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CASTING SURFACE FOR PRODUCING CAST-SURFACED MINERAL COATED PAPER

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This invention relates to the passivation of metal casting surfaces such as chromium and more particularly provides a passivated casting surface for the manufacture of highly glossed finish cast-surfaced, mineral-coated paper.

A primary object of this invention is to provide an improved casting surface for producing cast-surfaced coated paper, said surface affording excellent release of mineral coatings during continuous cast coating operations at the same speeds of operation, or in excess of those obtainable by known methods of the prior art.

Another object of this invention relates to the development of a paper product distinguished by its extremely high gloss which substantially exceeds that of presently known cast-surfaced mineral-coated paper products.

Still another object is to provide a passivated casting surface for continuously producing such a paper product having said characteristics, which casting surface facilitates ready release of the coating from said surface and decreases surface defects on the paper.

A further object of this invention is the conditioning of a casting surface to a passive state for producing cast surfaced mineral coated paper, which surface has been found to be activated and exhibits an attraction to mineral coatings during cast coating operations, so that said casting surface exhibits repulsion or a remarkable lack of adhesion to mineral coatings and provides a paper product of extremely high gloss during substantially continuous cast coating operations.

Other and more specific objects, as well as the novel characteristics of the casting surfaces of this invention which contribute to functional improvement, will appear hereinafter.

Heretofore, mineral coated paper has been provided with a glossy finish by various methods which utilized a casting surface. One of these methods involved placing the surface of the paper, wet with the coating material, against the surface of a heated chromium-plated drum or endless belt casting surface to which the wet paper adhered. As the drum revolved, the water in the coating material evaporated and, theoretically, but not in actual practice, when the coating material was sufficiently dry, the paper no longer adhered to the drum so that it could be led away to a winding roll. Thus by such method, it was not thought necessary to calender cast coated paper, because the coating material was expected only to remain in contact with the polished surface of the chromium-plated drum or endless belt until the coating material was dry, with the anticipation that the coated paper would have the luster of the chromium drum or endless belt surface. However, the products made in this manner were subject to the objection that when the coating material had dried, the coated paper was not completely released from the casting surface, particles of coating were attracted and firmly adhered to the chromium surface, thereby damaging the quality of the paper with consequent surface defects.

Another method which has been proposed for producing high-gloss cast coated paper relates essentially to the application of a mineral coated web to a chromium drum or endless belt casting surface which is continuously treated with certain oily, relatively water-insoluble materials sometimes designated as "oleaginous film-forming material" which wet the casting surface and spread into a continuous film, yet will not vaporize too readily at operating temperatures. The coating on the web is intended to adhere to the casting surface until the coating has dried to a substantially non-plastic condition and thereafter to be released from the chromium casting surface. Satisfactory results utilizing this method allegedly are obtained but only by continuously replenishing the oil material necessarily on the casting surface.

The product of such a method is subject to the objection that the required function of the oily liquid material on the chromium casting surface is necessarily dependent on and the exact quantity thereof determined by a skilled operator who watches the point at which the paper leaves the chromium casting surface, and hopefully increases or decreases the percentage of liquid oily material on the chromium drum and/or in the coating color in order to obtain release of the coated paper from the chromium casting surface. As a result of such deficiencies, the paper industry has long been aspiring to make available a high-gloss paper product, the dried coating of which can be satisfactorily and effectively released from a casting surface without dependence on the skill of an operator, and which is sufficiently cheap, adapting it to large-scale usage.

Certain properties have been recognized in the prior art as being required of casting surfaces, if such surfaces are to be successfully employed as casting surfaces in the production of high-glossed finish cast-surfaced, mineral coated paper. For example, casting surfaces should effect a condition of non-adhesion for the fluid and subsequently dried mineral coating on the paper web. And it is now known that this condition requires a substantially non-reactive casting surface. Metal casting surfaces are in general chemically reactive and in order to prevent the development of an adhesive bond with a mineral coating material as applied to a paper web, these surfaces should in some way be changed to cause reduced or substantial non-reactivity so as not to develop an adhesive bond with the mineral coating material during casting operations. As noted above, an attempt has been made to accomplish this requirement by the use of oily liquids. And it has been found that certain oily or so-called oleaginous liquids under critical conditions could possibly accomplish this aforementioned reduction in reactivity. However, such oleaginous liquids which are most effective have long chain molecules with a polar grouping which orients on a metal surface to leave a non-polar grouping which provides a separating plane. Moreover, such oleaginous liquids as films are easily destroyed and must be continuously applied to a casting surface, as taught by prior methods, in order not to interrupt continuous casting operations.

In accordance with the present invention, the desired non-adhesive requirement for cast coating has been unexpectedly discovered by utilizing as the casting surface a drum or belt plated with chromium, with the chromium in a passive state or condition. Chromium can exist in either an "active" or a "passive" condition (see Mellor, Comprehensive Treatise on Theoretical and Inorganic Chemistry, 1st edition, vol. XI, pp. 148–153, 1931), and this invention in its broadest sense resides in the discovery that coating compositions comprising aqueous dispersions of mineral pigment and adhesive are non-adherent to passive chromium when dried thereon, but adhere tenaciously to active chromium under the same operating conditions.

Chromium in the passive state is characterized by inertness and non-reactivity to chemical reagents. While the existence of the aforesaid two states of chromium has been known for a good number of years, being first recognized by Michael Faraday, it remained for the present inventors to discover that cast coating compositions exhibit a remarkable and unexpected repulsion and non-adherence to chromium in the passive state when such coatings are dried thereon.

In accordance with this invention, the passive condition of chromium can be induced by treating a normally active chromium casting surface with an oxidizing agent to passivate it. For example, one practice of the invention involves the treatment of the polished chromium surface of the casting drum or belt with a water rinse, to remove deposits of dust, salts or other material which might scratch the chromium surface. If necessary, the rinsing is accompanied by gentle polishing with a soft material, such as cotton gauze, until the chromium surface appears clean and mirror-like to the unaided eye. The next step is the application of the passivating agent. A water solution containing from 2½ to 10% of acetic acid has been found to be highly effective for this purpose. Likewise, another effective passivating agent is a solution of nitric acid at a concentration that results in a pH between 1 and 3. Such a solution is applied to the chromium surface of the drum, the manner of application not being critical. Rubbing the chromium surface with cloths impregnated with the acidic solution will give effective results and is preferred. Other methods are to let the passivating solution come in contact with the drum without incidental scum-forming contamination, such contamination being evidenced by a visible cloudy deposit on the face of the chromium. Application by flooding the surface as from buckets or a pipe, is also suitable, or another method is to apply the acid solution from a fine spray, such that a mist of acid covers the entire surface. When the treatment has been continued long enough to expose every spot on the surface to contact with the passivating solution, the treatment is finished, and the drum is then in condition for the casting of coated paper.

When initiating treatment of an active chromium surface with dilute acetic or nitric acid solution to make it passive, it may be observed that the dilute acid solution readily wets the surface and spreads into a resonably continuous film. As the passivation progresses, the acid solution wets the surface less readily and when the operation is complete, application of the solution results in droplets of liquid which do not spread on the surface. These observations indicate a low contact angle for the dilute acid solution on active chromium and a high contact angle for the dilute acid solution on passive chromium. This change provides a visual indication of the attainment of the passive condition. In practice, the acid treatment is continued beyond the point where high contact angles are observed. Acidic oxidizing agents have been found to be more effective than alkaline oxidizing agents, since alkaline conditions seem to destroy the passive state and render the chromium active.

Thus, in the preferred practice of this invention, a casting surface of chromium is passivated by treatment with an acidic oxidizing agent before the manufacture of cast-coated papers. By the use of such a passivated chromium casting surface, release agents, either in the coating composition or applied directly to the casting surface, are no longer required. In ordinary operations, the coating composition is applied in any suitable manner to the paper and smoothed thereon, prior to the casting step, or it may be applied directly to the casting surface and the paper pressed onto the wet coating. Moreover, in accordance with this invention, paper may be coated, dried and supercalendered, if desired, and then re-wet with water and cast finished by pressing the re-wetted coated surface against a passive chromium casting surface.

In practicing this invention, it has been observed that

the characteristics of a passive chromium surface impose certain requirements which should be observed in order to maintain the chromium in a passive, releasing condition. For example, certain alkaline solutions, such as solutions of sodium carbonate or sodium hydroxide, tend to destroy the passive surface and convert it to an active condition. Coating compositions cast against such an active chromium surface adhere to the surface with great tenacity, in the absence of a releasing agent, making the cast surfacing process inoperable. Likewise, highly alkaline coating compositions appear to cause a passive chromium surface to revert to the active state, and such coatings show undesirable, tenacious adherence to the casting surface. However, the change in chromium from a passive condition to an active condition is readily reversible by following the teachings of this invention and the passive condition may be restored by cleaning the casting surface with water followed by treatment with a mild acidic oxidizing solution, such as dilute nitric or acetic acid. And it has been found that these transitions from the active to the passage condition may be done periodically with no apparent effect upon the mirror surface of the chromium. It should also be pointed out that abrasive agents, such as finely divided magnesium oxide or alumina, which are frequently used to clean and/or polish chromium surfaces, may, under certain conditions, cause activation of the chromium. In this respect, alumina, because of its greater hardness, is the worst offender. Obviously, it may be necessary to resort to the passivating treatment of this invention following the use of such abrasive or polishing agents.

As stated heretofore, highly alkaline coating compositions can cause activation of chromium casting surfaces. But this upper limit on alkalinity is fairly high, and lies above the range normally used in the manufacture of cast coated paper. Not only does the activation of the chromium surface depend on the concentration of alkali with which it comes in contact, but also upon the time or duration of such contact. In using alkali coating compositions of relatively high solids content, the passive chromium surface is not affected adversely because the time of contact is short, due to rapid drying and also because of the relatively small amount of alkali present per unit area of the casting surface. Coating compositions of sufficient alkalinity for good printing and ink drying of the finished cast coated paper, and for proper dispersion of the mineral pigments can be prepared, and such compositions do not activate a passive, releasing chromium casting surface. For example, coating compositions with a pH of 8.5 and a non-volatile solids content of 55% by weight release satisfactorily when cast and dried against a passive chromium surface under acceptable conditions of operation such as set forth in copending patent application of John W. Smith, Serial No. 648,227, filed March 25, 1957. Such mildly alkaline coatings can be satisfactorily used over a range of 45–65% by weight of non-volatile solids in the practice of this invention. Coating compositions with a pH as high as 11 have been found to release from a passive chromium surface, when cast and dried thereon, when such compositions are used in connection with an absorbent paper and drying is carried out as rapidly as possible by operation of the casting surface at a temperature just below a temperature which will cause formation of steam blisters between the paper and the casting surface. Such highly alkaline coating compositions are seldom used in commercial operations, the preferred range of pH for such compositions being 8.0–10.0.

When dealing with highly alkaline coating compositions in accordance with this invention, an agent such as tributyl phosphate may be added to the coating composition to prevent slow reversion of the passive state of the chromium to the active state. In such instances, it has been found that an addition of a protective agent

such as 1% or less of tributyl phosphate to the coating composition, prevents such reversion.

As a transistory condition of operation, overdrying of the paper may occur, accompanied by the generation of static at the line of separation where the dried cast-coated paper is stripped from the casting surface. The discharge of the static so formed, against the surface of the passive chromium, will cause the chromium to revert from the passive to the active state in those areas bombarded by the electrons of the discharging static, with the result that the cast coated paper will cease to release from those areas. This reversion may likewise be prevented by the use of an anti-static agent incorporated in the coating composition. Tributyl phosphate, in quantity of 1% or less, is an example of such an agent.

It has also been found that the atmosphere surrounding the cast-coating operation may include chemical substances which act to cause the reversion of the passive chromium casting surface to the active state. One example of such a chemical substance is finely divided sodium carbonate discharged from the smoke stack of a recovery boiler commonly associated with the process of pulping wood by the soda process. Another example of such a chemical substance is ozone, which may be formed by the sparking of electrical equipment. A protective film against these substances is formed over the passive chromium casting surface by incorporating an organic liquid in the coating composition. And tributyl phosphate in quantity of 1% or less is an example of such an organic liquid.

While the invention as herein described is for purposes of illustration only, it is to be understood that it includes all modifications and equivalents which fall within the scope thereof.

What is claimed is:

1. A method of producing highly glossed finish cast-surfaced, mineral coated paper comprising applying to the surface of a web of paper a relatively fluidic cast coating composition consisting essentially of an aqueous pigment-adhesive suspension, said coating composition having from about 45% to about 65% by weight of non-volatile solids bringing the coated surface of the paper into contact with a passivated chromium casting surface while said coating is still fluent on the paper, and maintaining the passivated surface by the addition of a protective agent in said cast coating composition.

2. A method of producing highly glossed finish cast-surfaced, mineral coated paper comprising applying to the surface of a web of paper a fluidic cast coating composition consisting essentially of an aqueous pigment-adhesive suspension, said coating composition having from about 45% to about 65% by weight of non-volatile solids, bringing the coated surface of the paper into contact with a passivated chromium casting surface while said coating is still fluent on the paper, and maintaining the passivated surface by the addition of tributyl phosphate in said cast coating composition.

3. A method of producing highly glossed finished cast-surfaced, mineral coated paper comprising applying to the surface of a web of paper a fluidic cast coating composition consisting essentially of an aqueous pigment-adhesive suspension, said coating composition having from about 45% to about 65% by weight of non-volatile solids, bringing the coated surface of the paper into contact with a passivated chromium casting surface while said coating is still fluent on the paper, and maintaining the passivated surface by the addition of 1% or less of tributyl phosphate in said cast coating composition.

4. A process to provide a cast-surface coated paper comprising the steps of applying a quantity of fluent mineral coating material on the paper, and bringing the coated surface of the paper into contact with a passivated chromium casting surface while said coating is still fluent on said paper whereby said coated surface is readily releasable from said passivated surface.

5. A process to provide a cast-surfaced coated paper comprising the steps of applying a quantity of fluent mineral coating material on the paper, bringing the coated surface of the paper into contact with a passivated chromium casting surface while said coating is still fluent on said paper, thereafter drying said coating while said coating is in contact with said casting surface, and removing said coated paper from said casting surface.

6. In the coating of paper to provide a cast-surfaced mineral coated paper, the process which comprises the steps of applying a quantity of fluent mineral coating material comprising an aqueous dispersion of mineral pigment and adhesive material to form a substantially smooth surface coating on the paper, bringing the coated surface of said paper into contact with a passivated chromium casting surface while said coating is still fluent on said paper, thereafter effecting drying of said coating while said coating is in contact with said casting surface, and removing said coated paper from said casting surface.

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