

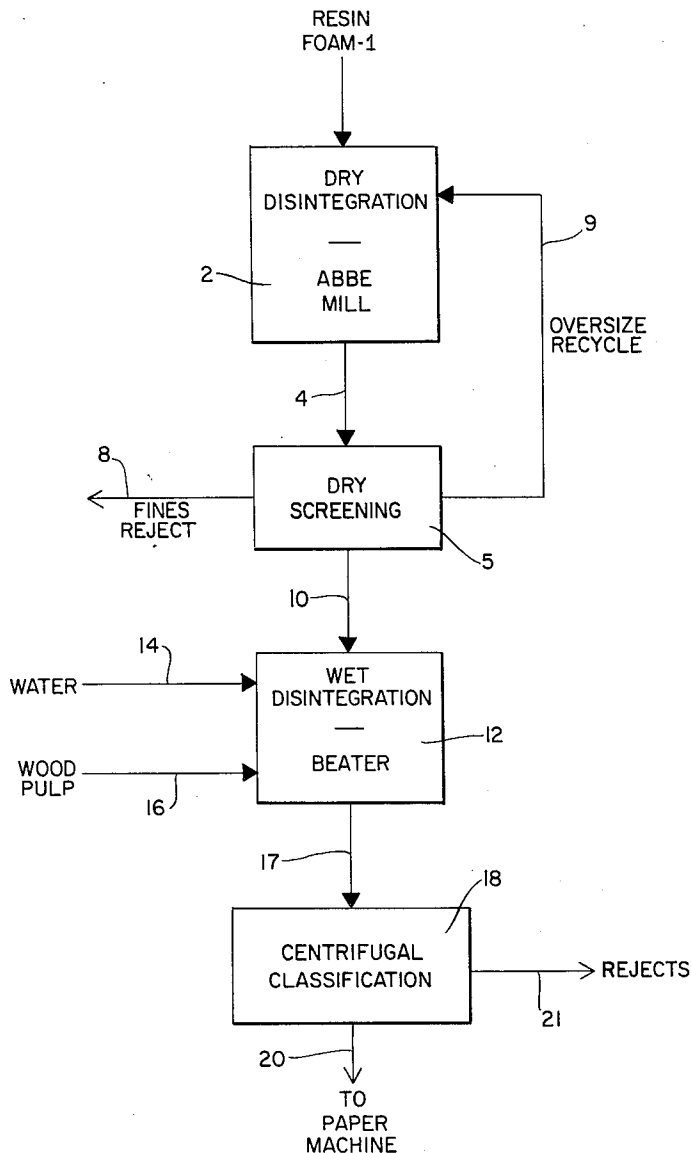
Oct. 5, 1965

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3,210,239

PROCESS OF FORMING PAPER CONTAINING FOAMED AMINOPLAST RESINS

Filed June 21, 1962



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3,210,239

PROCESS OF FORMING PAPER CONTAINING FOAMED AMINOPLAST RESINS

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Filed June 21, 1962, Ser. No. 204,118

2 Claims. (Cl. 162-166)

This application is a continuation-in-part of our application Serial No. 841,015, filed September 21, 1959.

The present invention relates to sheeted, fibrous materials containing angulate fibrous fragments of foamed aminoplast resins, and processes for the manufacture thereof. The invention particularly includes paper, paperboard and pulp stocks composed of incompletely disintegrated urea-formaldehyde resin foam in admixture with cellulosic fibrous materials of the kind normally employed in the manufacture of paper products.

Paper, as it is generally known today, is composed of matted or felted cellulosic fibers, such as those obtained from wood, cotton, bagasse and similar vegetable sources. For certain special applications, a portion of the paper-making cellulosic fibers may be replaced by mineral fibers, for example, vitreous fibers, or filaments of synthetic resins generated by a wet-spinning process, including regenerated celluloses, cellulose acetate, polyester-amides, polynitriles, acrylonitriles, polyvinyl acetate-chloride copolymers. For many purposes, fillers are also included in the paper furnishes. Among the fillers which have been so employed are asbestos, vermiculite, diatomaceous earth, clay, silica, titanium dioxide, calcium carbonate, etc. Such additives, however, frequently produce deleterious results in the ultimate papers, as for example, reduction in brightness, increase in brittleness or stiffness, loss of surface character, and of major importance to sanitary tissues, the prevention of ordinary decomposition induced by bacterial action in waste disposal units.

We have now found that a novel filler prepared by the controlled disintegration of certain foamed resins may be combined with the usual papermaking stocks in the formation of papers possessing increased bulk and opacity which papers are free of the disadvantages occasioned through the use of ordinary filling agents. Supplementing the effects of the filler increments, the physical aspects of the paper may be modified by adjustment of the density of the furnish to form a thicker sheet and, with less compression during drying, a bulkier product is enabled.

It is an object of our invention to provide a sheeted, paperlike material from a composite furnish of fibrous stock and disintegrated foamed aminoplast which enables generation of a "fulled" product possessing surface characteristics resembling those of piled fabrics with high brightness, improved printing characteristics and insulation values.

Another object of the present invention is the provision of a sheeted, paperlike material from a mixture of cellulosic fibers and partially disintegrated synthetic resin foams which product has increased softness and absorptivity.

A further object of the present invention is to provide means whereby easily fibrillated wood fibers may be combined with fragments of synthetic resin foam, and united in a strong, felted sheet possessing a high bulk and opacity.

Other objects and advantages of the present invention will be readily apparent from the following description of certain preferred embodiments thereof.

Briefly stated, the present invention contemplates the inclusion in conventional paper stocks of a disintegrated

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urea-formaldehyde resin foam whereby to alter to a substantial degree the physical characteristics of the ultimate paper products derived from such stocks.

Many resins have been used as paper additives. Some have been incorporated into the pulp in an intermediate stage of formation in order that post curing will impart wet-strength, flame proofing, grease resistance and comparable characteristics to the ultimate product. Also, some cured resins, in the form of discrete particles, have been employed as fillers. It has been discovered that certain synthetic resins can be converted into semi-rigid foams, with structures of definite geometry. A urea-formaldehyde prepolymer, for example, formed by condensing urea and formaldehyde in an approximate 1 to 2 molar ratio may be "foamed" by its addition to a cellulated mass of a surface active agent, water and an acid catalyst, such as sulfuric acid. Regulation of the density of the cellulated matrix by aeration thereof enables control of the density of the resin foam within limits of from 0.2 to 1.5 pounds per cubic foot. Additionally, it has been noted that the degree of aeration and matrix agitation affects the fineness of pore size of the ultimate foam. Upon curing and drying, some regulable collapse or reticulation of the cell structure occurs leaving a skeletal configuration composed of rod-like strands and cross-linked elements, which under agitation, may be disintegrated into fragments, segments and cell residues of various degrees of complexity. Melamine-formaldehyde resins, mixed melamine-urea-thiourea-condensation products with formaldehyde and phenol-formaldehyde resins may be similarly processed to produce lightweight foams. Other foamed resins are disclosed in U.S. patents, Nos. 2,273,367, 2,384,387 and 2,559,891 and British patents, Nos. 768,562 and 773,809.

The foamed resins, described above, are subjected to a controlled disintegration as by dry grinding, to produce angulate fibrous resin fragments compatible in size to the pulp fibers with which they are to be blended. The extent to which the dry grinding is carried on is somewhat dependent upon the grade of paper to be made from the mixture of fragmentized aminoplast resin foam and papermaking fibers. For instance, in the case of a fine texturized tissue, a more severe dry grinding is preferred than in the case of an industrial wiping paper where an intermediate degree of particle reduction is preferred. Preferred operative sizes fall within range of .05 mm. to 4.0 mm., but sizes both above and below these dimensions can be used, and are to be selected depending upon type of composite paper product desired.

Disintegration of the resin foam may also be effected in part in conventional hydropulpers, beaters, Jordans, fiberizing disc mills and the like, equipment usually employed in the preparation of wood fiber pulps. The degree of deagglomeration or foam fracture again will depend upon the nature of the apparatus utilized and the time of exposure. Manifestly, vigorous agitation under increasing increments of pressure will result in more disintegration than would be possible when operating at low pressures for short periods of time. It is, of course, possible to effect the requisite amount of resin foam deagglomeration with the beating of the wood pulp and the blending of the cellulosic and resin fibers preliminary to the sheet formation.

The type as well as the amount of uni-axial fibers with which the disintegrated resin foam is combined may be varied within wide limits as desired and will, of course, also have a bearing upon the nature of the ultimate paper which is formed. Cellulosic fibers from soft and hard woods, bagasse, bamboo, cotton are suitable source materials and the treatment thereof may include sulfite, sulfite, semi-chemical as well as chemi-mechanical pulping.

Where a wood base is employed, groundwood pulps are quite appropriate. Although mineral fibers can replace a portion of the cellulosic fibers in the base pulp, it is preferred that these be in the minority in order to obviate the need of special bonding additives in the final sheet formation. Similarly, the presence of a small percentage of uni-axial filaments of a spun synthetic resin is also contemplated. It is preferred, however, that uni-axial cellulosic fibers constitute the major portion of the paper stock, although as much as 50% by weight of such stock may be composed of the disintegrated resin foam.

Although the fragmentized aminoplast resin foam may be combined with the papermaking fiber after the major part of the beating or refining of the paper furnish essential to the mechanical or physical strength characteristics desired in the final paper has been completed, we have found it desirable in the preferred embodiment of this invention to add the aminoplast resin foam component to the pulp and to subject the composite mixture to further beating, jordaning, disc refining, etc., to insure complete homogeneity.

Furthermore, we have found that in the preliminary deagglomeration of the foamed resin there normally exists a distribution of fragment sizes from small through intermediate to relatively large. Complete resin foam disintegration is possible only upon prolonged grinding with the result that there usually persists in the composite furnish of wood pulp and foamed aminoplast, larger fragments which remain intact or are retained as agglomerates even after the subsequent wet refining of the blend.

The preferred embodiment of this invention, therefore, encompasses the removal of these larger aggregates via the process of centrifugal wet cleaning or classification of the blend of wood pulp and foamed aminoplast, and this additional refining of the mixed resin foam-pulp fiber furnish permits the formation of fine papers of particularly uniform physical characteristics.

To those skilled in the art, it is well known that cured and dried aminoplast resin foams assume or acquire a crust or skin at the interface of the mold and also at the foam-air interface. In the preferred embodiment of this invention, it is desirable to remove that crust or skin from the foam block prior to grinding. However, if desired, the whole of the foam may be processed in the dry grinding equipment prior to blending with the papermaking fibers. In such case, it is usually necessary to subject the resin foam to more severe grinding conditions in order that the harder and denser crust or skin is also reduced to particle sizes compatible with those of the papermaking fibers with which it is to be blended. Furthermore, in such cases, the hydraulic pulp refining, as well as centrifugal screening or cleaning operation, prior to sheet formation, are essential to remove any coarse fragments or agglomerates that have resisted the disintegration stages of the stock preparation.

It will be apparent to those skilled in the art of papermaking, that in general the greatest effects in improving the bulk of paper will be observed where the residual fragment sizes of the disintegrated foam are large and the very low density of the foam is transferred in part to the paper. However, the limitations here are that the sizes should be of the same order of magnitude as those of the papermaking fibers in order that a homogeneous blend may result, otherwise coarseness and grittiness of the surface prevails.

A simplified flow diagram illustrative of our improved process of manufacturing a composite foam-pulp fiber paper furnish is shown in the accompanying drawing. As can be seen in the drawing, a cured resin foam 1, which may be partially crushed or shredded, if desired, to facilitate its subsequent processing is subjected to an initial, dry fragmentization in a mill 2 of the hammer or ball type, the well-known Abbe mill for example, and the reduced product is discharged through a conduit 4 into a

screen 5 wherein fines are removed through a reject conduit 8 and oversize fragments are recycled to the mill 2 through conduit 9 for further reduction. Foam fragments of an acceptable size pass through conduit 10 to a beater 12, supplied with water through line 14 and a slurry of wood pulp or other cellulosic fibrous material through a line 16. The composition of the ultimate paper furnish is adjusted at this time by control of the quantity and type of fibrous material which is combined with the foam fragments. After beating for a time sufficient to effect fibrillation of the cellulosic pulp, homogenization of the pulp and foam fragments accompanied by some further size reduction of such fragments, the mixture of pulp and foam passes through conduit 17 into a classifier 18 wherein the furnish is fractionated and an acceptable mix exhibiting special uniformity of fiber length and foam fragment dimension is discharged through conduit 20 to the paper machine. Unacceptable fractions are removed from the classifier 18 through line 21.

The invention will be more particularly described with reference to the following examples which are intended for purposes of illustration only.

Example I

A urea-formaldehyde foam (0.8 lb./cubic foot, 150 micron cell diameter), commercially available as Colfoam Insulation Shred from the Colton Chemical Company, was pulverized in an Abbe mill with a $\frac{1}{16}$ inch screen plate. Blends of the reduced material with bleached sulfite pulp from western hemlock were formed by agitation in water at 0.2% consistency in a British Standard Disintegrator, and charged through a 3 inch Bauer centricleaner employing a $\frac{1}{8}$ inch reject tip at 45 lbs./square inch pressure. The accepted pulp was taken for Tappi handsheets.

The resulting paper had improved bulk when compared with paper made from wood pulp alone.

Paper composition:	Bulk cc./gm.
100% wood pulp	1.31
90% wood pulp, 10% resin	2.35
80% wood pulp, 20% resin	2.90
70% wood pulp, 30% resin	3.10

Accepts 2.11
Rejects 3.52

Example II

Bleached sulfite pulp from western hemlock was beaten to 400 Canadian Standard freeness in a Valley beater. A quantity of Abbe mill pulverized Colfoam Insulation Shred reduced in an Abbe mill to an average overall particle size 200 micron equivalent to 20% by weight of the wood pulp was added to the beater and slushed, with the bed plate lowered from the beating roll, for a period of 5 minutes. Following classification as in Example I, Tappi handsheets were prepared from the acceptable pulp. The paper had an improved bulk, improved surface smoothness and brightness when compared with paper made from the wood pulp alone.

Paper composition	Bulk, cc./gm.	G.E. brightness
100% wood pulp	1.25	82.5
80% wood pulp, 20% resin	2.75	84.9

Accepts 1.75. Rejects 3.40.

Example III

A blend of 20% by weight of ground Colfoam Insulation Shred (average overall particle size 100 microns) and 80% by weight of bleached sulfite pulp, prepared in a manner similar to that described in Example II, was thickened to 7% consistency and refined in a Bauer single disc mill. Following classification, Tappi handsheets were made from this blend. The resulting paper had an im-

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proved softness when compared with paper where only wood pulp was used.

Paper composition:	Bulk cc./gm.
100% wood pulp -----	1.25
80% wood pulp, 20% resin -----	2.50

Example IV

Bleached sulfite pulp from western hemlock was slushed in the Valley beater for 5 minutes and then beaten for 5 minutes, according to Tappi standard method 200m-45, to a Canadian Standard freeness of 722.

Colfoam Insulation Masterblock, obtained from Colton Chemical Company, in the form of 20½" x 10½" x 2" blocks with a density of 0.8 pound/cubic foot and an average cell size of 150 microns, was broken into pieces approximately 1 cubic inch in size and fed to an Abbe mill, equipped with a ½ inch wire mesh screen, for dry grinding.

The fragmented resin foam was blended with sulfate wood pulp at 0.2% consistency for 5 minutes in the British Standard Disintegrator and subjected to centrifugal classification. Tappi handsheets were prepared from the composite and their properties measured:

Paper composition:	Bulk cc./gm.
100% wood pulp -----	1.84
90% wood pulp, 10% resin foam -----	2.90
80% wood pulp, 20% resin foam -----	4.01

Example V

Fragmentized Colfoam as prepared in Example IV, was added to bleached sulfite pulp, previously beaten to a Canadian Standard freeness of 700, in a ratio of 1 part of foam residue to 9 part sof pulp and slushed for 5 minutes in the Valley beater with the bed plated lowered.

The blend was diluted to 0.15% consistency and fed to a type 600-3 Bauer centricleaner with a ½ inch reject tip, operating with a primary accepts to rejects ratio of 6 to 1. The accepted stock was collected and Tappi handsheets made.

The paper produced exhibited both improved opacity and improved bulk when compared with paper prepared from wood pulp alone.

Paper composition:	Bulk cc./gm.
100% wood pulp -----	1.77
90% wood pulp, 10% resin -----	2.80

Accepts 2.34
Rejects 3.83

Example VI

Colfoam Insulation Shred, dry ground in an Abbe mill equipped with a screening plate having ¼ inch holes on ½ inch centers, to an average overall particle size of 150 microns was transferred to a ball mill and further ground to a particle size of 100 microns. The resulting material was washed from the ball mill, collected, thickened and air dried.

The reduced resin foam was then blended with bleached sulfite pulp of a freeness of 722 in the British Standard Disintegrator in various ratios of resin to pulp. Tappi handsheets were prepared following classification of the mixtures as in Example V, and again found to possess improved softness as well as improved bulk.

Percent by weight of resin in paper	G.E. brightness	Bulk, cc./gm.
0	82.6	1.92
10	83.0	2.27
20	83.2	2.61
30	84.2	2.92

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Furthermore, these papers have a fine surface texture and improved opacity.

Example VII

Colfoam Insulation Shred, processed as in Example VI, was blended with a semi-bleached sulfate pulp from Douglas fir of 734 Canadian Standard freeness by co-dispersion in the British Standard Disintegrator and was thereafter subjected to classification. Tappi handsheets exhibited the following bulk measurements:

Paper composition:	Paper bulk cc./gm.
100% wood pulp -----	1.91
90% wood pulp, 10% resin -----	2.59
80% wood pulp, 20% resin -----	3.10
70% wood pulp, 30% resin -----	3.42

Example VIII

To the composite pulp-resin foam blend of Example VII was added 1% by weight of a cationic urea-formaldehyde wet strength resin produced according to the teachings of U.S. application, Serial No. 722,642, filed March 20, 1958. Tappi handsheets were prepared and after curing the paper exhibited the following properties:

Paper composition	Percent wet strength resin	Paper bulk, cc./gm.
100% wood pulp -----	0	1.92
	1	1.92
90% wood pulp -----	0	2.57
10% resin foam -----	1	2.55
80% wood pulp -----	0	3.07
20% resin foam -----	1	3.01
70% wood pulp -----	0	3.52
30% resin foam -----	1	3.50

Example IX

Colfoam Insulation Shred, as produced in Example VI, was added to a furnish consisting of 70% bleached sulfite pulp from western hemlock and 30% bleached sulfate pulp from southern oaks and gums of a Canadian Standard freeness of 660. The composite of reduced resin foam and wood pulp was co-dispersed in the British Standard Disintegrator, and Tappi handsheets prepared with the following properties:

Paper composition	G.E. brightness	Bulk, cc./gm.
100% wood pulp -----	81.3	1.87
80% wood pulp, 20% resin -----	83.0	2.71
70% wood pulp, 30% resin -----	84.5	3.09

Example X

Colfoam Insulation Shred of the type employed in Example V was blended with a bleached Mitscherlich sulfite pulp from Michigan poplar, which had been beaten to a freeness of 475. The Tappi handsheets had the following properties:

Paper composition:	Opacity, percent
100% wood pulp -----	92.6
90% wood pulp, 10% resin -----	94.7
80% wood pulp, 20% resin -----	94.2
70% wood pulp, 30% resin -----	94.4

Example XI

Urea-formaldehyde foams obtained from the Plaskon Laboratories, Barrett Division, Allied Chemical and Dye, were ground dry and blended according to the techniques

set out in Example I with unrefined bleached sulfite pulp. Tappi handsheets had the following properties:

Percent wood pulp	Percent resin foam	Foam density, lb./cu. ft.	Bulk, cc./gm.
100	0	-----	1.89
80	20	0.3	2.79
80	20	0.4	3.07
80	20	0.6	3.23

Example XII

Colfoam Insulation Masterblock, having an apparent density of 0.5 lb./cubic foot and an average 100 microns cell diameter, was combined with unrefined bleached sulfite pulp from western hemlock according to the procedures described in Example I. Tappi handsheets were prepared. These papers had an exceptional softness, a very attractive surface appearance and hand feel. The brightness, opacity and bulk of the papers were improved. The sheets also had improved absorption and writing characteristics.

The following data was obtained:

Percent wood pulp	Percent resin foam	G. E. brightness	Bulk cc./gm.
100	0	82.5	1.94
90	10	83.1	2.14
80	20	84.7	2.46
70	30	84.7	2.80

Example XIII

A weight of 324 grams of commercial formalin solution (37% formaldehyde) was treated with 20 grams of pyridine in a 1-liter, 3-necked flask equipped with mechanical stirrer and condenser adjusted to permit distillation. One hundred fourteen grams of urea and 7.6 grams of thiourea were added. The solution was heated to boiling and distilled at atmospheric pressure, with removal of 165 ml. of distillate over a period of about two hours. The residual solution, when cooled to room temperature, was of medium viscosity and had a cloudy appearance.

This resin solution was foamed as follows:

Three ml. of Neomerpin-N (an alkylated naphthalene sulfonic acid surface active agent) were dissolved in 50 ml. of water. A volume of 1.5 ml. of 85% phosphoric acid was added and the solution whipped into a foam at room temperature, to which 50 grams of the above aqueous resin solution were added slowly, the whipping being continued until the foam set.

The foam was transferred to an aluminum foil-lined pan and permitted to stand at room temperature for about 2 hours. It was then dried in a forced-draft oven at 60° C. for 5 hours. The dried foam was white and had a soft and resilient texture. The density of the foam was 0.8 lb./cubic foot.

This urea-formaldehyde structure was first dry ground by hand with a mortar and pestle. The reduced material was co-blended with unrefined bleached sulfite pulp as in Example I, and Tappi handsheets prepared.

These papers had a very smooth and velvet hand feel and had improved softness. The following data was obtained:

Percent wood pulp	Percent resin	G.E. brightness	Bulk, cc./gm.
100	0	82.7	1.92
90	10	83.7	2.35
80	20	84.6	2.74
70	30	84.7	3.18

Example XIV

A cationic urea-formaldehyde porous structure was prepared by dissolving:

Two ml. of Du Pont Alkanol 189.5 (an aliphatic hydrocarbon sulfonate surfactant) and 4 ml. of 85% phosphoric acid in 350 ml. of water converted into a froth by vigorous whipping. A solution of 6 grams of urea in 50 ml. of water was added to the froth together with 100 grams of cationic urea-formaldehyde pre-resin solution containing 31.1% solids, prepared according to the teachings of U.S. application, Serial No. 722,642, filed March 28, 1958. The whipping continued until a stable foam resulted. This was then transferred to a pan and finally cured and dried as in Example XIII. The final dried product was a soft and resilient porous structure having a density of 0.46 lb./cubic foot.

The material was dry ground via a mortar and pestle, and blended with unrefined, bleached sulfite pulp from western hemlock as in preceding examples. Tappi handsheets prepared from the composite furnish had the following properties:

Percent wood pulp	Percent resin	Bulk, cc./gm.
100	0	2.00
90	10	2.30
80	20	2.82
70	30	3.14

Example XV

A urea-formaldehyde porous structure was prepared from an alkaline polymerized urea-formaldehyde pre-resin as follows:

A weight of 324 grams of 37% formaldehyde solution (4 mols) was treated with 10 grams of sodium bicarbonate. The mixture was stirred for about 10 minutes and then filtered into a 1-liter, 3-neck flask equipped with a mechanical stirrer, a thermometer and a condenser turned down for distillation. Additions of 114 grams of urea (1.9 mols) and 7.6 grams of thiourea (0.1 mol) were made to the clear formaldehyde solution, which was then heated to boiling, and distillation carried out at atmospheric pressure for a period of about 2½ hours to effect removal of 180 ml. of distillate. During the distillation at which a maximum temperature of 108° C. was attained the pH of the solution was measured at between 8 and 9. The residual solution, when cooled to room temperature, was a cloudy, syrupy liquid of medium viscosity. It was diluted with 25 ml. of water to give a solution containing 73.6% solids.

A mixture of 3 ml. of DuPont Neomerpin-N (alkylated naphthalene sulfonic acid surface active agent) and 1.5 ml. of 85% phosphoric acid catalyst in 50 ml. of water was whipped into a uniform foam with the aid of the injection of compressed air at the start, and 50 grams of the alkaline polymerized urea-formaldehyde pre-resin solution were then added slowly with simultaneous whipping. This whipping was continued until the foam showed signs of setting, as indicated by an increase in the viscosity of the foam and its water insolubility. The foam was transferred to a pan lined with aluminum foil, allowed to stand at 25° C. for 1 hour and then cured and dried in an oven at 60° C. for a period of 18 hours. The resultant product was a fine textured porous structure having a density of 0.76 lb./cubic foot. This material was dry ground via a mortar and pestle and blended with unrefined bleached sulfite pulp from western hemlock, as in

the previous examples. The Tappi handsheets had the following properties:

Percent wood pulp	Percent resin	Bulk, cc./gm.
100	0	1.95
90	10	2.41
80	20	2.84
70	30	3.35

Example XVI

A foamed resin was produced in accordance with the disclosures of British patents, Nos. 768,562 and 773,809. The density of the resultant foam was 0.56 lb./cubic foot, although its texture and physical appearance were in other respects substantially identical to that of the foam of Example I.

This material was dry ground in an Abbe mill with the screen plate removed. The product was fragmentized and shredded by the milling but not completely disintegrated. This was blended with unrefined bleached sulfite pulp in the British Standard Disintegrator classified and Tappi handsheets prepared from the acceptable furnish had the following properties:

Percent wood pulp	Percent pulverized material	Bulk, cc./gm.
100	0	1.92
90	10	2.24
80	20	2.50
70	30	2.65

From the foregoing, it is quite clear that the resin inclusions in the various paper furnishes improve the bulk of the sheeted paper, increases sheet opacity in direct proportion to resin content and at the same time contribute to improvement of other properties which are of particular value to such products. Immeasurable physical properties, ascertainable only upon inspection, of the papers of our invention are increased softness, enhanced surface attractiveness and feel.

It has also been ascertained that the inclusion of angular fragments of foamed aminoplast resins in paper stocks will improve the absorbencies of ultimate paper products, and, moreover, the rate at which these absorbencies deteriorate with aging is greatly reduced. These resin inclusions also result in increased air entrapment within the sheeted paper, thus leading to products containing excellent thermal barriers. The insulating quality of the modified sheeting will be dependent to a large extent upon the degree of disintegration of the foamed resin employed therein. Where necessary, or desirable, the high bulk, insulating and/or absorptive paper of our invention may be laminated to thermoplastic film material in order that there will be established an impervious skin or layer upon the composite sheeting and its utility as an insulating medium will be increased.

The high bulk papers of our invention are acceptable substitutes for the conventional papers of modern commerce and the development of a novel source of paper-making fibers, that is, disintegrated foams and more especially disintegrated aminoplast resin foams enables the generation within the ultimate paper products of properties which impart to such products considerable commercial potential.

It is realized that in all practical grinding operations, involving the foamed resins to which our invention pertains, a distribution of particle sizes of varying shapes and contours inevitably results. In the making of a foamed resin product, the froth matrix consists of many

small bubbles which upon expansion are converted from spheres to contiguous dodecahedrons constituting cells having, ideally, twelve pentagonal membranous faces. During resin condensation and post-cure, a majority of these faces are removed, the substance thereof moving into the marginal strands, resulting in reticulation of the cellular structure and formation of a skeletal configuration consisting of these marginal strands, the residues of intersecting cell faces, joined anisotropically at spaced nexus.

Upon disintegration, both in the initial dry grinding and the subsequent beating in aqueous suspension, these reticulated three dimensional strands are broken irregularly to create various spacial geometric forms, a majority of which may be considered as substantially angular fibrous fragments of the original mass. It is preferred that the disintegration be so regulated or limited that the average overall dimension of the foam fragments be from 0.5 to 1.5 times that of the average length of the papermaking fiber with which they are to be blended.

In the case of conifers such as pine, spruce and hemlock, the fiber length may be as high as 4 mm., while in the case of hardwoods such as gum, oak and poplar, the fiber length may be as low as 1 mm. It resolves, therefore, in the preferred embodiment of this invention that the average overall dimensions of the particles of the pulverized foamed resin should lie in the approximate range of from 0.5 to 6 mm.

Since the foam disintegration will produce some particles or granules of resin as well as some oversize fragments, classification or screening may be needed for separation of the reduced foam into different grades or sizes as desired to supply varying degrees of "bulking factor" to paper products in which they are embodied. Additionally, a final classification of the slurry of mixed pulp fibers and reduced foam fragments will establish the ultimate in dimensional uniformity of the solids content thereof and insure maximum compatibility during utilization in the papermaking processes.

It will be understood that the paper products of the present invention may be modified by the inclusion therein of other paper-forming fibrous materials, sizes, impregnating agents, coating materials, fillers, wet strength resins commonly encountered in paper manufacture. Additionally, manifold variations in compositions and procedural details of their formation are possible without departing from the spirit of the invention or the scope of the appended claims.

What we claim is:

1. A process of making a paper of high bulk which comprises partially disintegrating a dry, cured, urea-formaldehyde resin foam, combining said partially disintegrated foam with an aqueous slurry of uniaxial fibrous material, beating said combination to effect a further disintegration of said foam, and fibrillation of the fibrous material and a blending of said foam and uniaxial material, classifying the mixture to produce a fraction of acceptable dimensional uniformity, and thereafter sheeting said fraction.

2. A process as defined in claim 1 in which the urea-formaldehyde resin foam constitutes from about 1% to about 30% of the weight of the sheeted paper.

References Cited by the Examiner

UNITED STATES PATENTS

3,004,884	10/61	Eberl et al.	162—101
3,006,561	10/61	Eberl et al.	162—101
3,037,903	6/62	Baumann et al.	162—101
3,038,867	6/62	Czepiel	162—166
3,047,538	7/62	Steinman	

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