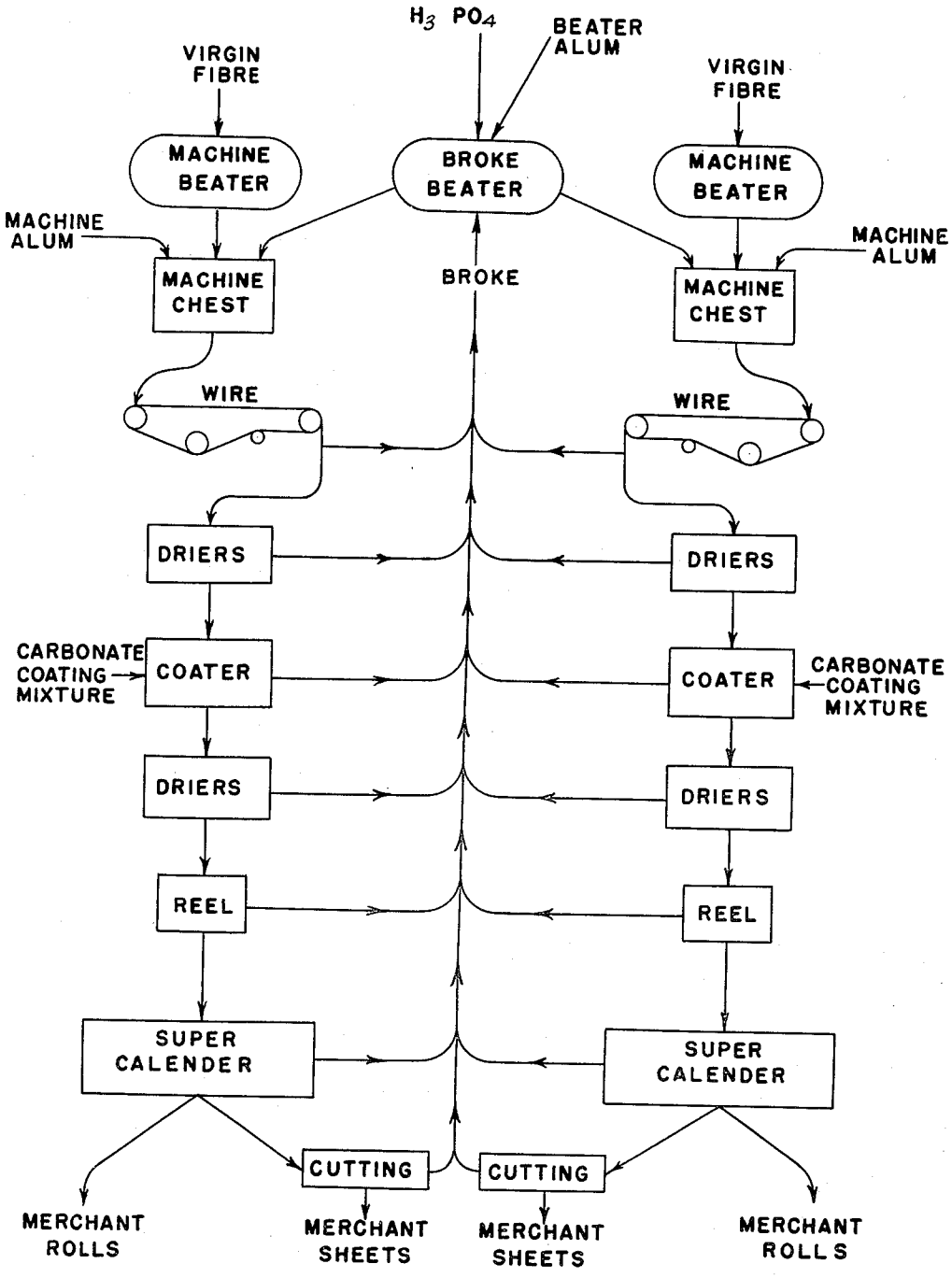
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MANUFACTURE OF PRINTING PAPER

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MANUFACTURE OF PRINTING PAPER

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This invention relates to the manufacture of printing paper, and has particular value in connection with the manufacture of book paper. In order to enable a grade of book paper to be sold at a satisfactory profit in competition with other paper, the paper must not only exceed or equal competitive paper in respect of the various market requirements as to quality, but the cost of producing such paper must be kept as low as possible in order to maintain a satisfactory margin of profit. The various requirements as to quality include printability, brightness, opacity, fold, gloss, Pop or Mullen test, and Pick test. Printability is obviously an important requirement. Brightness and opacity are of perhaps equal importance from a manufacturing standpoint. Under existing methods of manufacture the degree of brightness required is a considerable factor in the cost of production.

The principal object of the invention is to produce at reasonable cost a paper having high printability and brightness, without sacrifice of other properties affecting the quality or salability of the paper.

The invention has its chief application in connection with the manufacture of printing paper, and particularly coated book paper which is coated as an incident to the paper-making operation on the paper-making machine.

An important feature of the invention is based upon the discovery that when relatively small amounts of calcium carbonate and ortho-phosphoric acid are reacted together in the presence of paper-making fibers contained in a paper-making furnish, a calcium phosphate will be formed in the furnish and deposited on the fibers, thereby raising the brightness index of the finished paper to an unexpectedly high value, which is materially higher than can be obtained at comparable cost by merely adding any known available pigment to the furnish.

The invention, furthermore, has outstanding value in connection with the manufacture of coated paper. Heretofore the importance of the base sheet composition has not been fully appreciated in respect of papers coated on the paper machine, and generally sold or described as coated papers, and which papers may have a coat weight as high as 10 pounds or more per side per ream of 3,300 square feet. It was believed that with coatings of such weight, the surface of the base sheet was so efficiently covered that the composition of the base sheet itself was of relatively small importance as affecting the brightness of the finished supercalendered paper. We have found, however, by actual test and experiment that the composition of the base sheet is of very great importance as affecting brightness and printability even in the case of such heavily coated papers as have been referred to, and that the invention herein described also has remarkable value in the manufacture of such coated paper.

Although calcium carbonate is properly considered to be an efficient pigment for improving the brightness of paper, and, for this reason, is used as an ingredient of the mixtures used for coating printing paper, we have found that within certain limits, calcium carbonate is more efficient in improving brightness, and the increased brightness can be obtained more economically, when it is included in the furnish and converted into phosphate by the process herein described than when the same amount of calcium carbonate is merely included in the coating mixture.

In practicing the invention, the carbonate may be supplied to the furnish in various ways. Where there is no other source of carbonate, it may be added to the beater as commercial calcium carbonate. Or, if the unmerchantable paper or "broke" resulting from the operation of the paper machine contains a sufficient supply of carbonate, it is not necessary to add any additional carbonate to the beater furnish. Also, where the paper made by the paper machine is coated with a mixture containing a substantial percentage of calcium carbonate as a pigment, the broke produced by this machine may itself contain such an amount of calcium carbonate that, in practicing the invention described herein, the supply of other calcium carbonate to the beater may be materially reduced or dispensed with entirely.

It has been observed that high alkalinity of the stock due to the presence of calcium carbonate in the beater furnish, introduces certain difficulties into the paper-making operation. For example, it has been customary to add substantial amounts of alum to reduce the pH to the desired value, but this has often resulted in the formation of undesirable amounts of calcium sulphate which may and do cause scaling in the system. This undesirable condition may be largely overcome as an incident to the practice of the invention, since less alum is required. Hence, in this way the forming of a pulp having a sufficiently low pH to satisfy the requirements of the paper-making operation, is aided or simplified.

When the beater furnish contains such an amount of calcium carbonate that it has been necessary to add substantial amounts af alum, usually in the machine chest, in order to adjust the pH of the furnish to an optimum value, it has been difficult to arrive at the proper amount of alum to be added, on account of the fact that the alum under these conditions has a pronounced buffering action, with the result that available tests for pH cannot be depended upon to determine the condition of the pulp with sufficient accuracy. In such cases, this particular difficulty is corrected by the use of the described invention, because we have discovered that when phosphoric acid is employed to replace part of the paper-maker's alum (aluminum sulphate), generally employed to lower the pH of the furnish, this buffering effect, within the desired pH range, is largely eliminated so that the amount of alum to be added to the furnish to obtain the correct degree of acidity in the pulp can be accurately determined. Also, due to the rapidity with which the pH of the furnish changes within the desired range due to the addition of alum, the operator cannot escape the responsibility of adding the correct amount of alum to produce the optimum pH condition demanded by the paper-making operation.

The invention, under present market conditions, appears to have its chief value in connection with the manufacture of coated paper on the paper machine, employing coating mixtures which contain clay, calcium carbonate and an adhesive such as starch or casein. In such an operation a sufficient amount of calcium carbonate is used in the coating mixture so that under ordinary operating conditions the broke resulting from the paper-making operation contains carbonate in such amount that sufficient phosphoric acid may be economically employed to raise the brightness of the finished paper from one to three points measured on the Tappi Standard brightness scale as determined by the G. E. Reflectance Meter described on pages 51–53 of Paper Trade Journal, No. 20, May 13, 1937.

In the case of uncoated papers, or paper coated with

only from 1 to 3 pounds of mineral per side per ream, the amount of calcium carbonate in the broke resulting from the operation of the machine making that particular grade of paper may not be adequate to make the best use of the invention and, therefore, in such cases additional carbonate should be included in the furnish either by adding carbonate as such or by adding broke from a machine which is applying a heavy coat containing a relatively large amount of calcium carbonate in the coating mixture.

Since it is common practice to operate paper machines in pairs, using a single broke beater for handling the broke from each machine, it is possible to operate two such paper machines in combination in practicing the invention on both machines, and without the necessity of adding carbonate in the beater provided that the average of the broke from the two machines contains an amount of carbonate necessary to insure efficient practice of the invention. Obviously, if it is found that the supply of high carbonate broke is insufficient, it is necessary to add other carbonate. On the other hand, if the amount of carbonate in the broke is greater than is needed in practicing the invention, the carbonate content of the broke can be reduced by reducing the amount of carbonate in the coating mixture.

In practicing the invention, the amount of the relatively expensive phosphoric acid which is used is limited to the amount which past experience has indicated to be necessary in order to obtain the desired brightness. If desired, the invention may be employed to effect economies in fiber cost without loss of brightness rather than for the purpose of up-grading the brightness of the sheet.

The improvement in brightness due to the process is believed to be a function of the amount of phosphoric acid added, it being understood that there is at least sufficient carbonate in the furnish to insure complete reaction with all of the phosphoric acid. In general, it has been found that an increase of from 1 to 3 points in brightness can be secured by adding from 10 to 50 pounds of ortho-phosphoric acid per ton of finished paper.

We will now describe examples of procedures which have been actually employed in experimental runs or in actual commercial production. A typical example of the commercial application of the invention to an installation of two machines, each equipped for coating paper on the paper machine with coating mixtures containing calcium carbonate, may be represented by the flow sheet on the drawing forming a part of this specification, which illustrates Example No. 1.

Example No. 1

This example illustrates two Fourdrinier paper machines, preferably arranged side by side with a common service aisle, and producing book paper having a coat weight (total for the two sides) of about 20 pounds per ream of 3300 square feet, and a finish weight of about 60 pounds per ream. Each machine has its own machine beater for receiving and beating 1800 pounds, air-dry weight, of virgin fiber which, in the present instance, comprises 60% of chemical pulp, for example 30% of bleached kraft pulp and 30% of bleached sulphite pulp, and 40% of unbleached groundwood or mechanical pulp. This will be sufficient to make about 2700 pounds of finished merchantable machine-coated paper.

The beaten fiber stock proceeds from the machine beater to the machine chest at which point there is added from the broke beater usually about one-half of the broke made by the two machines. From the machine chest the stock proceeds to the Fourdrinier wire and from there to the line of driers and through the coater which is interposed between the first set of driers and the second set of driers.

In its passage through the coater, the web is coated on both sides with a starch-clay coating mixture which is conventional except that 25% of the clay has been replaced with calcium carbonate. After leaving the driers, the dried coated paper is reeled up into rolls after which it is supercalendered. The supercalendered paper may be sold in rolls or it may be cut into merchant sheets.

As an inevitable incident to the paper-making operation, substantial amounts of unmerchantable paper or broke are produced at the points indicated on the flow sheet or diagram. For example, the broke may come from the paper machine at the end of the wire or the first set of driers ahead of the coater. This broke will not be coated. However, at subsequent points in the machine, such as on the coater, the final driers, the reel, the supercalender, and as an incident to the trimming of the rolls and cutting of the sheets, substantial amounts of unmerchantable coated paper are produced. All of the broke from the two machines is charged into the broke beater which is then alkaline, having a pH of about 8.0 to 8.5.

When the broke from the two machines represents about 12 to 20% of the production, about 40 pounds of commercial phosphoric acid containing 75% of H_3PO_4 per 1800 pounds of virgin fiber supplied to the two machines, are added to the broke beater. This amount is sufficient to bring the pH down to about 5.5. On account of the fact that phosphoric acid is a somewhat expensive chemical, the amount added should be kept as low as possible, consistent with the results desired. When there is a large amount of carbonate present in the broke beater, and after the prescribed amount of phosphoric acid has been added, the pH of the stock should be further reduced to the optimum amount, normally between 4.2 and 5.5, by adding to the broke beater a greater or less amount of alum normally about 20 to 50 pounds per 1800 pounds of virgin fiber supplied to the two machines. It will be understood also that, according to standard practice, some alum is added to the furnish in the machine chest, so that the pH of the stock going to the wire is not above 5.5 or below 4.2. Care should be taken that the total amount of alum incorporated in the furnish should be limited so that the pH of the tray water coming from the wet end of the paper machine should not go below about 4.0, otherwise the corrosive effect of the stock will cause obvious difficulties in respect of the economical and efficient operation of the machine.

On the other hand, if the combined acidifying effect of the phosphoric acid and alum is too small in respect of the total amount of calcium carbonate contained in the furnish so that the pH of the stock remains much above 6.0, this high pH figure may cause other troubles such as picking on the felt press roll, foaming and possibly the development of slime, and rotting of felts, any of which effects may interfere with the economical production of good paper.

In the case of a starch-clay coating mixture which contains calcium carbonate in an amount equal to 25% of the pigment, and with a broke production of about 12 to 20% of the total amount of paper produced, there should be ample carbonate coming back in the broke so that there is no need to add any other carbonate to the broke beater in order to obtain the desired brightness.

According to the above procedure, the brightness of the finished paper is increased from 74 to 76, i. e. about two points by the use of the phosphoric acid, and at a cost of about $1.00 per ton of finished paper.

Example No. 2

In the case of a single machine producing a high-grade of coated paper having a finish weight of 80 pounds per ream and having a coat weight of 11 pounds on each side, where the base sheet must contain no groundwood, and the fiber consists of 100% chemical pulp, i. e. soda pulp, bleached kraft pulp, or sulphite pulp, or a combination of these types of chemical pulp, the broke which is to be reintroduced into the furnish

must be kept free from groundwood. Therefore, it is necessary to exclude from the furnish any broke which comes from a machine which is producing paper containing groundwood or any other type of pulp which would adulterate the virgin 100% chemical pulp from which the high-grade sheet of paper is made. However, there need be no other material change in the procedure set forth in Example No. 1. In this case, the use of 50 pounds of 75% ortho-phosphoric acid per 1800 pounds of air-dry virgin fiber will raise the brightness from 78 to 80.

Example No. 3

In the case of a single machine producing uncoated paper composed of 55% groundwood and 45% chemical pulp, and where the finished sheet weight was only about 40 pounds per ream, about 15 pounds of carbonate and 20 pounds of 75% H_3PO_4 were added to the beater per 1800 pounds of virgin pulp, in order to supply enough carbonate so that there was an increase in brightness from 64 to 66.

I claim:

1. An integrated process for the manufacture of coated paper, which comprises making up a furnish from papermaking materials which include a supply of unmerchantable coated paper made by the process and having a coating containing calcium carbonate, adding to the furnish a supply of phosphoric acid so as to form a phosphate pigment in the furnish, forming a web from said phosphate-containing furnish, and coating said web with a mixture containing a substantial percentage of calcium carbonate, the amount of carbonate in the furnish being at least sufficient to react with all of the added phosphoric acid.

2. A process for the manufacture of paper of improved brightness which comprises making up a furnish from papermaking materials which include a supply of unmerchantable paper containing calcium carbonate, reacting the carbonate in the furnish with enough acidic material including phosphoric acid to provide a pH value in the range between about 6 and about 4 in the furnish going to the paper machine, and to form a phosphate pigment in the furnish, the amount of phosphoric acid used being enough to form sufficient phosphate pigment to produce a definite increase in brightness in the paper web formed from said furnish, the carbonate being present in the furnish at the time of the addition of the phosphoric acid and in an amount at least sufficient to react with all of the phosphoric acid added.

3. A process for the manufacture of printing paper of improved brightness which comprises making up a furnish from papermaking materials which include a supply of unmerchantable paper coated with a coating mixture containing calcium carbonate, adding to the furnish a supply of phosphoric acid and thereby forming a phosphate pigment in the furnish, including in the furnish an amount of alum which together with the phosphoric acid is sufficient to produce a pH of between 6 and 4 in the furnish going to the paper machine, and forming a web of paper from said furnish, the amount of carbonate being at least sufficient to react with all of the phosphoric acid added to the furnish.

4. A process for the manufacture of printing paper of improved brightness which comprises making up a furnish from papermaking materials which include a supply of unmerchantable paper coated with a coating mixture containing calcium carbonate, adding to the furnish a supply of phosphoric acid and thereby forming a phosphate pigment in the furnish, then adding to the furnish an amount of alum which together with the phosphoric acid is sufficient to produce a pH of between 6 and 4 in the furnish going to the paper machine, and forming a web of paper from said furnish, the amount of carbonate being at least sufficient to react with all of the phosphoric acid added to the furnish.

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