

[54] PAPER FRICTIONIZING
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[56] References Cited
UNITED STATES PATENTS
2,577,485 12/1951 Rule 117/152 UX
2,643,048 6/1953 Wilson 117/152 X
2,801,938 8/1957 Iler 117/152
2,833,661 5/1958 Iler 117/154 X

2,872,094 2/1959 Leptien 117/152 UX
2,980,558 4/1961 Dempcy et al. 117/152
3,440,174 4/1969 Albrecht 106/286 X

FOREIGN PATENTS OR APPLICATIONS

495,662 9/1957 Canada 117/152

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[57] ABSTRACT

A paper composition having excellent antiskid properties consisting of paper coated with large particle diameter colloidal silica sol. The particle diameters used must be at least 60 millimicrons.

2 Claims, No Drawings

PAPER FRICTIONIZING

Various articles such as containers fabricated from paper bags, kraft papers and other types of cellulose materials as used for the packing of foodstuffs, chemicals and the like possess the inherent disadvantage of slipping and sliding against each other. This tendency to slip and/or slide may be undesirable and in many cases harmful. Attempts have been made to overcome this difficulty. For example, containers fabricated from crepe paper or containers treated with a form of an adhesive have been employed. Such containers have not been entirely satisfactory either for reasons of economy, poor printing characteristics, insufficient slip resistance, unpleasant or uncomfortable handling characteristics, or for a combination of such reasons.

Prior art disclosures have shown that it is possible to coat cellulosic materials with colloidal silica sols. These coatings tend to impart definite antiskidding properties to the coated cellulosic materials. The colloidal silica sols are conveniently handled and readily applied to the cellulosic materials. Also from an economic standpoint they are very advantageous. At first glance it would appear that such coatings would overcome all the shortcomings which priorly existed in the prior art. However, one difficulty has arisen even in the use of colloidal silica sols.

Prior to the teachings of this invention colloidal silica sols used as surface coatings to impart antiskid properties to desired cellulosic material products were found to wear very quickly. As a consequence, they were effective for only short periods of time. Their use was therefore severely limited.

Accordingly, it is one object of the invention to provide an improved antislip cellulosic material.

A further object of the invention is to economically and conveniently provide improved antislip cellulosic materials without detrimentally affecting their printing and/or handling characteristics.

It is also another object of this invention to impart maintained antislip characteristics to the cellulosic materials which are extremely resistant to wear though constantly exposed to continuous slipping or sliding forces.

Other objects will appear hereinafter.

The present invention relates to improved antislip cellulosic materials.

The prior art, specifically U.S. Pat. No. 2,643,048, teaches the use of a colloidal silica sol as a coating for cellulosic materials to impart antiskidding properties thereto. However, the prior art has been plagued with short lived antiskidding characteristics imparted to the cellulosic materials due to the rapid deterioration of the antiskid coating.

Generally the antiskidding characteristics of cellulosic materials imparted by coating the same with colloidal silica sols taught by the prior art decrease with increased subsection of the cellulosic material to load sliding. This decrease has been found to be directly related to the particle diameter size of the colloidal silica sol which is used to coat the cellulosic material.

It has been found that cellulosic materials coated with silica sols having particle diameters in excess of 60 millimicrons and preferably 60-100 millimicrons can withstand continual subsection to loading forces without any substantial loss in antislip characteristics.

The amount of colloidal silica sol incorporated on the surface of the cellulosic materials of the invention comprises at least 0.05 lb. per 1,000 ft.² of paper surface area. Good results are achieved when the dosage ranges from 0.1 to 0.5 lb. per 1,000 ft.².

The colloidal silica may be incorporated on the surface of the cellulosic material in a variety of ways. For example, the cellulosic material may be fabricated and then sprayed, coated, dipped or otherwise treated with a solution comprising silica in a colloidal form. The colloidal silica may also be suitably incorporated in paper pulp which is subsequently fabricated into the cellulosic material and then into a finished product of some sort or by any other suitable method or combinations of the above methods which may be used.

The colloidal silica sols as used in this invention may be prepared in accordance with the procedures set out in U.S. Pat. No. 3,440,174. Very briefly, U.S. Pat. No. 3,440,174 teaches a large particle size aqueous silica sol and method of preparing the same. This new and valuable silica sol contains at least 35 percent by weight of silica expressed as SiO₂ and has a weight average particle diameter of from about 45-100 millimicrons in size. The silica which is the dispersed phase of the sol has a surface area ranging from 35-150 m²/g. The large silica particles may be further characterized as being spherical, uniform and in a nonaggregated state. They are dispersed in an aqueous carrier.

Further important features of the silica sols referred to by U.S. Pat. No. 3,440,174 is that they are characterized as having viscosities of less than 10 c.p.s. at 25° C. measured at a 50 percent SiO₂ concentration. The electrical conductivities of the sols produced in accordance with the invention are within the range 3,000-5,000 micromhos measured at 50 percent silica concentration expressed as SiO₂.

The method of producing sols of the type described above may be prepared by a process which comprises the steps of adding acidic silica sols containing silica particles with an average molecular weight of less than 90,000 to a dilute aqueous alkaline silica sol containing less than 3.5 percent by weight of solid silica particles having a weight average diameter of from about 10 to about 30 millimicrons. This addition of acid salt to alkaline salt is maintained, while continuously evaporating the liquid aqueous phase of the alkaline sol at atmospheric conditions according to the following rate formula:

$$F = kC_i^{2/3}C_o^{1/3}S_o$$

where F is the maximum feed rate at any time of the acidic silica sol in grams of silica contained therein per milliliter of alkaline sol per hour, k is a constant with a value of 5×10^{-3} when the temperature of the reaction is about 100° C., C_i is the silica concentration of the alkaline silica sol in grams per milliliter at any time, C_o is the initial silica concentration of the alkaline silica sol, and S_o is the initial specific surface area of the silica of the alkaline sol in square meters per gram of silica, all silica contents being expressed as SiO₂. If the addition is maintained according to the above rate formula and the pH of the alkaline sol is maintained over 7.0 units the weight average silica particle diameter of the starting silica sol may be uniformly increased until sol products having a silica particle diameter of 45-100 millimicrons are achieved. Preferably the starting silica particle diameter is typically increased from 2.5 to about 4.0 times according to the invention. The final products exhibit this uniform increase of particle diameter since they themselves are spherical and uniform in appearance with substantially no agglomeration having taken place during the process.

TEST PROCEDURE

To illustrate the superior results achieved by practicing this invention over prior art techniques, runs were conducted whereby paper was coated with silica sols of varying particle diameter sizes and subsequently tested for their immediate and subsequent or retained antiskidding properties.

In the referred to test, each of the sols used was diluted to both 3 percent and 5 percent SiO₂ on a weight percent basis. From previous analytical data it was known that about 0.10 pounds per 1,000 ft.² and 0.17 pounds per 1,000 ft.² SiO₂ would be coated on the paper to be tested upon applying 3 percent and 5 percent sols respectively to the test paper with a trailing blade paper coater.

The paper which was coated was light kraft paper of the type used for wrapping paper and paper bags. It was treated with each of the diluted sols on the trailing blade coater.

The trailing blade coater is a tool for applying very uniform layer of coating to 6 1/2 inch by 11-inch sheets of paper or board.

This laboratory coater comprises a flexible trailing blade coater fitted with a rubber covered backup cylinder and hand-

crank. Coating was applied to the leading edge of the test sheet with a dropper then spread evenly over the sheet by the coating blade as the backup cylinder and the test sheet were rotated past the blade.

After the silica sols were applied to the papers the treated papers including a water treated blank were equilibrated at ambient temperatures and humidity for 24 hours.

The finally dried coated papers and blank papers were then subjected to testing on a slide angle tester. Each sheet was tested for the critical angle data, i.e., the angle at which the test block slides down the plane on a St. Regis slide angle tester, Model CS-152 using the suggested TAPPI METHOD T503su-67.

The St. Regis slide angle tester may be generally described as comprising a sled and an incline plane.

The sled is a metal block preferably rectangular with a flat plane lower surface, 89 ± 1.3 centimeters (3.5 ± 0.5 inches) wide and 10.2 ± 2.5 centimeters (4.0 ± 1.0 inches) long and of such weight as to provide a measure of 14 ± 3 grams per centimeters squared (0.2 ± 0.04 p.s.i.) when horizontal.

The sled must also include a means for clamping the leading edge of the test specimen to the front or to the top surface of the sled.

The inclined plane is a plain surface hinged so it can be tilted with a smooth incompressible top surface of nonmagnetic material having a width of at least one inch wider than the sled and a length sufficient to permit the sled to move at least $1\frac{1}{2}$ inch and provided with a clamp from the test specimen at the upper end of the plane (and with a bumper stop at the lower end). Also the incline plane should include a means to indicate the angle of displacement of the plane within 0.5° and some means for smoothly increasing the inclination of the plane from horizontal to an arc of at least 45° at a rate of $1.5 \pm 0.5^\circ$ per second.

Test sheets of paper are cut and affixed to the sled. They are cut so that they are a little larger than the contacting area so that the sheet will extend slightly beyond the bottom edge of the sled.

The outer sheet is cut to be affixed to the surface of the plane. It is cut large enough to cover at least the working surface of the plane.

The plane is leveled so that it is horizontal when the inclinometer indicates zero.

One sheet is mounted on the plane with the machine direction parallel to the direction of the slide and with the surface to be tested facing upwards. The other sheets are attached to the sled. The sled is then positioned on the top of the lower sheet with its crosswise direction parallel to the direction of the slide and with the surface to be tested facing downward. Likewise surfaces of the specimen are now in contact with their machine directions at right angles.

There is allowed a dwell time of 30 ± 5 seconds, then the plane is inclined at the specified rate of $1.5 \pm 0.5^\circ$ per second. The inclinometer is stopped when the sled starts to move. The sled is permitted to slide until it stops. The slide angle θ is recovered to the nearest 0.1° . At this point the sled is lifted along with the attached specimen and the entire assembly is placed at the original starting position with the plane in its horizontal position.

In order to determine the retention of antiskid properties when subjected to continual sliding the tested paper was subjected to 10 successive slides. After the 10 successive slides

the paper was once again tested for its critical or slide angle θ .

The results for the test conducted in this invention are given below in Table I.

TABLE I

Run	Particle diameter size in μ	Loading, lbs. per 1,000 ft. ²	Percent improvement over blank θ	10th slide θ	Percent improvement over blank
A.....	Blank		27.0	26.0	
B.....	68	.10	37.5	39	27.8
		.17	38.0	41	31.0
C ¹	35-40	.10	34.8	29	26.0
		.17	35.3	31	29.0
D ²	20	.10	35.8	33	26.0
		.17	37.0	37	28.0

¹ Sylon® P-colloidal silica—mfd. by Monsanto.

² Nalcoag 1050 colloidal silica sol—mfd. by Nalco Chemical Co.

It should be noted that initially the sliding angle θ is fairly equivalent in magnitude and in its improvement over the blank paper run for all three of the silica sol coated papers with some slight exception. The large particle diameter silica sol coated paper shows an improvement over the smaller particle diameter silica sol coated papers.

However when measured after 10 successive slides the smaller particle diameter sols, Runs C and D, when used to coat paper at 0.10 pound per 1,000 feet² show no improvement over the blank run. The paper coated with large particle diameter sols (Run B) at 0.10 pound per 1,000 feet² shows a remaining improvement of seven percent. Similarly the percent improvement over the blank run of the paper coated with 0.17 pound per 1,000 feet² of smaller diameter sols (Runs C and D) was substantially less than that of the paper coated with a like amount of large particle diameter sols.

CONCLUSIONS

The prior art has disclosed many methods and compositions useful for imparting antiskidding properties to paper materials. However for reasons relating to quality control, economics or effectiveness such materials have had difficulty in acquiring acceptance.

One attempt to overcome these deficiencies in total has been to apply colloidal silica sols to the paper materials. Such an application gave encouraging results. However, such materials have the distinct disadvantage of other antiskid characteristics of relatively short duration.

As a consequence, this invention sought to improve the application of silica sols to paper products as antiskidding by employing large particle diameter silica sols. Such diameter being at least 60μ .

The prior art silica sols being limited to small particle diameters were shown vastly inferior to application of these higher particle diameter sols. As a consequence a significant improvement in the art has resulted.

Having described my invention I hereby claim:

1. A coated paper having improved antiskid properties which comprises paper which has at least one of its surfaces coated with at least 0.05 pounds of a colloidal silica sol per 1,000 ft.² of paper surface area, expressed as SiO₂, said silica sol having a particle diameter size of at least 68 millimicrons.

2. The coated paper of claim 1 where the particle diameter size of the silica sol is 68-100 millimicrons.

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