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Description**BACKGROUND OF THE INVENTION**

5 This invention relates to a coating apparatus according to the precharacterising part of claim 1 and to a method for applying a coating solution onto a belt-shaped flexible support.

An apparatus and a method of this type are known from e.g. JP-A-2 223 945. Such an apparatus and such a coating method are used for applying a variety of liquid-phase compound materials to a belt-shaped flexible support (hereinafter referred to as "a web", when applicable) which is run continuously, to manufacture photographing photo-sensitive materials such as photographing film and photographic paper, photographic printing plate, pressure-sensitive sheets, heat-sensitive sheets, and so forth.

10 Examples of a conventional coating method in which a web is electrostatically charged to coat it with a coating solution, are for instance as follows:

15 (1) First coating method: In coating a web with a coating solution, a DC, AC or pulse high voltage (300 to 2000 volts) is applied between a coating nozzle and a backup roller supporting the web, thereby to prevent discontinuation of the bead between the web and the coating nozzle (British Patent No. 1,166,500-B).

(2) Second coating method: In coating a web having a undercoat layer of gelatin containing surface active agent, similarly as in the first coating method a DC high voltage is applied to the backup roller (US Patent No.4,837,045).

20 (3) Third coating method: The web is processed in advance as follows: That is, the web is electrostatically

charged by corona discharge, and is heated to make the distribution of electrostatic charges uniform, and then cooled. The web thus processed is coated with a coating solution. When the web is coated in this manner, no streaks are formed on the resultant coating solution layer on the web. That is, the third coating method is to eliminate the difficulty that streaks are formed on the coating solution layer on the web.

25 The first and second coating methods suffer from the following problem: In the case where the surface of the web is relatively large in the number of polar groups; for instance in the case where, as in the case of the second coating method, the web contains surface active agent, the coating condition of the surface of the web is improved which is probably due to the orientation of the polar groups in the surface of the web as well as an electrostatic attraction force provided by the electric field applied thereto, as a result of which the coating speed can be increased. On the other hand, in the case where the surface of the web is relatively small in the number of polar groups (the number of polar groups per unitary area of the part of the web which is 1 μm in thickness from the surface being 4×10^{-3} equivalent/ m^2 or less), the coating condition of the surface of the web is not bettered, and the coating speed cannot be increased so much as expected.

35 In the third coating method, the surface of the web is made uniform in potential distribution by heating the web which has been electrostatically charged, whereby the difficulty is eliminated that streaks are formed on the coating solution layer on the support. However, in the part of the web which is heated, the surface potential is lowered, as a result of which it is difficult to maintain the surface potential so high, and the coating speed cannot be increased so much as expected. Another method and apparatus for applying a coating liquid to a moving web is known from EP-A-0 299 492.

SUMMARY OF THE INVENTION

45 Accordingly, an object of this invention is to eliminate the above-described difficulties accompanying a conventional coating method.

More specifically, an object of the invention is to provide a coating method in which, even in the case where the surface of a web is relatively low in the number of polar groups, a relatively high potential can be uniformly applied to the surface of the web, and the critical coating speed can be greatly increased.

50 The foregoing object of the invention has been achieved by the coating apparatus as defined in claim 1 and by the coating method as defined in claim 2.

The nature, principle, and utility of the invention will be more clearly understood from the following detailed description of the invention when read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING(S)

55 In the accompanying drawing:

FIG. 1 is a side view outlining the arrangement of one example of a coating apparatus practicing a coating method

of the invention; and

FIG. 2 is also a side view outlining the arrangement of another example of the coating apparatus practicing the coating method of the invention.

DETAILED DESCRIPTION OF THE INVENTION

With a coating apparatus shown in FIG. 1, the surface of a web 1 is made single polar by electrostatically charging it by corona discharge. The web 1 is heated to 35°C to 45°C while passing through a heating zone 2. The web 1 thus heated is electrostatically charged by a corona discharge electrode 7 which is connected to a DC high voltage source 3 and is confronted with a grounding electrode 8, so that the surface of the web is made single polar, having a potential of 0.5 to 2 kV. The web 1 thus processed is delivered to a coating backup roller 4 while being maintained sufficiently high in temperature, where a coating solution 6 from a coating nozzle 5 is applied to the web.

In the case of FIG. 2, a DC high voltage is applied to a web 1 at a backup roller. Similarly as in the case of FIG. 1, the web 1 is heated to 35°C to 45°C at a heating zone 2. The web 1 thus heated is delivered to a coating backup roller 4 to which a DC high voltage is applied by a DC high voltage source 3, where a coating solution 6 from a coating die 5 is applied to the web 1.

As was described above, in the coating method of the invention, the web is heated to 35°C to 45°C. This will be described in more detail.

Heretofore, a coating operation is carried out at a room temperature of 20°C to 25°C. In the invention, the web is heated to 35°C to 45°C by convection by using hot air, or by conduction by bringing it into contact with a high temperature pass roll, or by radiation by using infrared rays. If the temperature of the web thus heated is less than 35°C, then the macromolecules in the surface of the web are greatly limited in mobility, so that the coating speed cannot be increased so much as expected. In addition, when the temperature of the web is higher than 45°C, then the coating solution setting conditions are not satisfied.

Furthermore, in the coating method of the invention, the surface potential of the web on the backup roller is set to 0.5 to 2.0 kV. For this purpose, two methods are employed; in the first method, the web is charged by corona discharge; and in the second method, a DC voltage is applied to the backup roller.

In the first method, preferably a wire-like conductor 100 µm to 200 µm in diameter is laid tight with a tension of 1 kg or higher, and intermediate frames support the wire at points spaced at an interval of not more than 300 mm. Each intermediate holding frame is shifted in the longitudinal direction on each wire from a superposed (aligned) position on the wires in the transfer direction with a shift ≥ 20 mm from the immediately previous adjacent wire so that the distance between the wire-like, electrode and the web is smaller at the end of the wire than at the middle. In this case, the variations in potential in the direction of conveyance of the web and in the direction of width of the latter can be minimized, and therefore, the difficulty can be substantially eliminated that the coating solution layer becomes non-uniform in thickness because of the variations in potential (US Patent No. 5,138,971).

In the case of the second method, it is preferable that the journal of the backup roller is insulated with a ceramic cover and supported with a fluid bearing, and a connecting terminal other than a brush type slip ring is provided at a rotary part which is an extension of the journal, and connected to the DC high voltage source. In the second method, when compared with the conventional method in which a ball bearing is employed, the rotation is steady. Furthermore, when compared with the case where the brush-type slip ring is employed, a high voltage of 0.5 to 3 kV can be positively applied (cf. Japanese Patent Application (OPI) No. 251266/1990).

Employment of the above-described two methods in combination, the surface of the web on the backup roller can be set uniformly to 0.5 to 2.0 kV, preferably 0.5 to 1.2 kV. As a result, the polar groups of macromolecules are orientated in the surface of the web, thus increasing the web's surface energy, which improves the coating conditions. In addition, the electrostatic attraction force by the electrostatic field facilitates the sticking of the coating solution to the surface of the web.

In the invention, the term "belt-shaped flexible support" or "web" as used herein is intended to include those of paper, plastic film, resin-coated paper, and synthetic paper. Examples of the material of the plastic film are polyolefins such as polyethylene and polypropylene, vinyl copolymers such as polyvinyl acetate, polyvinyl chloride and polystyrene, polyamide such as 6,6-nylon and 6-nylon, polyesters such as polyethylene terephthalate, polyethylene-2, and 6-naphthalate, and polycarbonate, and cellulose acetates such as cellulose triacetate and cellulose diacetate. An undercoat layer of gelatin may be formed on the web as the case may be. The resin employed for manufacture of the resin-coated paper is typically polyolefin such as polyethylene. A web of resin-coated paper is not limited in surface roughness; that is, not only a web of resin-coated paper whose surface is smooth, but also one whose surface is rough can be employed.

Even in the case where the web is such that its surface is relatively low in the number of polar groups (the number of polar groups per unitary area of the part of the web which is 1 µm in thickness from the surface being 4×10^{-3} equivalent/m² or less), the occurrence of an air entrainment phenomenon (obstructing the application of a coating solution to a web) which limits the critical coating speed is prevented accordingly to the invention. That is, the critical

coating speed is increased according to the invention.

The term "coating solution" as used herein is intended to include a variety of coating solutions, such as those used to form a photo emulsion layer, undercoat layer, protective layer and a back layer thereby to form a photographing photo-sensitive material, or those for forming an adhesive layer, coloring layer, rust-proofing layer, etc. Those coating solutions may contain water-soluble binder, or organic binder.

In applying the coating solution to the web, for instance a slide coating method, roller bead coating method, spray coating method, extrusion coating method, and curtain coating method may be employed.

Concrete Example

As conducive to a full understanding of the invention, its concrete example will be described. However, it should be noted that the invention is not limited thereto or thereby.

A web was prepared by forming a gelatin layer 0.3 μm in thickness on a coating surface of a polyethylene resin coated sheet 220 μm in thickness, and an alumina-sol layer on the rear surface. The coating surface had an average surface roughness (R_a) of 4 to 5 μm . The surface of the web was 3×10^{-3} equivalent/m² in the number of polar groups.

Color paper coating solutions were employed. The layer structure was made up of three photo-sensitive layers containing silver halide, three color filter layers, and one protective layer. A total quantity of coating solutions supplied per unitary web area 1 m² was 106 ml. As for the lowermost layer, namely, a yellow coloring layer, the density of gelatin was 6% by weight, the viscosity was 40 cp (with a shear rate of 50 sec⁻¹), and the quantity of supply was 14.4 ml/m².

A slide bead coating method was employed. The pressure of the pressure reducing chamber was set to a value lower by 40 mm H₂O than the atmospheric pressure. The gap between the end of the coating nozzle and the web was about 400 μm .

A heating method using a hot air at 70°C to 50°C was employed. The length of the web in the heating zone was 18 m. The temperature of the web which was going to be coated being on the coating backup roller was measured as a web temperature.

The web was electrostatically charged as shown in FIG. 1. In this operation, the distance between the backup roller 4 and the corona discharge electrode 7 adapted to electrostatically charge the web by corona discharge so as to make the web's surface single polar was short, 2 m. Thus, the web was substantially free from temperature difference.

The surface potential of the web which was going to be coated being on the coating backup roller was measured as a web temperature. The critical speeds were measured when, depending on the web potential and web temperature, an air layer accompanying the web obstructed the application of the coating solution to the web. The results of measurement are as indicated in the following Table 1:

Table 1

	0 kV	0.5 kV	1.0 kV	1.2 kV
22°C	178 m/min	200 m/min	204 m/min	203 m/min
32°C	180 m/min	205 m/min	218 m/min	228 m/min
38°C	195 m/min	240 m/min	248 m/min	260 m/min
45°C	197 m/min	243 m/min	255 m/min	270 m/min

In the concrete example, the web temperatures were 38°C and 45°C, and the web potentials were 0.5 kV, 1.0 kV, and 1.2 kV, as indicated in Table 1. In the prior art, with 22°C and 0.5 kV, the critical coating speed was 200 m/min, as shown in Table 1. However, this critical coating speed was increased to 240 m/min. by raising the web temperature to 38°C according to the invention. In addition, in the prior art, with 22°C and 1.2 kV, the critical coating speed was 203 m/min. This critical coating speed was increased to 270 m/min.

Furthermore, in the concrete example, the surface of the product was satisfactory being free from defects such as streaks and non-uniform thickness.

As is apparent from the above-description, according to the coating method of the invention, even in the case where the surface of the web is relatively low in the number of polar groups, relatively high potential can be provided uniform on the surface of the web, and the critical coating speed can be greatly increased.

While there has been described in connection with the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined in claim 1 and in claim 2.

Claims

1. A coating apparatus comprising:

5 a backup roller (4);

a belt-shaped flexible support (1) supported on said backup roller (4);

10 heating means (2) for heating said belt-shaped flexible support (1);

discharging means (7, 8; 3, 4) for setting a surface potential of said belt-shaped flexible support (1); and

a coating nozzle (5) applying a coating solution onto a surface of said belt-shaped flexible support (1),

15 wherein said heating means (2) is disposed upstream said discharging means (7, 8; 3, 4), and said coating nozzle (5) is arranged downstream said discharging means (7, 8; 3, 4),

characterized in that

20 said heating means (2) are adapted for heating said belt-shaped flexible support (1) to 35°C to 45°C, and

said discharging means (7, 8; 3, 4) are adapted for setting said surface potential from 0.5 to 2kV.

2. A method for applying a coating solution onto a belt-shaped flexible support (1) which is being run continuously, said belt-shaped support (1) being supported on a backup roller (4), and said coating solution being supplied from a coating nozzle (5), and applied to said support (1), comprising the steps of:

25 heating said support;

30 setting a surface potential of said support on said backup roller; and

applying said coating solution onto said support;

characterized in that

35 said support (1) is heated to 35°C to 45°C; and

said surface potential is set to 0.5 to 2.0kV.

Patentansprüche

1. Eine Beschichtungsvorrichtung, umfassend:

45 eine Stützwalze (4);

einen bandförmigen flexiblen Träger (1), der auf der Stützwalze (4) gehalten ist;

50 eine Heizeinrichtung (2) zum Erwärmen des bandförmigen flexiblen Trägers (1);

eine Entladeeinrichtung (7, 8; 3, 4) zum Einstellen eines Oberflächenpotentials des bandförmigen flexiblen Trägers (1); und

55 eine Beschichtungsdüse (5) zum Aufbringen einer Beschichtungslösung auf eine Oberfläche des bandförmigen flexiblen Trägers (1);

in welcher die Heizeinrichtung (2) stromaufwärtsseitig in bezug auf die Entladeeinrichtung (7, 8; 3, 4) und die Beschichtungsdüse (5) stromabwärtsseitig in bezug auf die Entladeeinrichtung (7, 8; 3, 4) angeordnet ist,

dadurch gekennzeichnet, daß

die Heizeinrichtung (2) zum Erwärmen des bandförmigen flexiblen Trägers (1) auf 35°C bis 45°C ausgelegt ist, und

die Entladeeinrichtung (7, 8; 3, 4) zum Einstellen des Oberflächenpotentials von 0,5 bis 2 kV ausgelegt ist.

2. Ein Verfahren zum Aufbringen einer Beschichtungslösung auf einen bandförmigen flexiblen Träger (1), der kontinuierlich bewegt wird, wobei der bandförmige Träger (1) auf einer Stützwalze (4) gehalten ist und die Beschichtungslösung aus einer Beschichtungsdüse (5) zugeführt und auf den Träger (1) aufgebracht wird, umfassend die Schritte:

Erwärmen des Trägers;

Einstellen eines Oberflächenpotentials auf dem Träger auf der Stützwalze; und

Aufbringen der Beschichtungslösung auf den Träger;

dadurch gekennzeichnet, daß

der Träger (1) auf 35°C bis 45°C erwärmt wird; und

das Oberflächenpotential auf 0,5 bis 2,0 kV eingestellt wird.

Revendications

1. Appareil d'enduction, comprenant :

un cylindre d'appui (4) ;

un support flexible en forme de bande (1) supporté sur ledit cylindre d'appui (4) ;

des moyens de chauffage (2) destinés à chauffer ledit support flexible en forme de bande (1) ;

des moyens de décharge (7, 8 ; 3, 4) destinés à fixer un potentiel de surface dudit support flexible en forme de bande (1) ; et

une buse d'enduction (5) appliquant une solution de revêtement sur une surface dudit support flexible en forme de bande (1),

dans lequel lesdits moyens de chauffage (2) sont disposés en amont desdits moyens de décharge (7, 8 ; 3, 4) et ladite buse d'enduction (5) est agencée en aval desdits moyens de décharge (7, 8 ; 3, 4),

caractérisé en ce que

lesdits moyens de chauffage (2) sont adaptés pour chauffer ledit support flexible en forme de bande (1) entre 35 °C et 45 °C, et

lesdits moyens de décharge (7, 8 ; 3, 4) sont adaptés pour fixer ledit potentiel de surface entre 0,5 et 2 kV.

2. Méthode pour appliquer une solution de revêtement sur un support flexible en forme de bande (1) qui est déplacé continuellement, ledit support en forme de bande (1) étant supporté sur un cylindre d'appui (4) et ladite solution de revêtement étant délivrée par une buse d'enduction (5) et appliquée audit support (1), comprenant les étapes consistant à :

chauffer ledit support ;

fixer un potentiel de surface dudit support sur ledit cylindre d'appui ; et

appliquer ladite solution de revêtement sur ledit support ;

caractérisée en ce que

ledit support (1) est chauffé entre 35 °C et 45 °C ; et

ledit potentiel de surface est fixé entre 0,5 et 2,0 kV.

FIG. 1

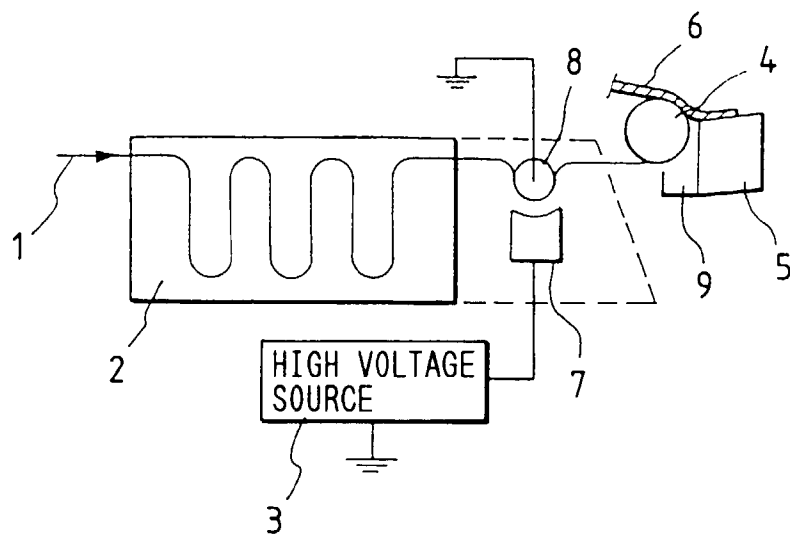


FIG. 2

