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MANUFACTURE OF FELTED-FIBER REINFORCED ABRASIVE PRODUCTS

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This invention relates to the manufacture of abrasive products such as abrasive wheels, disks, etc., and more particularly to such abrasive products which are reinforced by felted cellulosic or other fibres for obtaining maximum tensile and transverse strengths.

The prime object of this invention is to produce abrasive or grinding wheels of a felted fibre structure at a cost comparable to grinding wheels of non-fibrous nature well known in the art.

Grinding wheels of laminated fibres or laminated cloth reinforcement are known. However, their great disadvantage lies in the uneconomical process required to produce them. As an example of the prior art in this field is the laminated fibre wheel constructed by first making a sheet on a Fourdrinier machine from beaten wood pulp or rag stock, which sheet in the form of paper is then coated with a binder followed by a superficial application of abrasive grain; circular disks of the diameter required are then stamped from these sheets, and a plurality of these disks are superimposed on each other and compressed in an hydraulic press with or without heat at tremendous pressure to form a single laminated unit. The objection to this method is the high cost of providing machinery to accomplish the purpose, the waste involved in rejecting portions of unused sheet after stamping and the high labor costs involved in laminating such a multiple of sheets to arrive at the desired thickness of the finished product.

Another method for producing a fibre-reinforced abrasive wheel is one wherein medium weight cotton duck or other woven fabric is run through a conventional spreading machine where a thin layer of a pasty composition consisting of abrasive grains and a binder is spread over one surface or one side of the woven fabric, this being followed by drying the resulting product by passing the same through heated chambers after which these operations are repeated to coat the other surface or side of the woven fabric. Disks are then stamped out from this abrasive coated fabric, and these disks are laminated under heat and pressure to form the desired grinding wheel. To make a typical cut-off grinding wheel by this method requires five plies or laminations of the coated fabric; and it is obvious that the cost of equipment, waste of fabric after stamping out the disks, etc., involves a process and the making of a product which is beyond reasonable cost.

In order to dispense with the laminations, and with the thought of homogeneously distributing a felted fibre throughout an abrasive body, it has been attempted to make a mixture or a pulpy mass of fibre, binder and abrasive and cast the

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mass into the shape of the desired abrasive product. The employment of such technique would permit the making of abrasive wheels of any reasonable diameter and thickness by casting the same in one piece, and such technique would reduce manufacturing costs and also utilize inexpensive equipment. This method, however, is impractical because in order to properly wet and distribute the fibres for maximum felting requires water to the extent of one part fibre to 100 parts of water, and requires long agitation of this mixture to put the fibres in proper condition for felting; and this results in a slurry of such viscosity that the addition of abrasive grains thereto is impractical for the reason that the abrasive grains immediately settle out due to the difference in gravity and the lack of viscosity of the slurry. In order to remedy this difficulty, an attempt has been made to complete the fibrous water slurry and abrasive in a violent agitator, while adding a binder such as rubber or synthetic rubber latex and coagulate said binder on the fibres and abrasive while in motion, with a consequent separation of fibre-abrasive-bond phase and a water phase, after which the occluded water could be pressed out and the resulting mass dried and vulcanized. This method has been found unsatisfactory since the coagulation of the binder on the fibre and abrasive produced a mass of pellets which when compressed lost practically all semblance of the fibrous felting necessary for maximum strength.

We have found that the involved problems of producing a felted-fibre reinforced abrasive product in which the felted fibrous structure is homogeneously distributed throughout the body of the abrasive product are solved by employing a colloidal clay such as bentonite in the system, and more particularly, by first mixing the fibre flock with a water dispersion of such colloidal clay, thereby producing a base of a felt-forming viscous and thixotropic mass. The employment in the process of such a colloidal clay as explained hereinafter has been found to provide the solution to the problem and the following advantages thereof:

1. The introduction of bentonite clay, which need only be about 6% of the total water used, provides viscosity to the point of the mass being gelatinous. This viscosity alone solves the problem of securing proper suspension of the abrasive.

2. The introduction of the fibre flock to the clay-water gelatinous mass and mixing the same results in complete dispersion of the fibres to the extent that, upon subsequent expelling or removal of water, a perfect felting of the fibres is

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achieved, providing maximum fibre reinforcement.

3. The proportion of water in the system is decreased to the extent, that a 6% concentration, or more, of fibre can be introduced to the aqueous system, with consequent perfect felting, as against a maximum of 1% and a normal of ½% of fibre to water ratio which would normally be possible for obtaining the same degree of fibre dispersion.

4. The introduction of the bentonite provides an abrasive mix with properties that make the mass very easily pourable and spreadable because of the thixotropic character of the mass and further provides for stabilization of the mix against any tendency for coagulation of the binder during mixing of the mass and forming to product shape.

5. The introduction of a colloiddally dispersed binder, such as a rubber latex or a synthetic rubber latex, employed here by preference because of its smaller particle size, provides a clay-rubber final mix of extreme strength and adhesiveness, as it is well known, particularly in the rubber art, that colloiddally dispersed fillers provide the maximum reinforcing property for rubber; and, further, this colloiddal clay-rubber binder bonds the individual fibre particles which are also perfectly dispersed for maximum felting into a homogeneous mass supporting the distributed abrasive granules into a grinding wheel unit which can be characterized as practically unbreakable.

On the matter of dispersion of the fibres, it may be pointed out that the gelatinous nature of the water-clay mix provides sufficient friction during mixing with the fibre to separate the fibres from their original bundles into individual units, whereas to accomplish the same degree of dispersion would normally require 10 to 20 times more water. Also, the thixotropic nature of bentonite clay is such that while in motion in the mixer, it provides the necessary friction and fluidity not only to perfectly disperse the fibre but to distribute the abrasive granules, and also the colloiddal binder. On removal of motion and followed by casting into proper sized receptacles, the phenomenon of thixotropy asserts itself by an immediate gelatinization of the mass which permanently suspends fibre, abrasive, etc., into proper position for conclusion of the process.

The following are typical examples of practicing the method of the present invention for obtaining the mixes or masses ready for the casting or molding operation.

Example I

	Pounds
Bentonite clay	6
Water	60
Cotton flock	6

The clay is dispersed in the water and permitted to swell for several hours to maximum viscosity. The cotton flock is then added to the water dispersion with thorough mixing.

While the above is being stirred, the following ingredients are added in rotation or sequence:

Butadiene - acrylonitrile latex, 40% solids	22½ lbs.
Dispersed sulphur, 75% solids	1 lb. 6 oz.
Dispersed zinc oxide, 50% solids	8 oz.
Water	42 lbs.
Phenolic resin, powdered or dispersed	2 lbs.
Aluminum oxide abrasive	43 lbs.

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While this example is a typical one used, it may be varied over a fairly wide range of proportions in order to provide wheels of different physical characteristics, such as wheels of a soft rubbery nature, or wheels of a hard and stiff character as well as intermediate variations of these characteristics.

Example II

A typical example of a felted-fibre wheel having more resilient properties is that obtainable with the following formulation:

	Pounds
Bentonite clay	5
Water	50
Alpha flock	5

Bentonite clay and water are first mixed to form the dispersion of the clay and the alpha flock is subsequently added. To this dispersed fibre is added in rotation:

Butadiene-styrene latex, 40% solids	lbs. 24
Dispersed sulphur, 75% solids	oz. 8
Dispersed zinc oxide, 50% solids	oz. 4
Water	lbs. 30
Aluminum oxide abrasive	lbs. 50

This mix provides a flexible wheel in which the disclosed binder cures to what is normally known as a soft rubber cure.

Example III

An example for an extremely rigid and slower cutting wheel is as follows, said example being generic:

	Pounds
Bentonite clay	6
Water	40
Cotton flock	3
Nylon flock	3

Bentonite clay and water are first mixed to form a dispersion of the clay with subsequent addition of cotton and nylon flock. To this dispersed fibre is added:

	Pounds
Butadiene-acrylonitrile, 40% solids	10
Pulverized phenolic resin	6
Dispersed sulphur, 75% solids	1
Dispersed zinc oxide, 50% solids	¼
Water	45
Aluminum oxide abrasive #24	55

The binder in this example consists of a copolymer of phenolic resin and butadiene-acrylonitrile rubber in about equal proportions, which provides a binder of utmost rigidity both hot and at room temperature, and contributes to a wheel with slower cutting but long-lasting properties.

The entire mixing cycle with the exception of the preliminary time allowed for the swelling of the bentonite clay in water is of the order of 10 to 15 minutes. This is extremely fast mixing for the disclosed concentration of fibre and abrasive grains when compared to the fibre water slurry used in the making of paper.

We have found that the most suitable binders to be used in the process are the class of colloiddally dispersed rubbers such as natural rubber latex, butadiene-styrene latex, butadiene-acrylonitrile latex, and chloroprene latices. For the fibre we may use any of a variety of fibre flock, such as linen flock, nylon flock, rayon flock, alpha flock and cotton flock. The abrasive grain employed may be of any desired mesh, as from #24 to #80 mesh.

The viscous and thixotropic abrasive mix ob-

tained by any of the above examples is then cast into molds or pans of a specified diameter for further processing which consists in effecting coagulation of the mass and in subsequently curing or vulcanizing the same to produce the ultimate abrasive product.

We have found that after the mix or mass is cast or poured into a mold to diameter product size and shape, the coagulation of the latex binder, to achieve the most efficient results, should be effected in such a way as to preserve the felted structure of the fibres and the relation thereto of the other components of the mix. In the coagulation step, the water in the system has to be eliminated or expelled and we have found that coagulation must be accomplished in such a way that any disturbance of the structure in the form of even slight bleeding or expelling of the components of the mix in the operation of removing or expelling water has to be guarded against.

To accomplish these ends, we discovered that the most appropriate method consistent with producing enhanced properties of the finished product, involved the freezing of the cast mass at temperatures below 32° F. with subsequent thawing. The latex binder is thus coagulated into a two phase system, namely, a continuous rubber-fibre-abrasive phase and a discontinuous water phase. By this step of the method the cast product is frozen in exactly the same position as it is cast, and in subsequent thawing, the ice crystals separate into individual water globules which may now be expelled from the now spongy mass by squeezing or pressing the mass even with moderate pressure.

The pressing of the thawed mass in the mold is preferably done with hydraulic pressure applied in the order of 500 p. s. i. of wheel; and at this pressure, more than 90% of the water is expelled, the abrasive product at the same time assuming its final product form. In so doing, the abrasive product decreases in thickness to approximately one-third of its cast thickness. The balance of the occluded water is then removed at low temperature drying at 100° F. to 150° F. for eight to twelve hours.

After these steps of coagulation and water expulsion, the product is then cured or vulcanized to its final condition. Curing or vulcanizing may be performed in any of several ways, and the preferred method for so-called grinding wheels with a recessed center is one wherein the coagulated pre-dried blank is cured directly in a mold of the proper dimensions under heat and pressure in an hydraulic ram press for one to one and a half hours at 330° F. Flat wheels or disks where it is unnecessary to change the contour of any portion of said disk, are usually cured or vulcanized between plates, with light clamping pressure to hold the plates parallel, in gas heated or electric heated ovens for 12 to 18 hours at 320° F.

The finished abrasive products obtained in the practice of this method, in the form of a grinding wheel or disk, is strong to the point of being unbreakable due to centrifugal force at operating speeds on the usual high speed grinders known in the art. The obtained products are exceptionally efficient in their grinding and polishing ability and they provide finishes more in the order of so-called "set-up" wheels because of their inherent quality of absorbing shock.

These wheels or disks can be made in various degrees of stiffness by altering either the sulphur

content up or down, the phenolic resin content up or down, and their cutting ability can be varied by either raising or lowering the abrasive content.

The thin disks used for so-called disk grinding can be made flexible enough to mount on equipment which now carries the so-called coated disks which are extremely flexible. They can also be made practically rigid where such is the requirement. The rigid type is more adaptable to cutting-off operations where greater rigidity is required for making straight cuts. It is interesting to note that with this maximum rigidity, these cutting-off disks or wheels are tough enough to withstand a twisting of the piece being cut to the extent that a wedge-shaped groove can be cut in the object with a consequent flexing of the cutting wheel to the same extent without breakage.

We claim:

1. The method of making a felted-fibre reinforced abrasive product which consists in mixing a water dispersion of a colloidal clay with a fibre flock and producing a felt forming mass in which the fibres are dispersed in the mass, the concentration of fibre in the water being of the order of 6% to 15% and the weight content of the fibres in the mass being of the same order of magnitude as the weight content of the colloidal clay in the mass, mixing the said mass with abrasive grains and a binder, including a colloidal dispersed rubber binder, thereby producing a felted-fibre reinforced abrasive-binder mass, shaping said abrasive mass to abrasive product form, expelling the water therefrom and then curing the same.

2. The method of making a felted-fibre reinforced abrasive product which consists in mixing a water dispersion of a colloidal clay with a cellulosic fibre flock and producing a felt forming viscous and thixotropic mass in which the fibres are dispersed in the mass, the concentration of fibre in the water being of the order of 6% to 15% and the weight content of the fibres in the mass being of the same order of magnitude as the weight content of the colloidal clay in the mass, mixing the said mass with abrasive grains and a binder including a colloidal dispersed rubber binder, thereby producing a felted-fibre reinforced abrasive-binder mass, shaping said abrasive mass to abrasive product form, expelling the water therefrom and then curing the same.

3. The method of making a felted-fibre reinforced abrasive product which consists in mixing a water dispersion of a colloidal clay with a fibre flock and producing a felt forming mass in which the fibres are dispersed in the mass, the concentration of fibre in the water being of the order of 6% to 15% and the weight content of the fibres in the mass being of the same order of magnitude as the weight content of the colloidal clay in the mass, mixing the said mass with abrasive grains and a binder including a colloidal dispersed rubber binder, thereby producing a felted-fibre reinforced abrasive-binder mass, pouring said abrasive mass in a mold, coagulating the mass and expelling the water therefrom and then curing the same.

4. The method of making a felted-fibre reinforced abrasive product which consists in mixing a water dispersion of a colloidal clay with a fibre flock and producing a felt forming mass in which the fibres are dispersed in the mass, the concentration of fibre in the water being of the order of 6% to 15% and the weight content of the

fibres in the mass being of the same order of magnitude as the weight content of the colloidal clay in the mass, mixing the said mass with abrasive grains and a binder including a colloiddally dispersed rubber binder, thereby producing a felted-fibre reinforced abrasive-binder mass, freezing and thawing said abrasive mass to produce a continuous bonded phase and a discontinuous water phase, shaping said abrasive mass to abrasive product form, expelling the water and then curing the resulting product.

5. The method of making a felted-fibre reinforced abrasive product which consists in mixing a water dispersion of a colloidal clay with a fibre flock and producing a felt forming mass in which the fibres are dispersed in the mass, the concentration of fibre in the water being of the order of 6% to 15% and the weight content of the fibres in the mass being of the same order of magnitude as the weight content of the colloidal clay in the mass, mixing the said mass with abrasive grains, a binder including a colloiddally dispersed rubber binder, and a vulcanizing agent, thereby producing a felted-fibre reinforced abrasive-binder mass, shaping said abrasive mass to abrasive product form, freezing and thawing said abrasive mass to produce a continuous

bonded phase and a discontinuous water phase, compressing the mass to final product form and expelling the water therefrom and then vulcanizing the resulting product.

6. The felted-fibre reinforced abrasive product obtained by the method of claim 1.

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References Cited in the file of this patent

UNITED STATES PATENTS

	Number	Name	Date
	1,668,475	Wescott	May 1, 1928
	1,931,428	Boudy	Oct. 17, 1933
15	1,953,983	Benner	Apr. 10, 1934
	2,301,998	Bernstein et al.	Nov. 17, 1942
	2,396,907	Volk et al.	Mar. 19, 1946
	2,418,282	Williamson	Apr. 1, 1947
	2,460,367	Sharpe	Feb. 1, 1949
20	2,580,076	Deane	Dec. 25, 1951

FOREIGN PATENTS

	Number	Country	Date
	360,482	Great Britain	Nov. 9, 1931
25	117,723	Australia	Nov. 18, 1943