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(54) **Process for producing castcoating papers.**

(57) Cast-coated papers produced by the two-stage treatment with a highly polished drum performed in accordance with the present invention retain the high degrees of gloss and smoothness which are characteristic of cast-coated papers, that are free from such surface imperfections as low surface strength and uneven adhesion between the base paper and the cast-coated layer, and that have sufficiently high water content to provide improved resistance to curling and surface waviness.

EP 0 428 057 A2

PROCESS FOR PRODUCING CAST-COATED PAPERS

The present invention relates to a process for producing cast-coated papers. More particularly, this invention relates to a process for producing cast-coated papers that have high degrees of gloss and smoothness, that are free from surface imperfections such as low surface strength and problems caused by uneven adhesion between the base paper and the cast-coated layer, and that have improved resistance to curling and other undesirable qualities affecting paper.

Because of advantages such as high degrees of surface gloss and smoothness, cast-coated papers permit printing to be performed with consistent results, so they are suitable for precise and high-grade printing operations and are extensively used in artistic printed matter, high-quality catalogs, the front covers of magazines, labels, wrapping papers, etc.

Cast-coated papers are conventionally produced by a process that comprises applying an aqueous pigment coating (i.e., a composition that contains a pigment and an adhesive as main components) onto the surface of a base paper to form a pigment coating layer, which is then pressed and dried in contact with a heated, highly polished metal drum.

While this process is practiced in several ways, they can be roughly divided into three types, a wet (direct) method, a gelation (coagulation) method and a re-wet (indirect) method in accordance with the manner in which the pigment coating layer is pressed and dried in contact with the heated, highly polished metal drum to obtain a cast-coated paper with a glossy surface. In the wet method, the pigment coating layer is pressed and dried in contact with the heated metal drum while it is still in a wet and plasticized state. In the gelation method, the pigment coating layer is passed through a coagulating bath so that it gels and becomes plasticized before it is pressed and dried in contact with the heated metal drum. In the re-wet method, the pigment coating layer is first dried, then optionally supercalendered, and thereafter re-wetted with a wetting solution to be rendered plasticized so that it can be pressed and dried in contact with the heated metal drum to give a glossy surface.

The three basic processes for producing cast-coated papers share the common feature that the pigment coating layer, while it is in a plasticized state, is pressed and dried in contact with a heated, highly polished drum. Hence, the water in the pigment coating layer partly evaporates through the base paper and partly through the pigment coating layer toward the drum surface. If the rate of water evaporation exceeds a certain level, pinholes will develop in the surface of the cast-coated layer and the resulting cast-coated paper is no longer suitable for use in printed matter. In other words, the rate of production of cast-coated papers is reduced.

If the surface of the pigment coating layer is subjected to rapid heating and evaporation, blisters will form and part or all of the pigment coating layer will adhere onto the highly polished drum surface to make subsequent casting operations impossible. If, on the other hand, the pigment coating layer is fed onto the drum surface while it is at low temperature, insufficient drying and cast-coated paper release often causes such problems as lifting of the pigment coated surface, picking and failure to achieve a satisfactory gloss due to poor casting. Even if the temperature conditions are maintained within an appropriate range, the highly polished drum surface becomes stained over time and the resulting decrease in paper release quality will in many cases cause imperfections in the surface of the cast layer such as loss of gloss and picking.

Even if there are no problems in the casting conditions and cast-coated papers having satisfactory surfaces are produced, conventional cast-coated papers usually have a pigment coating layer on only one side and tend to curl during heating and drying steps. This tendency becomes more conspicuous as the basis weight of the cast-coated paper decreases (i.e., as it becomes thinner). Since the pigment coating layer must be thoroughly dried to insure smooth release from the drum surface, the water content of the cast-coated paper will decrease and it will readily experience deformations such as curling and surface waviness upon absorption of moisture.

As a result of the intensive studies conducted to eliminate the aforementioned defects of the prior art methods for producing cast-coated papers, the present inventors successfully solved the problems by modifying the step of finishing papers to have a high surface gloss. The present invention has been accomplished on the basis of this success.

The present invention relates to an improvement of a process for producing a cast-coated paper that comprises the basic steps of: applying onto the surface of a base paper an aqueous pigment coating that contains a pigment and an adhesive as main components, whereby a pigment coating layer is formed; pressing the pigment coating layer onto a heated, highly polished metal drum; and drying said pigment coating layer in contact with the heated drum. The improvement comprises a two-stage process in which

subsequent to the first stage of treatment with a highly polished drum which consists of pressing the pigment coating layer, while it is in a plasticized state, onto the heated, highly polished metal drum and drying said pigment coating layer in contact with the drum, the dried pigment coating layer is subjected to the second stage of treatment with a highly polished drum in which it is re-wetted with a re-wetting solution, pressed onto a heated, highly polished metal drum, and dried in contact with the drum.

Other objects and advantages of the present invention may become apparent to those skilled in the art from the following description.

It is known that the gloss and smoothness of cast-coated papers can be improved by selecting a proper formulation of the pigment, latex and additives in the pigment coating layer or by controlling the conditions of pressing the pigment coating layer onto a heated, highly polished metal drum. On the other hand, these approaches sometimes impair qualities of the product paper such as its air permeability and release properties and no completely satisfactory results have been attained by adopting those techniques alone. It is also known that if moisture evaporation from the pigment coating layer is too rapid, the layer will be damaged and pinholes or blisters will form. In order to avoid these problems, attempts have been made to enhance the air permeability of the base paper or to improve the air permeability of the pigment coating layer by modifying the recipe for pigments and latices. However, the improvements that can be achieved by these approaches are limited and, furthermore, substantial modifications to the formulation of the aqueous pigment coating often cause adverse effects on such important factors as the viscosity of the aqueous pigment coating and the quality of the cast-coated paper as the final product. Thus, no completely satisfactory results have been achieved by the previous attempts.

As for the problems of curling and surface waviness of cast-coated papers, it is known that increasing the water content of the papers by lowering the casting temperature so that no rapid evaporation of water will take place is effective. However, this method not only reduces the rate of production of cast-coated papers; no completely satisfactory results have been attained.

The present inventors conducted intensive studies to overcome these difficulties and found that by finishing a cast-coated layer to a high gloss under mild conditions through a two-stage treatment with a highly polished drum, high degrees of gloss and smoothness could be retained and surface imperfections such as low surface strength and uneven adhesion between the base paper and the cast-coated layer could be eliminated and yet improved resistance to curling and surface waviness could be achieved. The present invention has been accomplished on the basis of this finding.

In accordance with the two-stage treatment with a highly polished drum, high degrees of gloss and smoothness are imparted to a cast-coated layer by the first stage of treatment with a highly polished drum and, then, the pigment coating layer is re-wetted with a re-wetting solution and thereafter pressed onto a highly polished drum surface having a temperature of no more than about 100° C, preferably no more than about 90° C, and dried in contact with said drum under mild conditions. As a result, higher degrees of gloss and smoothness could be imparted and surface imperfections such as low surface strength and uneven adhesion between the base paper and the cast-coated layer could be eliminated. Further, the mild drying conditions and the treatment with a re-wetting solution contributed to an increase in the water content of the cast-coated paper as the final product, whereby improved resistance to curling and surface waviness could be achieved.

Details of the present invention are described below. The first stage of treatment with a highly polished drum can be carried out with marked results whether it is by the wet (direct) method, the gelation (coagulation) method or the re-wet (indirect) method.

The aqueous pigment coating that is used to provide a cast-coated layer on the surface of a base paper may be of any type commonly used in the art to provide aqueous pigment coating on paper. The main components of this aqueous pigment coating are a pigment and an adhesive and it may optionally contain suitable additives including release agents, colorants, defoamers, viscosity modifiers, water-proofing agents, etc. as required.

Suitable pigments include clays, kaolin, aluminum hydroxide, calcium carbonate, titanium oxide, barium sulfate, satin white and various plastic pigments. Suitable adhesives include synthetic resin latices such as styrene-butadiene latex, methyl methacrylate-butadiene latex and styrene-vinyl acetate latex, as well as water-soluble adhesives such as casein, soybean protein, oxidized starches, modified starches and polyvinyl alcohol. These adhesives are incorporated in amounts ranging from 15 to 35 parts by weight per 100 parts by weight of the pigment. Besides the pigment and adhesive, additives such as release agents, colorants, defoamers, viscosity modifiers and waterproofing agents may be incorporated in the aqueous pigment coating.

The aqueous pigment coating that contains a pigment and an adhesive as main components and which optionally contains suitable additives to a solids content of 40 - 70% is applied onto the surface of a base

paper (basis weight, 40 - 350 g/m²) to give a coat weight of 10 - 30 g/m² with a suitable apparatus such as an air-knife coater, a blade coater, a roll coater or a rod coater.

The pigment coating layer thus provided on the surface of the base paper is subjected to the first stage of treatment with a highly polished drum in which it is pressed onto a highly polished metal drum surface and dried in contact therewith by either the wet method, gelation method or the re-wet method. In the wet method, the pigment coating layer on the surface of the base paper is treated in a wet state. In the gelation method, the coating layer is first coagulated with a gelling agent while it is wet or half-dry before it is subjected to the first stage of treatment with a highly polished drum. In the re-wet method, the coating layer is dried with hot air at 100 - 180 °C, optionally smoothed with a supercalender, a gloss calender, a thermoplanisher, a soft calender or by some other means of surface treatment, re-wetted with a re-wetting solution to become plasticized, and subjected to the first stage of treatment with a highly polished drum in which the coating layer is pressed onto a heated (80 - 150 °C) highly polished drum and dried in contact therewith.

After the first stage of treatment with a highly polished drum, the coating layer is wetted once again with a re-wetting solution so that it is rendered plasticized, and thereafter subjected to the second stage of treatment with a highly polished drum in which it is pressed onto a heated highly polished drum and dried in contact therewith, whereby a cast-coated paper is obtained that retains a highly glossy and smooth surface, that is free from surface imperfections such as low surface strength and uneven adhesion between the base paper and the cast-coated layer, and that is improved in resistance to curling and surface waviness.

Further resistance to curling can be imparted by re-wetting the base paper on the back side of the cast-coated paper with a re-wetting solution either just before it is pressed onto the highly polished drum or on the surface of that drum.

The re-wetting solution that can be used in the present invention is water that may contain a dispersant such as sodium hexametaphosphate, sodium tripolyphosphate, sodium pyrophosphate or sodium polyacrylate or a release agent such as sodium stearate, ammonium stearate, calcium stearate, sodium oleate, ammonium oleate, calcium oleate, microcrystalline wax, polyethylene emulsion or stearic acid emulsion. These dispersants and release agents may be used either individually or in admixtures. If necessary, organic carboxylic acids such as formic acid, citric acid and succinic acid, a variety of surfactants, sulfated oils and other additives may be incorporated in the re-wetting solution as in the usual practice of the re-wet casting method.

Examples

The following examples are provided for the purpose of further illustrating the present invention but are in no way to be taken as limiting.

Example 1	
Recipe for cast-coated layer	Parts by weight
Kaolin	100
Sodium polyacrylate	0.7
Casein	15
Styrene-butadiene latex	15
Calcium stearate	0.2

An aqueous pigment coating (solids cont. 45%) was prepared from this recipe and applied onto the surface of a base paper (basis weight = 65 g/m²) with an air-knife coater to give a dry coat weight of 24 g/m². While it was half-dry, the coating layer was coagulated with a 2% aqueous solution of calcium formate, pressed onto a heated (surface temperature = 120 °C) highly polished metal drum at a linear pressure of 120 kg/cm and dried in contact with the drum. Thereafter, the dried coating layer was re-wetted with water to a plasticized state, pressed onto a heated (surface temperature = 90 °C) highly polished drum at a linear pressure of 40 kg/cm and dried in contact with the drum, whereby a cast-coated paper was obtained in accordance with the present invention.

Example 2	
Recipe I for cast-coated paper	Parts by weight
Kaolin	60
Precipitated calcium carbonate	40
Sodium polyacrylate	0.7
Casein	6
Styrene-butadiene latex	18
Polyethylene emulsion	0.5
Recipe II for re-wetting solution	Parts by weight
Water	100
Polyethylene emulsion	0.5
Succinic acid	0.2

An aqueous pigment coating (solids cont. 45%) was prepared from the recipe I and applied onto the surface of a base paper (basis weight 65 g/m²) with an air-knife coater to give a dry coat weight of 24 g/m² and dried with hot air at 130 °C. Subsequently, the dried coating layer was treated with a re-wetting solution according to the recipe II, pressed onto a heated (surface temperature = 120 °C) highly polished metal drum at a linear pressure of 200 kg/cm and dried in contact with the drum. Thereafter, the dried coating layer and the base paper layer on the other side were plasticized by re-wetting with a re-wetting solution according to the recipe II, pressed onto a heated (surface temperature = 90 °C) highly polished metal drum at a linear pressure of 40 kg/cm and dried in contact with the drum, whereby a cast-coated paper was obtained in accordance with the present invention.

Example 3	
Recipe III for cast-coated prime layer	Parts by weight
Kaolin	80
Precipitated calcium carbonate	20
Sodium polyacrylate	0.15
Modified starch	10
Styrene-butadiene latex	10
Calcium stearate	0.5
Recipe IV for cast-coated top layer	Parts by weight
Kaolin	90
Precipitated calcium carbonate	10
Sodium polyacrylate	0.15
Casein	8
Styrene-butadiene latex	14
Calcium stearate	0.3

An aqueous pigment coating (solids cont. 65%) was prepared from the recipe III and applied onto the surface of a base paper (basis weight = 65 g/m²) with a blade coater to give a dry coat weight of 12 g/m² and dried with hot air at 120 °C. Subsequently, an aqueous pigment coating (solids cont. 45%) was prepared from the recipe IV and applied onto the prime layer with an air-knife coater to give a dry coat weight of 12 g/m². The resulting top layer was pressed against a heated (surface temperature = 85 °C) highly polished metal drum at a linear pressure of 50 kg/cm and dried in contact with the drum. Thereafter, the cast-coated prime and top layers and the base paper layer on the other side were plasticized by re-

wetting with water, pressed onto a heated (surface temperature = 85 °C) highly polished metal drum at a linear pressure of 40 kg/cm and dried with the drum, whereby a cast-coated paper was obtained in accordance with the present invention.

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Example 4

An aqueous pigment coating (solids cont. 45%) was prepared to the recipe used in Example 1, applied onto a base paper having a basis weight of 107 g/m², and subsequently treated as in Example 1 to obtain a cast-coated paper in accordance with the present invention.

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Comparative Example 1

A comparative cast-coated paper was produced by a method which employed the same conditions as in Example 1 up to the first stage of treatment with a highly polished drum.

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Comparative Example 2

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Another comparative cast-coated paper was produced by a method which employed the same conditions as in Example 2 up to the first stage of treatment with a highly polished drum.

Comparative Example 3

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Another comparative cast-coated paper was produced by a method which employed the same conditions as in Example 3 up to the first stage of treatment with a highly polished drum.

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Comparative Example 4

Still another comparative cast-coated paper was produced by a method which employed the same conditions as in Example 4 up to the first stage of treatment with a highly polished drum.

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The cast-coated papers obtained in Examples 1 - 4 and those obtained in Comparative Examples 1 - 4 were subjected to a quality test and the results of the test which are summarized in the table that follows show that the cast-coated papers obtained in accordance with the present invention are highly gloss and smooth on the surface and have a sufficiently high water content to ensure satisfactory resistance to curling and surface waviness.

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Results of Quality Test						
	Gloss (%)		Smoothness (sec.)	Water content (%)	Curling (mm)	Waviness
	White paper	After printing				
Ex. 1	89	96	230	5.2	CD axis 2	absent
2	92	99	235	5.5	CD axis 1	absent
3	91	97	250	5.3	CD axis 1	absent
4	91	96	225	5.8	CD axis 1	absent
Comp. Ex. 1	84	91	165	3.5	MD axis 21	present
2	88	93	168	3.9	MD axis 20	present
3	86	92	185	3.6	MD axis 21	present
4	85	91	160	3.9	MD axis 18	present
Gloss on white paper : JIS P-8142 (%)						
Gloss after printing: JIS P-8142						
Smoothness: JIS P-8119 (sec.)						
Water content: JIS P-8127 (%)						
Curling: The amount of curling (mm) at the edge of a sample (10 cm x 10 cm) at 20 ° C x 65% r.h.						
Waviness: Waviness at the edge of a sample						

As described and demonstrated on the foregoing pages, the two-stage treatment with a highly polished drum performed in accordance with the present invention enables efficient production of cast-coated papers that retain the high degrees of gloss and smoothness which are characteristic of cast-coated papers, that are free from such surface imperfections as low surface strength and uneven adhesion between the base paper and the cast-coated layer, and that have a sufficiently high water content to provide improved resistance to curling and surface waviness.

Claims

1. A process for producing a cast-coated paper which comprises the steps of: applying onto the surface of a base paper an aqueous pigment that contains a pigment and an adhesive as main components, whereby a pigment coating layer is formed; pressing the pigment coating layer onto a heated, highly polished metal drum; and drying said pigment coating layer in contact with the drum, characterized in that subsequent to the first stage of treatment with a highly polished drum which consists of pressing the pigment coating layer, while it is in a plasticized state, onto the heated, highly polished metal drum and drying said pigment coating layer in contact with the drum; after the dried pigment coating is re-wetted with a conventional re-wetting solution, the dried pigment coating is subjected to the second stage of treatment which consists of pressing the pigment coating onto a heated, highly polished metal drum, and drying it in contact with the drum.
2. A process according to Claim 1 wherein the first stage of the treatment consists of passing the pigment coating layer through a coagulating bath, pressing the resulting layer, while it is in a plasticized state, onto a heated, highly polished metal drum, and drying it in contact with the drum.
3. A process according to Claim 1 wherein the first stage of the treatment consists of initially drying the pigment coating layer, then optionally supercalendering it, and thereafter re-wetting it with a conventional re-wetting solution, pressing the resulting layer, while it is in a plasticized state, onto a heated, highly polished metal drum, and drying it in contact with the drum.

4. A process according to Claim 1 wherein the first stage of the treatment consists of directly pressing the pigment coating layer, while it is in a plasticized state, onto a heated, highly polished metal drum, and drying it in contact with the drum.

5. A cast-coated paper produced by the process of any of the Claims 1 to 4.

5 6. Use of the cast-coated paper produced by the process of any of the Claims 1 to 4 for producing printed matter in a precise and high-grade printing operation.

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