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SIZED PAPER

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This invention relates to paper and its manufacture. Specifically it pertains to paper comprising alkaline pigment filler and surface or tub sizing contributed by non-fatty constituents of soy beans.

In the paper industry the terms "size" and "sizing" are used loosely to designate various classes of materials including the following:

(1) Those that impart resistance to water, as resin, wax or the like;

(2) Those that impart stiffness or rattle; for example, sodium silicate;

(3) Those that fill pores and harden the surface, e. g. starch;

(4) Those that act as adhesives in binding surface coatings, as casein, glue, or the like.

The term "sizing" is also used to designate a property of paper which can be tested by writing on the paper with pen and ink or by floating the paper upon a bath of ink or other aqueous medium until the paper is penetrated thereby. The present invention is concerned with materials falling in class (1) above.

It has long been customary to apply to paper, and especially to writing and bond papers, a surface-size or tub-size comprising glue, casein, or equivalent protein. Generally such paper is engine-sized prior to the application of the surface-size in order to avoid excessive absorption of the expensive protein size. It is true, however, that well beaten, unfilled paper, such as bond or writing paper, can be successfully tub-sized even if it has not been previously engine-sized, although such procedure requires a large quantity of the surface-sizing material. On the other hand, in the case of book papers, which ordinarily are less well hydrated and which contain a considerable quantity of inert mineral filler such as clay, it has been impossible to size successfully by a surface application of protein unless sufficient of the latter were used so that the paper could be said to be coated rather than sized. That is, the quantity of protein material ordinarily used in tub-sizing, say up to four pounds per ream, is not sufficient to give water or writing-ink resistance to such unsized clay-filled book paper.

The protein obtained from soy beans is commonly regarded as being an equivalent of casein. In the case of book paper filled with inert filler, soy bean protein and casein are both ineffective as surface-sizes. If, however, the paper is filled with an alkaline filler such as calcium carbonate, calcium sulfite, magnesium carbonate, magnesium hydroxide or the like, it is found that while casein is no more effective than on clay filled paper, soy protein acts as an effective surface-size.

This invention accordingly has for an object the production of surface or tub sized paper containing alkaline filler in which the sizing agent is, at least in part, soy protein. Another object is to size paper containing alkaline filler by applying to the surface thereof a size comprising soy flour. A similar object is to make sized alkaline filled paper by using engine sizing in the furnish and applying to the surface a size containing soy protein. Other objects and advantages will be apparent from the following description:

After the oil has been removed from soy beans by pressure or preferably by solvent extraction, the residual cake contains approximately 45% of protein material, the remainder being chiefly carbohydrate material with a small quantity of mineral matter and some moisture. For use according to this invention the protein may be removed from the cake by extraction with dilute alkali solution, or the cake may be ground to flour which may be dispersed in water containing a little alkali, such as ammonia, caustic soda, or the like. Obviously the latter procedure is the cheaper and may in many cases be satisfactory. Accordingly, in this disclosure the term "soy protein" is intended to include both the relatively pure protein and the protein in association with the other constituents going to make up soy flour.

In practicing the invention a paper-making furnish comprising fibrous material and alkaline filling material is formed into a web on a web-forming device, for example a Fourdrinier wire. To at least one surface of the formed web, either before or after partial or complete drying, is applied an alkaline dispersion of soy protein or soy flour and the web is dried. It will be found that the paper so treated has developed resistance to water; that is, it is sized.

The sizing effect is believed to be due to a specific action between the alkaline filler and some constituent of the protein material. Equivalent results are not obtainable with casein, glue, or other usual substitute therefor.

It is to be noted that the sizing effect is obtained even in the absence of other sizing material or of size precipitant such as alum. Obviously the paper may be engine-sized, if desired, before the application of the soy protein. In that case the sizing effects are additive, and more sizing is obtained than would be given by either method alone.

It is possible to mix clay or other pigment in the protein dispersion to form a thin slurry which acts to fill the surface of the paper, and still get the effect of sizing.

Following is a description of several examples in accordance with the invention:

The following size compositions were employed:

A. Casein of paper coating grade, 20 parts, cooked with water containing 7 parts of strong ammonia water, to make a 5% casein solution.

B. Soy protein was prepared from solvent-extracted soy meal by extraction with dilute caustic soda solution. The protein was precipitated from solution by acid, and dried.

20 parts of the dried protein were dissolved by 7 parts of strong ammonia water in 373 parts of water to make a 5% soy protein solution.

C. "Lime-soluble" soy protein was prepared from soy meal by extraction with calcium hydroxide solution. The protein was precipitated from solution by acid, and dried.

20 parts of the dry lime-soluble protein was dissolved by 7 parts of strong ammonia water in 373 parts of water to make a 5% solution.

D. Soy flour was prepared by grinding solvent-extracted soy meal in a ball mill, and passing it through bolting cloth.

30 parts of the dry flour were dispersed in 570 parts of water containing 0.5 part of sodium hydroxide.

E. 30 parts of soy flour were dispersed in 560 parts of water and 10 parts of strong ammonia water.

F. 15 parts of soy flour and 15 parts of china clay were dispersed in 565 parts of water and 5 parts of strong ammonia water.

G. 15 parts of soy flour and 15 parts of calcium carbonate were dispersed in 565 parts of water and 5 parts of strong ammonia water.

Several moderately beaten paper furnishes containing soda and sulfite fiber and mineral filling material, but without alum or size, were run out on a wire, pressed and dried, making paper weighing 60 pounds per 500 sheet ream cut to 25 x 38 inches. To portions of the paper so made were applied the various protein dispersions listed above. As mineral filling materials for the paper were used the inert material clay; and the alkaline materials magnesium carbonate, calcium sulfite, and calcium carbonate. In some cases the protein dispersion was applied at a size-press after the web had been pressed but not dried; in other cases the protein dispersion was applied to the surface of the dried paper.

The samples prepared as described were tested by being written upon with pen and ink or by being floated on an ink bath. The former test showed merely whether or not the paper was sized, while the latter test gave an indication of the degree of sizing obtained. The results of the sizing tests are shown in the following two tables which likewise indicate the mineral filling material in the sheet, the dry weight of the protein size dispersion applied to the sheet, and whether the size was applied before or after the sheet was dried. Table 1 shows the effect of casein and soy protein, each on clay-filled and on alkaline-filled paper. Table 2 shows the effect of various soy sizes on each of several papers containing different alkaline fillers.

Table 1

Filler in paper	Weight size added	Added before or after drying	Pen and ink test
Clay, 18%	Size A, 1.5 lbs.	Before	Not sized.
Do	Size B, 1.1 lbs.	do	Do.
Do	Size G, 0.9 lbs.	do	Do.
Do	Size A, 3.5 lbs.	After	Do.
Do	Size B, 3.2 lbs.	do	Do.
Calcium carbonate, 30%	Size A, 1.6 lbs.	Before	Do.
Do	Size B, 1.4 lbs.	do	Sized.
Do	Size G, 0.9 lbs.	do	Do.
Do	Size A, 3.5 lbs.	After	Not sized.
Do	Size B, 3.2 lbs.	do	Sized.

Table 2

Filler in paper	Weight size added	Added before or after drying	Seconds sizing, ink flotation test
Calcium carbonate, 30%	Size F, 2.4 lbs.	After	8 secs.
Do	Size E, 1.0 lb.	Before	3 secs.
Do	Size E, 3.5 lbs.	After	13 secs.
Calcium carbonate, 18%	Size D, 2.7 lbs.	do	7 secs.
Do	Size C, 3.7 lbs.	do	9 secs.
Calcium sulfite, 22%	Size E, 2.6 lbs.	do	7 secs.
Magnesium carbonate, 15%	Size E, 2.8 lbs.	do	10 secs.

The percentages of mineral filler shown in the foregoing tables are based on the air-dry weight of the finished sheet of paper before application of the surface size. The weights of size are the dry weights thereof applied to a 60-pound ream (25 x 38 inch—500 sheets) of base paper.

In another example a 60-pound paper was prepared containing soda and sulfite fiber and 20% of calcium carbonate, the furnish having been engine-sized with premixed rosin size and alum. This paper had a two-second ink flotation test, but would not stand pen and ink writing. To this dry sheet was then applied two pounds dry weight of size dispersion E. After drying the ink flotation test was now 8 seconds, and the paper could be written upon with pen and ink.

Whether the action of soy protein with alkaline filler as herein disclosed is chemical or physical in nature, it is evidently different than and distinct from its action with inert filler. For the practice of this invention imparts to paper containing alkaline filler a degree of moisture resistance not given by the same treatment to paper containing only inert filler. Neither is the moisture resistance given to alkaline filled paper by the soy protein-alkaline filler action duplicated by the action of casein or glue on the same paper. But when soy protein or soy flour is applied by well-known surface-sizing methods to alkaline filled paper, and especially to book paper containing alkaline filler, the paper so treated is rendered reliably moisture-resistant and may be said to be satisfactorily sized.

I claim:

1. An alkaline filled, uncoated paper, surface sized with a soya bean protein size, said size consisting essentially of soya bean protein.

2. An alkaline filled, surface sized, uncoated paper as defined in claim 1 in which the soya bean protein size consists of isolated soya bean protein.

3. An alkaline filled, surface sized, uncoated paper as defined in claim 1 in which the soya bean protein size consists of soya bean flour.

4. An alkaline filled, surface sized, uncoated paper as defined in claim 1 containing rosin engine sizing.

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