceed 90°.

A similar separate smoothing roller and accompanying equipment are associated with sheet **15**.

Sheets **14** and **15** are after treatment dried by exposure to radiation from an electric fire for 5 seconds. The gap **13** between the rollers **11** and **12** is then increased to 0.0024", the sheets reintroduced, but this time with their previously coated sides towards the nip-rollers **11** and **12**, and the copolymer dispersion in applied as before. After evaporation of the water, the coatings are consolidated by exposure to radiation from an electric fire for 15 seconds. A layer 0.00005" thick is left on each side of the sheet.

The moistureproof sheet wrapping materials thus produced are clear and transparent, and free from lines and streaks, and have a permeability value of 120.

The "permeability value" was determined by the method of Charch and Scroggie for measuring permeability, as described in Paper Trade Journal TAPPI Section, October 3, 1935, pages 201–209.

I claim:

1. A process for forming a smooth continuous coating of a synthetic organic film-forming polymer selected from the group consisting of homopolymers and copolymers of ethylenically unsaturated compounds on the surface of a travelling film of a water-sensitive organic non-fibrous material which process comprises applying to the film a thin coating of a liquid aqueous dispersion of said polymer and before the aqueous phase of the aqueous dispersion of the coating has been imbibed by the film, bringing the coated surface of the film into contact with the barrel of a water wet smoothing roller rotating in such a direction that at the zone of contact of the roller with the coated surface of said film, the barrel of the roller is moving in a direction opposite to the direction of travel of the coated film, each point on the barrel of the roller being supplied with a fresh film of water upon each revolution of the roller before making fresh contact with the coated film.

2. The process of claim 1 wherein said polymer is the homopolymer of vinylidene chloride.

3. The process of claim 1 wherein said polymer is a copolymer of vinylidene chloride and another ethylenically unsaturated compound copolymerizable with said vinylidene chloride.

4. The process of claim 1 wherein said polymer is a copolymer consisting by weight of 35–96% vinylidene chloride, 4–65% methyl methacrylate, and 0.5–10% itaconic acid.

5. A process for forming a smooth continuous coating of a synthetic organic film-forming polymer selected from the group consisting of homopolymers and copolymers of ethylenically unsaturated compounds on the surface of a base sheet of a water-sensitive organic non-fibrous material which process comprises applying to the base sheet a thin coating of a liquid aqueous dispersion of the polymer and before the aqueous phase of the aqueous dispersion of the coating has been imbibed by the base sheet bringing the coated surface of the sheet into contact with the barrel of a smoothing roller maintained water wet by partial immersion in a water bath, the water wet smoothing roller rotating in such a direction that at the zone of contact with the coated surface of said sheet, the barrel of the roller is moving in a direction opposite to the direction of travel of the coated sheet, each point on the barrel of the roller being supplied with a fresh film of water upon each revolution of the roller before making fresh contact with the coated surface.

6. The process of claim 5 which includes contacting the surface of said barrel while immersed in said bath with a stationary pad to remove any of said polymer adhering thereto.

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