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HIGH-STRENGTH PAPER AND METHOD OF MAKING

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This invention relates to an improved paper product, and to a method of manufacturing the said product. More particularly, this invention relates to the production of a high strength paper further characterized by being resistant to deterioration under the action of chemicals, oils, greases, water, and the like, and to a method of making the paper.

The primary object of this invention is to provide a paper product, and a method of making the product, in which the product is a paper sheet of greater strength than papers made in the ordinary manner.

A still further object is the provision of a paper product and a method of making it which has great strength and resistance to deterioration, but which is considerably less costly than high strength papers made according to the prior art.

A still further object is the provision of a new paper product containing latex but in which the strength of the paper is far in excess of that which can be obtained merely by the addition of the latex to the pulp from which the paper is made.

It is also an object to provide a paper product that is substantially homogeneous and in which all of the paper fibers are brought together in such a manner that the paper has exceedingly high strength characteristics.

A still further object is the provision of the method of manufacturing a high strength chemically resistant paper which can be carried out without any substantial changes in conventional apparatus merely by modifications in the arrangement of the apparatus and in the manner of treating the fibers and pulp.

In one form, the new paper making process which I have invented is characterized in three things. First, the addition of a latex emulsion or dispersion in the beater before the paper pulp is brought to the paper making machine; second, the addition of relatively long raw fibers to the paper pulp, either in the beater or refiner or at the head box of the paper making machine before the paper web is formed; and third, a final top sizing of the paper sheet with an additional latex emulsion or dispersion.

In another form, the latex is not added to the pulp or stock, but is applied to the sheet after it is formed and at least partly dried.

Any suitable latex composition, of which a number are sold commercially, is satisfactory for the purposes of this invention. Most latices in their commercial form have a rubber content

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of about thirty to forty percent, although a number of concentrated latices are manufactured and sold, and the concentration of rubber in these compositions may run as high as from sixty to seventy-five percent.

The function of the latex when incorporated in a paper sheet according to this invention is to bind the fibers of the sheet together and to effect a sealing of the sheet. By binding of the fibers together, the paper is made stronger by distributing stresses thereon over a greater number of fibers and by preventing the fibers from slipping relative to each other, as is the case when a paper is torn.

The latex also gives the paper sheet resilience so that it will resist abrasion and may be folded or bent about relatively small radii without cracking or tearing. A paper sheet containing latex is also resistant to abrasion and will not fray or crumble as an ordinary paper sheet does under these circumstances.

Due to the sealing action of the latex, moisture, oil, grease, and most chemicals cannot act on the paper, and it therefore becomes useful in many instances where ordinary paper is unsatisfactory.

In connection with the chemical resistance of the latex impregnated sheet, it will be evident that for certain purposes a natural rubber latex is satisfactory, while in other cases, it will be preferable to employ a latex of synthetic rubber. In either case, the paper is relatively free from deterioration due to the effect of heat and exposure which occurs in a paper containing the usual fillers and sizing agents employed in the manufacture of paper.

I have found that the amount of latex dispersion added to the paper pulp in the beater can vary widely and still produce a satisfactory paper sheet, the exact amount of the dispersion used depending on the particular purpose for which the paper is being made.

In practice, the latex dispersion is added to the paper pulp in the beater and is allowed to mix thoroughly therewith, and, thereafter, the beaten pulp is conveyed to the paper making machine and passes through the usual treating equipment, such as refining engines or Jordan engines, or any combination thereof desired, and then through a strainer to the wet end of a paper making machine, such as the head box of a Fourdrinier machine, or the cylinder of a cylinder type machine, or the point of formation of the paper web in whatever type of machine is being employed.

In order to give the final paper sheet consid-

erably more strength than can be had merely by the addition of the latex in the beater, I add a certain amount of untreated raw fibrous material, the fibers of the material being of considerably longer length than those in the pulp in the beater. I have found that when this long fiber content is included in the paper pulp before it is formed into the paper sheet, an exceedingly strong paper results due to the strength of the added fibers and to the binding effect thereof, whereby stresses on the paper are distributed over a wide area.

The amount of added fibers may vary greatly from a very small percentage to a large percentage of the body of the paper sheet, depending on the manner in which the paper sheet is to be employed. Similarly, the length of the fibers added will also vary considerably, depending on the character of the pulp to which they are added. When the fiber length of the pulp is very short, the added fibers will add considerable strength to the paper sheet, even though they are relatively short also, the essential thing being that their average length is substantially greater than the adjacent length of the fibers in the pulp. Thus, in some instances the added fibers may be only a fraction of an inch long, and in other instances, the added fibers may be an inch or more in length.

A number of different fibers, both natural and man-made, have been found suitable for this purpose, and among those which have been utilized are manila tow, abaca fiber, jute, sisal, raw silk, raw wool, cotton, rayon, nylon, orlon, and many other well known fibers characterized in that they can be had in relatively long lengths.

When the fibers referred to above are added in the beater they are preferably introduced therein well after the start of the beating process so that the added fibers are not substantially reduced in length and still reach the paper making machine substantially unchanged, except that they are thoroughly admixed with the other paper pulp and impregnated with the latex which has been added and with the liquid of the pulp.

I have also found that these raw fibers may be added at the wet end of the paper making machine where the pulp forms into the sheet. In a Fourdrinier type machine, the mechanism for adding the long fibers may take the form of an auxiliary head box or other distributor which supplies the fibers in the form of a pulp or wet mix to the other pulp immediately prior to the time the pulp begins to form on the wire as a paper sheet, or immediately thereafter. In any case, it is preferable for the added long fibers to be supplied to the pump prior to the pulp reaching the "shake" so that the added fibers will be thoroughly mixed with the pulp and oriented in a completely random pattern throughout the paper sheet.

The paper sheet so formed in the paper making machine is conveyed therethrough and the liquid is drained from the pulp in the usual manner so that a self-supporting web forms which can then be transferred to the usual felts and carried through a drying process.

After the paper web has been reduced to the proper degree of moisture content, it is passed through a top sizing operation in which it is treated with another latex emulsion. The paper so sized is then further dried, as, for example, by the application of pressure and heat by heated rolls, so that a smoothly finished, dense, paper results, with the surface thoroughly sealed on both sides. The final paper product, when tested, exhibits extraordinary strength and has chemical properties far beyond the range of ordinary papers.

While it will be evident that the exact percentage of latex employed and the amount of raw untreated fibers added may vary widely in accordance with the exact type of paper required, the following example will serve as an illustration of one manner in which the process of this invention can be carried out.

To unbleached kraft pulp, either lightly beaten or brushed, there was added raw manila tow fiber in the amount of fifteen parts of the tow fiber to eighty-five parts of the kraft pulp. The manila tow fiber was added in an unbeaten state when the treatment of the kraft pulp was substantially complete. The tow fiber was cut into uniform lengths of about one inch.

To the foregoing mixture there was added ten percent by weight of latex dispersion, and this formed the paper stock from which the paper sheet was formed. After the paper sheet was formed, the sheet was dried and then subjected to a top sizing operation with another latex dispersion, and then again thoroughly dried.

The resulting paper sheet, as mentioned above was characterized by extraordinary strength and chemical properties beyond the range of ordinary papers.

It will be understood, of course, that the latex may include any sort of preservative, coagulation inhibitor, or vulcanizing agent, according to well known practices in the art, and that the drying of the paper sheet, or the top sizing operation carried out thereon, or both, are accompanied by the application of heat and pressure to the paper sheet, which will result in a complete coagulation of the latex and a vulcanizing thereof, so that the fibers in the paper pulp, including the long added fibers, are firmly bound together by the binder in the pulp and by the latex. The latter assures that the paper will be entirely sealed on both surfaces and throughout, whereby penetration of the paper by oils, greases, moisture, and certain chemicals is absolutely prevented.

A paper manufactured according to this invention is highly useful due to its strength and its properties of oil, moisture, and chemical resistance. The paper may be employed for a number of different purposes, such as wrapping paper, paper bags, cartons, sealing tape, electrical insulation, and for other uses where the described qualities of the paper of this invention are of importance.

While I have disclosed the use of fibers of a length of substantially one inch, it will be understood that the fibers could be much shorter than this or much longer, depending on the exact amount of strength it is desired to build into the paper and the smoothness and finish desired on the finished product. In any case, however, the paper will exhibit the novel and valuable characteristics referred to due to the combination of latex and long fibers in addition to the regular paper stock.

Due to the nature of the service to which the paper of this invention will be put, it is ordinarily preferable that all alums, rosin sizes, and other chemicals usually added to paper stock for sizing, binding, and filling, be eliminated. In this manner, a paper that is highly chemically resistant will result.

In other cases, where the principal attribute to be desired is strength, it is not so important to eliminate these elements, because the desired

strength of the paper will come about mainly because of the long fibers and the latex dispersion added in the beater and the top sizing operation.

It will be evident that certain changes and modifications can be made in the process described above in order to accommodate my invention to varying circumstances. For example, it is conceivable that in practice it may be more practical not to add any latex in the beating or refining stage of the process, but that it will be more practical to run a waterleaf sheet on the machine and impregnate it with latex after the sheet has been formed, for example, by means of a size tub located in the drying section of the paper machine.

This could readily be accomplished by splitting the drier section of the machine and interposing a size tub or similar apparatus therein, so that the paper sheet could be dried to a predetermined moisture content in the first section of the split drier, then thoroughly impregnated with the latex emulsion, and then completely dried in the second section of the split drier. The paper sheet could thereafter pass through a light calendering treatment to the paper reel.

When the long fibers are added in the beater machine, it will be preferable to eliminate the screens between the beater and the paper machine, as in most cases it will be impossible to screen the resulting furnish.

Also, inasmuch as the long fibered stock which is introduced into the paper making furnish according to this invention is usually rather large in diameter in comparison with the ordinary fibers, it is preferable not to press the resulting paper sheet very heavily, or to attempt to carry out any conventional calendering operations thereon, because the aforementioned fibers, due to their large diameters, would tend to cut completely through the paper sheet and offset the advantage of including them in the paper stock.

As mentioned above, it may be found practical in many instances to produce the paper sheet by adding the long fibers to the paper stock before the sheet is formed, and the latex after the sheet is formed and partially dried, whereby the sheet would actually be an impregnated article, rather than a top sized paper sheet.

It will be understood that I do not wish to be limited to the exact proportions, ratios, and other factors specifically set forth in the foregoing description, but desire to comprehend such changes thereof as may be further desirable to adapt my invention to different conditions and usages.

I claim:

1. As a new article of manufacture, a paper product comprising a mixture of short wood pulp fibers and long raw manila tow fibers which are bound together by a latex binder, said short wood fibers comprising about 85% of the total fiber content and said long raw tow fibers comprising about 15% of the fibrous mass, said short fibers consisting of fibers of a substantially uniform length and on the order of a fraction of an inch and said long fibers consisting of fibers which are of a substantially uniform length and on the order of one inch in length and of a diameter greater than said short fibers, said latex bound fibrous mixture forming a paper which is characterized by extraordinary strength which is substantially beyond that of ordinary papers.

2. The method of manufacturing a high strength paper suitable for making paper bags, sealing tape and the like which comprises introducing long fibered unbeaten stock into water with lightly beaten paper stock after the beating of said furnish has been substantially completed, thoroughly mixing said long fibered stock with said furnish, the fibers of said long-fibered stock being on the order of one inch in length and larger in diameter than the fibers in said beaten stock, forming a paper sheet from the modified beater stock, partially drying the formed sheet, impregnating the partially dried sheet with a latex emulsion, and drying and lightly pressing the impregnated sheet, and carrying out the foregoing steps as a continuous cycle to produce a completed product in a single operation.

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