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PROCESS FOR MANUFACTURING PAPERBOARD WITH HIGH GREASE RESISTANCE BY APPLYING A PLURALITY OF STARCH COATINGS TO A WET BOARD

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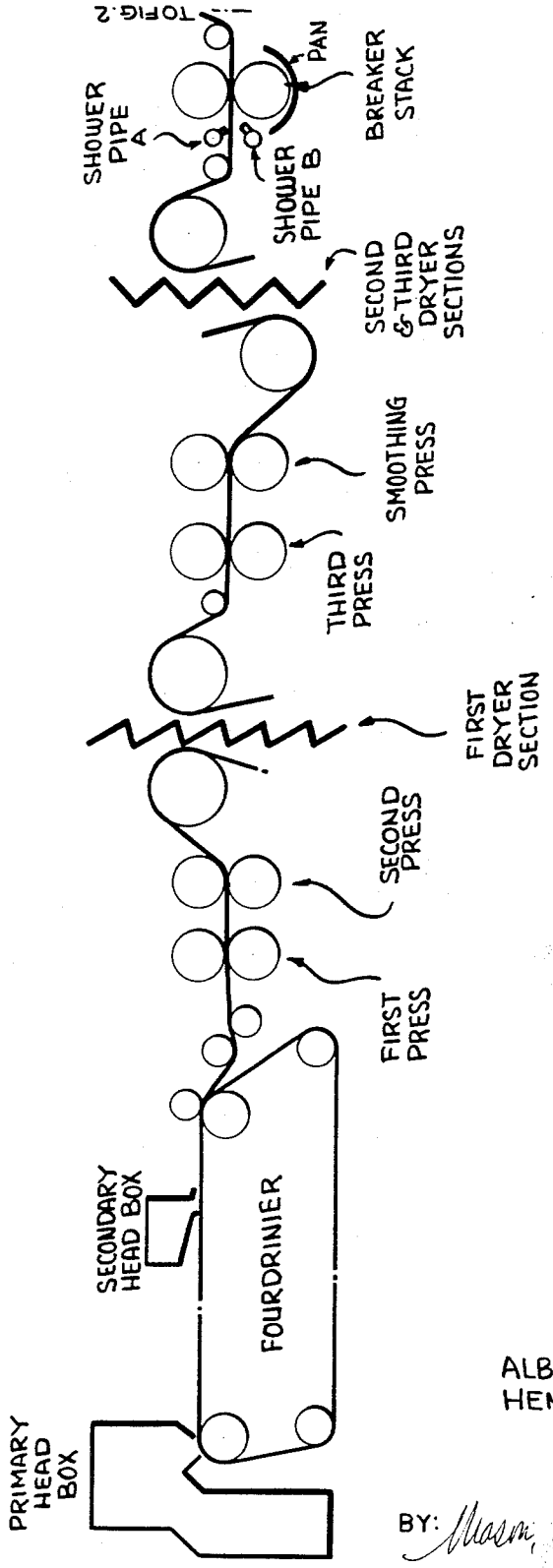


FIG. 1

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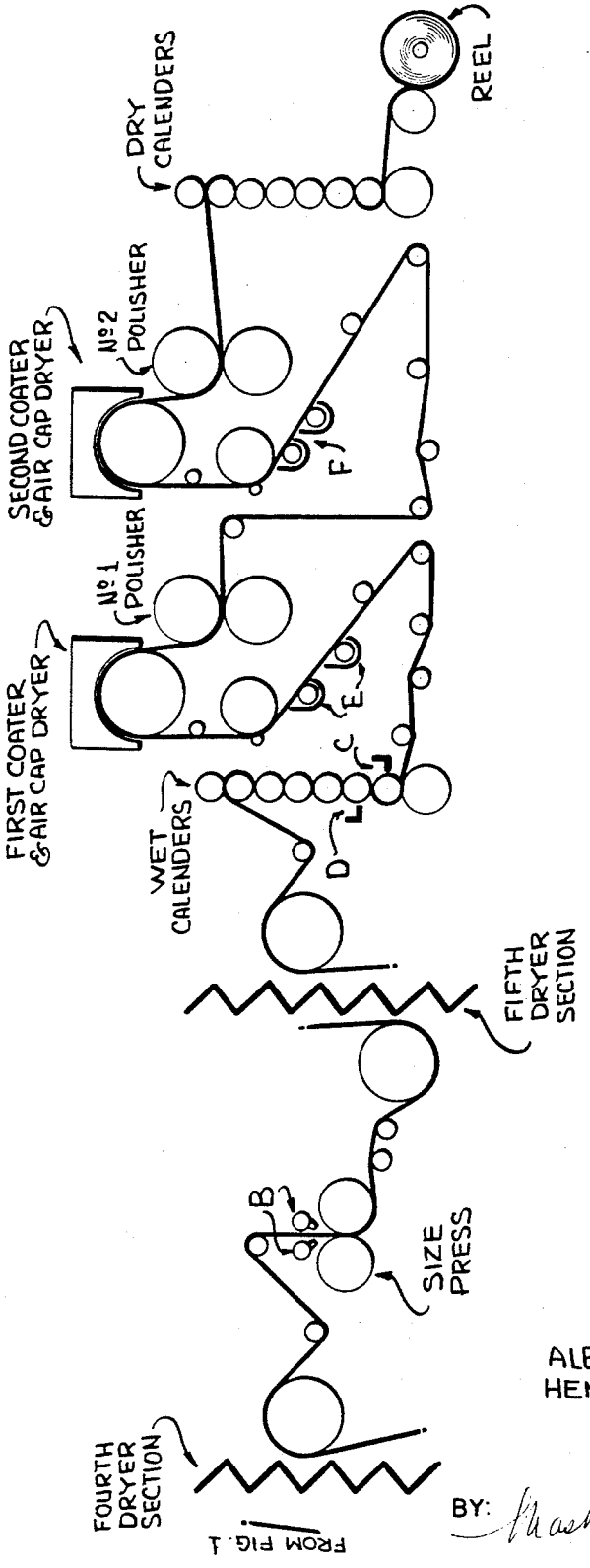


FIG. 2

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3,413,190

PROCESS FOR MANUFACTURING PAPERBOARD WITH HIGH GREASE RESISTANCE BY APPLYING A PLURALITY OF STARCH COATINGS TO A WET BOARD

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1 Claim. (Cl. 162—175)

ABSTRACT OF THE DISCLOSURE

A process for manufacturing paperboard having high grease resistance wherein a plurality of starch coatings are applied to the surface of the paperboard sheet, the first of the coatings being applied at the breaker stack which is before the application of any other surface coatings.

This invention relates to a product and a process for manufacturing paperboard and more specifically to a product and a process for obtaining a board which is substantially impervious to greases, oils, and the like.

Packaging and container materials maintain a predominant position in our economy. The range of materials employed in this field vary from metal containers and packaging material to metal foils, metal coated papers and plastics, coated papers and paperboards, etc. Throughout this specification, the term "packaging" or "packaging material" will be used to denote any type of material or container employed to contain or house, singly or in bulk, whether hot or cold, liquids, paste, semi-solids, solids or gases.

The requirement for packaging materials vary greatly. Of paramount interest, is the selection of the best material with the least cost. In many instances, the cost of the packaging material may exceed the cost of its contents. In this instance, increased emphasis would be applied to reduce the cost of the packaging material or container so that the container represents only a small fraction of the total cost of the article. Due to the increased popularity of the throw-away container, greater economies must be effected for the packaging of these products since the container is used only once for its intended purpose.

This invention relates to a product and a process for the manufacturing of paperboard which may be utilized, due to its high resistance to grease, oils, other liquids, etc. as a packaging material for these materials or for compositions containing these materials. In the past, the use of metal packaging material has dominated the field due to the inability of greases, oils, etc. to penetrate to the metal. However, metal containers are relatively expensive and attempts have been made to replace the use of metal containers with coated papers and paperboard. Early attempts employed a type of combination metal and paperboard wherein a thin coat of metal or foil was deposited in some manner on one side of the paperboard so that the paperboard would lend rigidity to the container while the metal contributed the impervious quality. This method considerably reduced the cost of the packaging material but was not entirely satisfactory due to the inherent problems concerned with the bonding of two dissimilar materials.

Further attempts were directed to the preparation of packaging materials constructed solely of paper or paperboard along with suitable coatings which were applied to the paperboard during or immediately after its manufacture. The coatings were designed to contribute the impervious quality required for the use of packaging materials utilized in the fields of packaging greases, oils, hot beverages, etc. Many such types of coatings were employed and none were found to be entirely satisfactory. Coatings which were impervious to the aforementioned products were expensive and thus undesirable from an economic viewpoint. Although inexpensive, many other coatings retained their imperviousness for only a short period of time and thus were undesirable from a quality standpoint. Many such coatings which were employed in the manufacture of paper and paperboard container materials included coatings of polyvinyl alcohol, polyester resins, waxes, latex, stearto-chromic chloride, various fabric sizes and coatings of starch.

This invention relates to the application of starch coatings to paperboard to produce high grease resistance materials and although the application of starch coatings to paperboard is known in the art, the production of high grease resistant materials has not been achieved. The present invention sets forth a novel manner in which the starch coatings are applied which yields truly unexpected results.

The term "grease" will be employed throughout the specification to denote greases, oils, turpentines, hot beverages, and the like.

Accordingly, it is the principal object of the present invention to improve the grease resistance of packaging and container materials.

It is a further object of the present invention to improve the grease resistance of materials constructed of coated paperboard.

It is a further object of the present invention to provide a grease resistant material of coated paperboard wherein the principal ingredient of the coating is starch.

It is a further object of the present invention to provide a grease resistant material of coated paperboard wherein coatings of starch are applied to the paperboard at selected steps or points in the manufacture thereof.

It is still a further object of the present invention to provide a process for manufacturing grease resistant paperboard wherein coatings of starch are applied at selected steps or points to the paperboard during the manufacturing process.

The manufacturing of a routine grade of paperboard, e.g., a coated cold waxing, bleached paperboard, is well known in the art. Further, it is known to apply starch coatings and other materials during certain steps in the manufacture of paperboard possessing some grease resistance. In the past, these coatings have usually been applied at the size press or the wet calenders. However, the paperboard produced according to that process, did not possess the high grease resistance which is required for many applications. This invention relates to the application of a high solids (approximately 20% solids) cooked starch paste at the steps in the process heretofore unknown. In the usual operation, after the wet paperboard passes from the wire it is advanced through a series of presses and dryers at which time it then enters a breaker stack where the paperboard sheet is compacted and levelled. Just prior to the entry of the sheet at the nip of the breaker stack, a high solids cooked starch paste of approximately 20% solids is applied to the top or upper surface or, alternatively to the lower or bottom surface, of the sheet of paperboard so that a pool of the starch paste is on the surface of the sheet as the sheet enters the nip of the breaker stack. At that point, there is approximately one to one and one-half pounds of cooked starch solids applied to one thousand square feet of the surface of the sheet. The high solids starch is impressed into the surface of the sheet by the breaker stack at a point in the process where the sheet of paperboard is still relatively wet and absorbent. After further drying, sizing, and again drying, the sheet enters the wet

calenders where coatings are applied to both the top and bottom surfaces of the sheet. The bottom surface receives a coating of low solids starch mixed with a sodium alginate solution which increases the water holding capacity of the starch and increases the ability of the starch solution to form a film. The top surface of the sheet receives a second coat of high solids starch by the use of a waterbox at the wet calender. Thereafter, a first coater is employed to apply a third coating of high solids starch to the top surface of the paperboard sheet. From then on, the remaining steps are conventional in that the sheet is polished, regular pigmented coatings are applied, the sheet is again polished and after advancement through the dry calenders is advanced to a reel where it is rolled about the reel. Although many of the steps in the process set forth are known, this invention relates to the application of a high solids starch to the paperboard at the breaker stack which is before the application of any other coatings and to the further application of a high solids starch coating at the wet calenders and the first coater.

The invention both as to its organization and method of operation together with further objects and advantages thereof will best be understood by reference to the following specification taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a flow diagram showing the formation of a sheet of paperboard from the primary headbox through the breaker stack; and

FIGURE 2, when positioned end-to-end with the FIGURE 1, is a flow diagram showing the remaining formation of the sheet from the breaker stack to the fourth dryer section and to the final reeling operation.

With reference to the FIGURE 1, the refining of the pulp and the addition of internal sizing agents and other wet end additives before application to the head boxes are in accordance with normal operations for the basis weight and caliper of the paperboard being produced. The primary head box, the secondary head box, the Fourdrinier, the first press, second press, first dryer section, third press, smoothing press, and second and third dryer sections are also operated in the same manner as they would be operated for a normal coated, cold waxing paperboard of the same basis weight and caliper. For example, a refined pulp of approximately one-half bleached pine and one-half hardwood pulp may be employed that is refined to a Canadian standard freeness of approximately 500 ml. on the primary sheet from the primary head box and a freeness of approximately 275 ml. on the secondary sheet at the secondary head box. It will be understood that the refined pulp includes the usual internal sizing agents, and wet-end additives such as rosin size, alum, or paraffin etc., for preparing conventional or normal, coated cold waxing board.

It will be understood that the ratio of pine (long fiber) and hardwood (short fiber) pulp may be varied considerably from the 1 to 1 ratio set forth. The use of hardwood pulp generally tends to make a smoother sheet surface. Since the present invention relates to obtaining a grease resistant paperboard by applying films to the sheet surface, it is desirable to have as smooth a surface as possible. However, the ratio of pine to hardwood in the grease resistant boards is not significantly different from the ratio in the usual coated, bleached board grades. Sheet smoothness may be influenced by the amount and type of mechanical refining of the pulp. Although the presence of hardwood in the pulp contributes to the grease resistance of the board, it is believed that grease resistant boards could be obtained by the practice of the present invention without the inclusion of hardwood in the pulp.

After the refined pulp is supplied to the primary head box and the secondary head box, the pulp is applied to the wire of the Fourdrinier. The portion of the Fourdrinier wire table between the breast roll and the suction boxes is considered to be the forming section on which the final sheet formation is established. The fibers are deposited on the machine wire as a result of suction which pulls the water through the wire and deposits the fibers on the surface of the wire. Table rolls, suction boxes, and the suction couch roll are used on Fourdrinier machines to aid in water removal and any increase in suction at these points results in an increased rate of drainage and a more compact sheet. From the wire, the sheet is transferred to the first press) in order to remove sufficient water from the fibrous mat to allow it to become sufficiently self-supporting and to advance along the machine without rupture. After the sheet leaves the first press, it is advanced to a second press of similar construction and then to a first dryer section which is shown symbolically as a zigzag line in the FIGURE 1.

After the sheet leaves the first dryer section it is advanced successively through a third press, a smoothing press, a second dryer section and a third dryer section. The sheet is then about to enter the breaker stack.

The breaker stack is employed during the manufacture of certain grades of paper. The breaker stack is a two-roll stack and usually located approximately one-half of the way along the dryer sections. The breaker stack smooths the paper while it still contains a high percentage of moisture and is most susceptible to calendering. As a result, the paper is appreciably increased in density, bursting strength and finish. A salient feature of the present invention is the application of a high solids cooked starch paste to the top surface and/or lower surface of the sheet of paperboard at this point.

Starch is used to a great extent for surface sizing and is cheaper than many other sizes such as animal glue. Most of the starch used in the United States is derived from corn, tapioca or potatoes. Starch is a white to buff colored material which is available in powdered, pearl or crystal form. Starch exists in the physical form of small grains or granules, the size, shape and physical markings of which are sufficient to identify the variety of starch. Chemically speaking, starch contains two major chemical entities, amylose which is a straight-chain polymer of glucose and amylopectin which is a branched chain polymer of glucose, although certain waxy varieties of starch contain only amylopectin. All starches contain minor amounts of fatty acids, other lipids, proteins, and inorganic salts. Before starch can be used for surface sizing, it must be heated in water and during the heating, the granules take on water, expand, the granule commences to dissolve and disintegrate. The degree of granular disintegration and the viscosity of the starch solution depend upon the type of starch, degree of modification, time and temperature of heating, and amount of agitation.

A number of starches may be successfully employed with the invention such as oxidized, dextrinized, hydrolized, esterified or etherified. As an example, oxidized starch will be discussed in some detail. Oxidized starch is available in a wide range of viscosities by treating a slurry of native starch with alkalyn sodium hypochloride at a temperature no higher than 130° F. During conversion, soluble products are formed and these are later removed by filtering and washing, after which the starch is dried and ready for shipment. A starch suitable for use in the practice of the present invention is the thin boiling, oxidized starch known as Fibersize by National Starch Products Incorporated, New York, N.Y.

Before the starch is suitable for coating the newly formed paperboard, it must be cooked. Approximately 1 part of starch is mixed with 4 parts of water and cooked by heating to a temperature in the range of 190° to 210° F. for approximately 15 to 20 minutes. It will be understood that the starch-water mixture may be varied as set forth in the examples hereinafter. Upon cooking, the starch forms a solution of improved colloidal properties compared to most other forms of modified starch.

The high solids cooked starch paste is now applied to

the top surface of the sheet of paperboard just prior to the entry of the sheet into the nip of the breaker stack as shown on the FIGURE 1. Alternatively, the starch coating may be applied to the lower or bottom surface only or to both the upper and lower surfaces, as shown at the shower pipes A and/or B of the breaker stack in the FIGURE 1. A pool of the starch paste forms on the surface of the sheet as the sheet enters the nip and is maintained at a temperature in the range of 170° to 180° F. At that point, approximately one to one and one-half pounds per 1000 square feet of paperboard of cooked starch solids is applied to the surface of the sheet and impressed into the surface by the breaker stack. At this point in the process, the oxidized starch tends to penetrate well into the sheet and form a surface film since the sheet of paperboard is still relatively wet and absorbent.

The manufacture of high grease resistant paperboard to which the present invention is directed, basically comprises the multiple application of a relatively highly concentrated cooked starch paste to the surface of the paperboard on which the grease resistance is desired. As set forth, the first application of the cooked starch paste to the top surface or the bottom surface of the sheet of paperboard takes place at the breaker stack shown in the FIGURE 1. At the breaker stack, a horizontal shower pipe indicated at A supplies the starch paste to the top surface of the sheet for application to the sheet of paperboard at the nip of the breaker stack. Similarly, a lower shower pipe B supplies the starch to the lower surface of the sheet. An excess of starch paste is applied so that a pool of the starch paste exists where the sheet enters the nip of the breaker stack.

With reference to the FIGURE 2, after the application of the starch paste to the top and/or lower surface of the sheet at the breaker stack, the sheet goes through the fourth dryer section and then through the size press. The size press usually comprises two rolls between which the paper travels while it receives the surface sizing solution. Size presses may be of the vertical type or of the horizontal type. The size solution is sprayed on both sides of the sheet. At the size press, indicated on the FIGURE 2 by the reference figure B, a starch-clay coating is applied to both sides of the sheet. The coating mixture applied at the size press contains approximately 15 to 22% total solids, of which approximately one-half is clay and approximately one-half is cooked starch, the cooked starch being prepared in the manner previously set forth. The clay is the usual clay used in the manufacture of paperboard and may be of the air-floated or water-washed type; however, the air-floated clay is preferable due to its lower cost. The clay is usually mixed in water with the starch and it may be desirable to add a small amount of rosin size. The clay disperses better in hot or warm water than in cold so that it is compatible with the warm starch solution.

After the sheet passes a size press of the FIGURE 2, it is advanced throught the fifth dryer section and to the wet calender stacks. In the construction of a wet calender, a box extends across the length of the calender roll and is used for holding the size or coating to be applied to the paper. The solution to be applied is picked up by the calender roll and applied to the paperboard surface. The lip of the box may be from 2 to 4 inches below the nip of the roll and aproximately ¾ of an inch from the roll face with a flexible lip extending to the roll face. The box is arranged so that vertical and horizontal adjustments are possible.

With further reference to the FIGURE 2, a coating is applied to both the upper and lower surfaces of the sheet at the wet calenders. To the top surface of the sheet, a second application of the high solids cooked starch paste is accomplished by means of a water box. This coating is applied by the water box indicated by the reference C of the FIGURE 2. The reference D is a second water box and applies, to the bottom surface of the sheet, an application of lower solids cooked starch paste in the range of 5 to 10 percent solids. In addition, to the water box reference D, algin or alginic acid is added. A suitable quantity may be 1 part of algin for each 24 parts of starch. Algin or alginic acid is a high molecular weight carbyl hydrate polymer of anhydro-B–D-mannuronic acid which is obtained from a certain type of seaweed growing in quantity off the West Coast of the United States. Alginic acid is insoluble in water, but it contains a high percentage of carboxyl groups which can be reacted with alkali to produce water-soluble salt known as alginates. Alginates can be dissolved readily in water by adding the dry product to water under vigorous agitation. Alginate is a filming-type sizing agent and tends to remain on the surface of paper when applied as a surface size. As in this application, it is used in combination with starches to produce grease resistant paper-board where a high density-well-closed surface is desired. Such an alginate is produced by Kelco, New York, N. Y., under the registered mark of Kelgin.

The temperature of the wet calenders in the area of the boxes C and D may be maintained at a temperature in the range of 170° to 180° F. After the coatings are applied to the upper and lower surfaces of the sheet of paperboard at the wet calenders, the sheet is advanced to the first coater and air cap dryer of the FIGURE 2 where the third high solids cooked starch past is applied by the coater indicated at the reference figure E. The temperature maintained at the first coater and air cap dryer is somewhat lower than at the breaker stack or the wet calender, being in the range of 120° to 125° F.

As the sheet leaves the first coater it is advanced through the No. 1 polisher and then to the second coater and air cap dryer where the last coating is applied. The second coater applies, at the reference numeral F, a normal pigmented coating which includes clay as the pigment with protein as the binder, along with the necessary lubricating agents, deformers, etc. The normal pigmented coating may contain from 5 to 6 parts of clay, 1 part of protein, and sufficient additives to insure proper flow characteristics.

As shown in the FIGURE 2, the sheet advances to the No. 2 polisher, through the dry calenders and is formed into a roll at the reel indicated at the end of the process line.

The following examples further illustrate the practice and principles of the manner in which the invention has been applied; however, the examples are not to be construed as limiting the scope of the invention.

EXAMPLE I

In this example, the operation of the paper machine to manufacture highly grease resistant paperboard was similar to the method of manufacturing a routine grade of a coated, cold waxing, bleached paperboard with the exception that a high solids cooked starch paste was applied to the top surface of the sheet of paperboard at the breaker stack, the wet calenders and the first coater, as shown in the FIGURES 1 and 2.

At the wet end, the pulp comprised approximately equal quantities of pine and hardwood along with the usual wet end additives such as rosin size, alum, etc. The Fourdrinier, first press, second press, first dryer section, third press, smoothing press, second dryer and third dryer are also operated in the same manner as they would be for a normal coated, cold waxing paperboard of the same basis weight and caliper. The first application of the high solids cooked starch paste to the top surface of the sheet of paperboard took place at the breaker stack. At this point, by means of a horizontal shower pipe, the starch paste is applied to the top surface of the sheet. An excess of the starch paste is applied so that a pool of the starch paste exists where the sheet enters the nip of the breaker stack. The temperature is maintained in approximately the range of 160° to 180° F. and approximately one to one

and one-half pound per 1000 square feet of paperboard of the cooked starch solids was applied to the surface of the sheet and impresed into the surface by the breaker stack at this point in the process where the sheet of paperboard was still relatively wet and absorbent.

The cooked starch paste used for these applications was a paste consisting of approximately 20% solids of an oxidized, thin boiling or low viscosity, starch. Prior to application on the surface of the paperboard, the starch is prepared by adding approximately 4 parts of cold water by weight to 1 part of starch. The temperature is then raised to approximately 195° F. and cooked for approximately 15 to 20 minutes. The starch is then ready for application to the surface of the sheet of paperboard at the breaker stack.

Following the application of the starch paste at the breaker stack, the sheet advances through the fourth dryer section and then to the size press. At the size press, FIGURE 2, a starch-clay coating is applied to both sides of the sheet. The coating mixture has from approximately 15 to 22% total solids, of which approximately one-half is clay and one-half is cooked starch. This is a normal application for a cold waxing grade of paperboard.

After the applications of the coating at the size press, the sheet advances through the fifth dryer section and then through the calender stacks, where a different application is made to each of the sides of the sheet. To the top side of the sheet, the second application of the high solids cooked starch paste is made by means of a water box. This starch in preparation and composition is substantially identical to that starch applied at the breaker stack. To the bottom side of the sheet, an application of cooked starch paste of approximately 7% solids along with approximately 1 part of an alginate for each 24 parts of cooked starch is accomplished of a water box. This is also normal application for a cold waxing grade of paperboard.

After the wet calenders, the sheet travels through the first coater and air cap dryer. The first coater applies a coating of the high solids cooked starch paste to the top side of the sheet, which starch paste is substantially identical to that applied at the breaker stack and the wet calenders.

The sheet then passes through a polisher and then to the second coater and air cap dryer. At the second coater, a normal pigmented coating was applied to the top side of the sheet. This coating employs clay as the pigment with protein as the binder, along with the necessary lubricating agents, deformers, etc. The paper is then again polished, advanced through the dry calenders and is reeled at the output station.

The sheet of paperboard produced by the foregoing method was highly successful in terms of grease resistance upon subsequent testing and observation. The grease resistance tests consisted in applying a one-half inch head of cooking oil (such as Mazola oil) or turpentine to the surface of the paperboard and measuring the length of time required for the oil or turpentine to penetrate the paperboard and stain 50% of the under surface. The cooking oil tests were terminated after six days with no penetration at all. The turpentine tests were terminated after 30 hours with no penetration. In addition, the coatings of starch and other coating materials adhered well to the paperboard under conditions of flexing and bending.

EXAMPLE II

This run was substantially identical to Example I except that the breaker stack was turned off and the coating of starch at the breaker stack was eliminated. The paperboard produced by this run had a turpentine test of 5 hours and 20 minutes as compared with 30 hours of no penetration when a coating of starch was applied at the breaker stack in Example I.

EXAMPLE III

The purpose of this example was to make a run substantially identical to Example I to see if the results achieved in the Example I could be reproduced. The highly grease resistant paperboard was again produced and the tests showed approximately the same imperviousness to oil and turpentine as that set forth in Example I.

EXAMPLE IV

This run was conducted to establish the effectiveness of the grease resistance of the paperboard by still applying three coats of heavy starch paste as in Example I but applying a high solids coating at the wet calender, the first coater and the second coater rather than at the breaker stack, the wet calender and the first coater as the Example I. The product produced by this method showed a cooking oil test of 11 minutes and a turpentine test of 240 seconds. Thus, the importance of increasing the grease resistance of the paperboard by applying a high solids cooked starch paste at the breaker stack is demonstrated since the cooking oil test decreased from no penetration after six days of exposure in the Example I to 11 minutes with 50% stain of the under surface in this example.

EXAMPLE V

The purpose of this run was to determine the effectiveness of wax and starch in the coating solutions. The conditions are substantially identical to those of Example IV except that a 10% wax was added to each of the high solids solutions. The cooking oil test was also terminated at 11 minutes with a 50% stain of the under surface while the turpentine test decreased to 210 seconds.

EXAMPLE VI

The purpose of this run is to establish the effectiveness of producing high grease resistant paperboard through the use of hydroxyethyl ether starch instead of oxidized starches. The hydroxyethyl ether starch is of higher viscosity than the oxidized starches so the concentration is reduced to approximately 7% solids starch (1 part of starch to approximately 13 parts of water) from the 20% solid starch solution (1 part of starch to approximately 4 parts of water) employed in the foregoing examples. The run is conducted in substantially the same manner as the run in Example I except for the substitution of the 7% hydroxyethyl ether starch for the 20% oxidized starch of the earlier examples. The paperboard produced as a result of this process, is substantially identical to the paperboard produced in Example I in regard to the cooking oil and turpentine tests.

EXAMPLE VII

The purpose of this run is to establish an upper limit for the starch concentration. The upper limit appears to be limited by the pumping equipment and other devices utilized for moving the starch to the surface of the paperboard to be coated. In this run, the conditions are substantially identical to those of Example I except that the starch concentration is increased to 25% which is accomplished by mixing approximately 1 part of starch by weight of 3 parts of water and cooking for the prescribed time. Subsequent testing of the product produced by this method showed results substantially identical to those obtained in Example I.

Thus, it has been determined that a high grease resistant paperboard can be obtained through multiple applications of a relatively highly concentrated cooked starch paste to the surface of the paperboard on which grease resistance is desired. Further, it has been found that the grease resistance of the paperboard has been enhanced to a high degree of applying a coating of the high solids starch paste much earlier in the manufacturing process than heretofore known, i.e., at the breaker stack and before the size press. The results are tabulated

below and are illustrative of the degree of grease resistance obtained:

Application points of high solids starch in the process	Holdout test (50% stain of under surface unless otherwise indicated)	
	Cooking oil	Turpentine
Example I: (a) At breaker stack (b) At wet calender (c) At first coater	No penetration after 6 days.	No penetration after 30 hours.
Example II: (a) At wet calender (b) At first coater	10 minutes	5 hrs. 20 minutes.
Example IV: (a) At wet calender (b) At first coater (c) At second coater	11 minutes	4 minutes.

Thus, the present invention may be embodied in other specific forms without departing from the spirit and the essential characteristics of the invention. The present embodiment is, therefore, to be considered in all respects as illustrative and the scope of the invention being indicated by the appended calims rather that the foregoing description, and all changes which come within the meaning and range of the equivalency of the claims are, therefore, intended to be embraced therein.

What is claimed is:

1. In a process for manufacturing grease-resistant paperboard wherein the sheet is formed in a conventional manner including the steps of pressing, drying, smoothing and sizing, the improvement comprising applying a plurality of cooked starch paste coatings to the surface of the sheet, the first of the coatings being applied to the top surface of the sheet at a breaker stack while the sheet is in a wet and absorbent state, and before the application of any other surface materials, applying a second coating of starch paste to the top surface of the sheet, and applying a coating of starch and aliginate to the other surface of the sheet, and applying a third coating of starch paste to the top surface of the sheet, each of the starch coatings applied to the sheet having a starch concentration of approximately 7% to 25%.

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