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WAX COATING COMPOSITION AND PAPERBOARD COATED THEREWITH

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7 Claims. (Cl. 106—270)

This invention relates to improved wax coating compositions, more particularly to wax coating compositions possessing superior performance characteristics at low load levels, and to paperboard coated therewith.

Paraffin waxes have been used widely for the coating of paperboard and similar porous sheet materials for the purpose of waterproofing and providing sealing means for such materials. Such wax coated paperboard is particularly useful in the manufacture of food cartons and milk containers. Since paraffin wax lacks the tensile strength and flexibility characteristics required for a paperboard coating composition, polyethylene in small amounts has been added to the wax to improve these properties. The waxes suitable for coating milk cartons, however, require additional properties in order that they will coat the carton uniformly and the finished cartons will have a long shelf life when filled with milk. It has been found that if thicker wax coatings are applied, longer shelf lives can be obtained, such coatings, however, are usually not uniform and tend to flake from the paperboard. This tendency increases as the load of wax on the paperboard increases and, in addition, the material cost of waxing the paperboard increases as the wax load increases.

A wax composition now has been found wherein a paraffin wax-polyethylene composition is modified by the addition of small amounts of a microcrystalline wax and a high melting point synthetic Fischer-Tropsch wax to produce a wax composition which, when utilized to coat paperboard, provides superior performance characteristics at low wax loads.

It is an object therefore of this invention to provide an improved wax coating composition.

It is another object of this invention to provide paperboard coated with an improved wax coating composition.

It is another object of this invention to provide a wax coating composition possessing superior performance characteristics at low load levels.

Other objects of this invention will be apparent from the following description of the invention and the claims.

In accordance with the present invention, a wax composition comprising a major amount of paraffin wax modified by the addition of small amounts of polyethylene, a microcrystalline wax, and a high melting point synthetic Fischer-Tropsch wax may be utilized at low wax loads to coat paperboard, particularly milk cartons, to provide a uniformly coated carton having an exceedingly long shelf life.

The major component of the wax composition of the instant invention comprises paraffin wax, i.e., the normal and isoparaffin hydrocarbon waxes derived from petroleum crude oils melting within the range of from about 110° F. to about 140° F. These paraffin waxes usually predominate in normal paraffins and ordinarily consist of a mixture of hydrocarbons differing only slightly in structure and molecular weight. They are obtained from waxy lubricating oils by well-known dewaxing procedures, generally by the use of dewaxing solvents. Paraffin waxes are characterized by their melting points and those

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suitable for use in this invention have melting points ranging from 110° F. to 140° F. and those preferred have melting points ranging from 120° F. to 125° F.

The second essential component of the instant wax composition comprises a solid polymer of ethylene, in particular, polyethylene having an average molecular weight of between about 10,000 and 14,000 (Staudinger method). Preferably the polyethylene should have a molecular weight of about 12,000.

The third essential component of the instant wax composition is a microcrystalline wax, sometimes designated as amorphous or petrolatum wax, such as that prepared by the solvent dewaxing and deoiling of Mid-Continent petroleum residuum stocks. The microcrystalline waxes preferred for the wax compositions of this invention are those having a melting point within the range from 145° F. to 160° F., a viscosity of from 80 to 90 Saybolt seconds Universal at 210° F., an oil content of not more than about 1.5 percent and a penetration at 77° F. of from about 23 to 30.

The fourth essential component of the wax composition of this invention consists of a synthetic Fischer-Tropsch wax. Fischer-Tropsch waxes which in recent years have become available in commercial quantities are produced by the well-known reaction of carbon monoxide with hydrogen. The waxes so produced are characterized by the fact that they contain very high percentage of normal paraffins, generally of the order of 90 percent or more. The remainder of such waxes are composed of slightly branched chain hydrocarbons and trace amounts of unsaturated compounds and oxygenated compounds. The synthetic Fischer-Tropsch waxes suitable for use in the instant compositions are those of high melting point ranging from 215° F. to 230° F. and preferably from 220° F. to 225° F.

It has been found that the quantity of each component used to modify the paraffin wax is exceedingly critical in order to obtain the objectives of the invention. Thus, the quantity of polyethylene should range from 0.3 to 1.0 weight percent based on the weight of the finished composition, this microcrystalline wax should range from 2.0 to 4.0 weight percent based on the weight of the final composition, preferably the microcrystalline wax should amount to about 3.0 percent, and the Fischer-Tropsch wax should range from 1.0 to 2.0 weight percent based on the weight of the final composition. Thus the paraffin wax may range from 93.0 to 96.7 weight percent and preferably from 94.0 to 95.7 weight percent.

The compositions of this invention are easily prepared. Paraffin wax is melted and the microcrystalline wax added thereto with vigorous agitation. This mixture is then heated to a temperature of approximately 240° F. and the polyethylene and the Fischer-Tropsch wax added with additional vigorous agitation. The final coating composition may be utilized for coating paperboard at coating temperatures of preferably 170° F.

In order to demonstrate the utility of the wax coating compositions of this invention as well as the criticality of each of the components and the amounts thereof, a large number of compositions were prepared and utilized to coat milk cartons according to a standard method and thereafter the coated cartons were subjected to certain performance tests.

A Model E Pure-Pak machine which takes carton blanks, forms them into cartons, waxes the cartons, fills the cartons with milk and seals the cartons in successive steps was utilized in these tests. The paperboard utilized was milk carton stock, 0.16 inch in thickness having 250-second Gurley densometer porosity. The machine was operated in the normal way with the coating being carried out at 170° F. except that the cartons were not filled with milk. Thus, the wax loads ob-

tained were solely dependent upon the wax being employed. In order to determine the amount of wax load on the cartons a predetermined number of cartons was weighed before and after waxing. The difference in weight was determined for the number of cartons utilized in the test and the wax load expressed in pounds per 1000 cartons. Thus, if 10 cartons were utilized in the test the difference in weight before and after waxing would be multiplied by 100 in order to obtain the wax load in pounds per 1000 cartons.

In order to determine the uniformity of the wax coating, a waxed carton was filled with an aqueous solution of methylene blue, 0.1 percent by weight and the solution allowed to stand in the carton for 10 minutes at room temperature (73° F.). The solution was then poured from the carton and the carton opened and flattened. Wherever the wax had failed to coat the paper, a blue stain appeared. The total area stained was measured with a grid ruled in squares measuring 0.25 centimeter on each side. The total area stained in terms of the number of such squares was reported as the staining number. Thus, the higher numbers indicate poor uniformity whereas low numbers correspond to a more uniform coating.

The shelf life of the waxed cartons was measured by filling the carton with a 1.0 percent aqueous solution of lactic acid also containing 0.1 percent methylene blue and allowing the filled cartons to stand at room temperature (73° F.). The cartons were inspected twice daily to note the development of leaks. The number of hours required for a leak to develop was reported as the shelf life of the carton. The methylene blue, of course, facilitated the detection of the leaks. It was found that the lactic acid solution simulated aged milk and therefore correlated very well with actual shelf life of cartons containing milk.

The paraffin wax utilized in these examples had a melting point of 124° F. according to ASTM Method D-87 and an oil content of 0.8 percent according to ASTM Method D-721. The polyethylene employed had a molecular weight of 12,000. The microcrystalline wax had a melting point (drop) of 146° F. according to the ASTM Method D-127, an oil content of 1.5 percent as measured by ASTM Method D-721, a viscosity of 87 Saybolt second Universal at 210° F. and a penetration at 77° F. of 26.2 as measured by ASTM Method D-1321.

The synthetic Fischer-Tropsch wax was a commercial material sold under the trade name "Paraffint" and had a capillary melting point of 221° F., a solidification point (rotating thermometer) of from 208.4° to 215.6° F., a drop melting point of about 230° F., a penetration at 77° F. of less than 1, an iodine number of from 3 to 5, an acid number of 0.0, a saponification number of 0.0, and a hydroxyl number of 0.0.

The compositions which were prepared and tested together with the results of the performance tests carried out thereon are set forth in Table I.

Table I

Example No.	Composition, Weight Percent				Test Results		
	Paraffin Wax	Polyethylene	Microcrystalline Wax	Fischer-Tropsch Wax	Wax load, pounds per 1,000 cartons	Staining Number	Shelf life, hrs. at 73° F.
1.....	100.0	0.0	0.0	0.0	36.3	-----	84
2.....	99.0	1.0	0.0	0.0	32.5	25	139
3.....	97.5	1.0	0.0	1.5	33.2	12	137
4.....	96.0	1.0	3.0	0.0	35.2	22	161
5.....	94.5	1.0	3.0	1.5	32.5	10	283

It will be seen from these data that the paraffin wax alone gives a high load and short shelf life whereas if

the paraffin wax is modified with polyethylene the wax load is decreased to a satisfactory level, but the shelf life is not increased to a satisfactory degree and the coating is rather non-uniform as shown by the high staining number. Example 3 shows that the composition of Example 2 may be improved by the addition of the Fischer-Tropsch wax as far as the uniformity is concerned, but the load is increased. Example 4 shows that the shelf life of the composition of Example 2 may be improved by the addition of microcrystalline wax, but the load is materially increased and the coating again becomes rather non-uniform. Example 5 shows the necessity of employing all three of the paraffin wax modifiers. This composition has a low load level, is uniform and has a superior shelf life.

In order to demonstrate the criticality of employing the high melting point Fischer-Tropsch wax in the composition of this invention, a high melting point microcrystalline wax was substituted for the Fischer-Tropsch wax in the composition of Example 5. This microcrystalline wax was a commercial product having a melting point of approximately 185° F. The paraffin wax, polyethylene, and lower melting point microcrystalline wax were the same as those employed in Example 5 and in the same amounts. The amount of high melting point microcrystalline wax employed was 1.5 percent by weight, i.e. the same as that of the Fischer-Tropsch wax in Example 5. The results of the tests on this composition are shown under Example 6 in Table II.

In another experiment the highest melting point petroleum paraffin wax available commercially, melting point 163.4° F., was substituted for the Fischer-Tropsch wax of Example 5. This composition designated Example 7 in Table II, employed the same paraffin wax base material, polyethylene and microcrystalline wax of Example 5 and in the same amounts as in Example 5. Likewise the high melting point paraffin wax was used in the amount of 1.5 percent by weight, the amount of the Fischer-Tropsch wax in Example 5.

Table II

Example No.	Wax Load, Pounds Per 1,000 Cartons	Staining Number	Shelf Life, Hours at 73° F.
6.....	34.5	17	262
7.....	34.7	24	252

These results show that neither a high melting point microcrystalline wax nor a high melting point petroleum paraffin wax can be substituted for the Fischer-Tropsch wax of this invention.

A large series of experiments were carried out in which the molecular weight and concentration of the polyethylene were varied and the wax load determined for each composition. From the correlation curves obtained it was determined that in order to obtain a wax load not greater than 32.5 pounds per 1000 cartons the average molecular weight of the polyethylene should range from 10,000 to 14,000 molecular weight (Staudinger method), preferably about 12,000, and the concentration should range from 0.3 to 1.0 weight percent based on the weight of the final composition. The concentration ranges of the microcrystalline wax (2.0 to 4.0 weight percent, about 3.0 percent preferred) and Fischer-Tropsch wax (1.0 to 2.0 weight percent) were determined from similar test data.

I claim:

1. A wax coating composition for paperboard consisting essentially of from 93.0 to 96.7 weight percent of a paraffin wax having a melting point ranging from 110° F. to 140° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, from 2.0 to 4.0 weight per-

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cent of a microcrystalline wax having a melting point ranging from 145° F. to 160° F., and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 215° F. to 230° F.

2. A wax coating composition for paperboard consisting essentially of from 93.0 to 96.7 weight percent of a paraffin wax having a melting point ranging from 120° F. to 125° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, from 2.0 to 4.0 weight percent of a microcrystalline wax having a melting point ranging from about 145° F. to 160° F., and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 220° F. to 225° F.

3. A wax coating composition for paperboard consisting essentially of from 94.0 to 95.7 weight percent of a paraffin wax having a melting point ranging from 110° F. to 140° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, about 3.0 weight percent of a microcrystalline wax having a molecular weight ranging from 145° F. to 160° F. and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 215° F. to 230° F.

4. A wax coating composition for paperboard consisting essentially of 94.0 to 95.7 weight percent of a paraffin wax having a melting point ranging from 120° F. to 125° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, about 3.0 percent by weight of a microcrystalline wax having a molecular weight ranging from 145° F. to 160° F. and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 220° F. to 225° F.

5. A wax coating composition for paperboard consisting essentially of 94.0 to 95.7 weight percent of a paraffin wax having a melting point ranging from 120° F. to

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125° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight of about 12,000, about 3.0 weight percent of a microcrystalline wax having a molecular weight ranging from 145° F. to 160° F. and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 220° F. to 225° F.

6. Paperboard having a wax coating consisting essentially of from 93.0 to 96.7 weight percent of a paraffin wax having a melting point ranging from 110° F. to 140° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, from 2.0 to 4.0 weight percent of a microcrystalline wax having a melting point ranging from 145° F. to 160° F. and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 215° F. to 230° F.

7. Paperboard having a wax coating consisting essentially of from 93.0 to 96.7 weight percent of a paraffin wax having a melting point ranging from 120° F. to 125° F., from 0.3 to 1.0 weight percent of polyethylene having an average molecular weight ranging from 10,000 to 14,000, from 2.0 to 4.0 weight percent of a microcrystalline wax having a melting point ranging from about 145° F. to 160° F. and from 1.0 to 2.0 weight percent of a Fischer-Tropsch wax having a melting point ranging from 220° F. to 225° F.

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UNITED STATES PATENT OFFICE
CERTIFICATION OF CORRECTION

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It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 19, for "coacting" read -- coating --;
column 2, line 22, for "Fisher" read -- Fischer --; column
3, line 45, for "second" read -- Seconds --.

Signed and sealed this 30th day of May 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents