March 19, 1974 K. M. ENLOE ET AL 3,798,120

# DISPOSABLE TISSUE WITH CONTROLLED WET BREAK-UP

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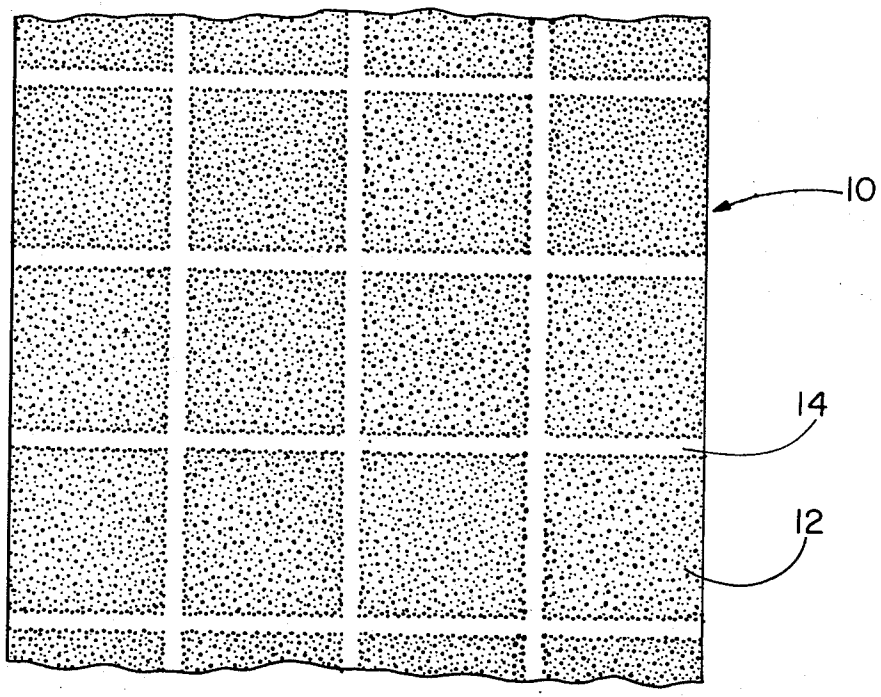


FIG. 1

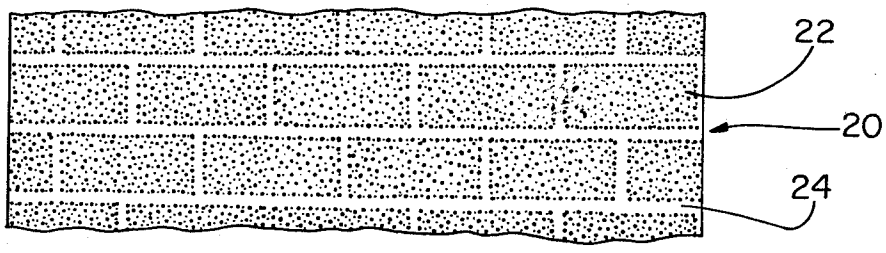


FIG. 2

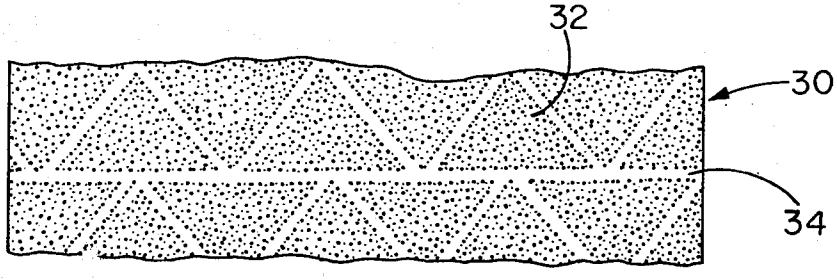


FIG. 3

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3,798,120

# DISPOSABLE TISSUE WITH CONTROLLED WET BREAK-UP

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## ABSTRACT OF THE DISCLOSURE

Absorbent tissue webs structured to control wet break-up and designed especially for disposal in recirculating toilets. Selectively spaced areas of the tissue are treated with a wet strength chemical which strongly binds the fibers to each other in the selected areas to prevent wet disintegration of these areas. The wet strengthened areas comprise a multiplicity of closely spaced patches of predetermined size arranged to cover the major portion of the total web area. These patches are separated by narrow web portions substantially free of binder. When sheets of the thus treated tissue web are deposited in the aqueous system of a recirculating toilet and subjected to circulatory action of the aqueous fluid therein, the narrow web portions quickly weaken and rupture. The major areas of the sheets represented by the wet-strengthened patches are dispersed in the water as small individual patches which retain their integrity and approximate size. The narrow unbonded web portions break up into individual component fibers but these fibers represent only a minimal part of the total fibers in the web.

## BACKGROUND OF THE INVENTION

Recirculating toilets are universally used in large commercial and private aircraft as well as in cross-country buses, land and water recreational vehicles, vacation homes, temporary restroom facilities for large crowd gatherings, and the like. These toilets normally use filtration units for separating out solid wastes so that relatively solids-free water is available for recirculation to transport and process additional waste materials as they are deposited in the toilet. In theory, the filtration units are supposed to separate out the solids and keep the toilet in useful operation until solids capacity of the filtration unit is reached, at which time servicing is necessary.

However, it has been found that in actual use this ideal condition is seldom achieved. In most cases. the filter media becomes fouled prematurely by having deposited on its working parts excessive quantities of the individual cellulose fibers which result primarily from the disintegration of the sheets of conventional bathroom tissue which users dispose of in the toilet. When this happens, passage of the circulating fluid through the filtration unit is impeded and the filtering function fails whereby the toilet not longer is usable. At this stage, the filter unit must be cleaned or replaced to unplug the toilet, in order that it can be returned to service.

The present invention provides a disposable tissue having a web structure which insures control of the wet break-up of the tissue so that only a minimal amount of individual fibers which make up the total web structure are freed by the action of the aqueous medium during the recirculation process. The remainder of the tissue is broken up into pieces of predetermined size which pieces retain their integrity during recirculation. Because of this the dispersed tissue is capable of being handled by the unit as efficiently as other solid wastes, and is therefore substantially non-clogging. The favorable result which derives from using the tissues of this invention is to considerably extend the time period during which the toilet can be operated satisfactorily without requiring service.



## SUMMARY OF THE INVENTION

The tissue of this invention comprises a coherent self-sustaining web made from conventional absorbent fibers of papermaking length, but which have selected areas of the web additionally bonded by a wet strength binder. The areas treated by the wet strength binder encompass a major percentage of the total web area and are preferably in the form of multiple patches arranged in a closely spaced patchwork pattern in which the patches are isolated from each other by narrow, binder-free web portions. These narrow intervening binder-free portions are of a minimal width. In the fiber-aligned or machine direction of the web these binder-free portions are preferably only slightly wider than the average fiber lengths. In the transverse direction the binder-free portions may be even narrower, again because of normal fiber alignment. However, in modern papermaking equipment, fiber alignment can be varied to increase cross direction strength. In such event, the transverse direction spaces may be slighty wider than fiber length too.

When tissue sheets of this nature are deposited in flowing or circulating water, as in flushing the toilet, the action of the water will quickly weaken the narrow unbonded portions, causing the sheet to break up into individual patches of a size corresponding to the size of the original wet-strengthened areas. When such tissue is used with a recirculating toilet, the released patches do not clog the filter media or its operating parts, as a large mass of individual fibers will do, since the patches have sufficient body to be moved around by the recirculating aqueous medium along with the rest of the solid wastes. The toilet may thus remain in serviceable condition for a longer time period than when ordinary easily disintegratable tissue, or overall wet-strengthened tissue is used. The latter type tissues also hamper toilet operation because they retain their entire sheet structure and tend to hang-up between the exterior surface of the filter assembly and reservoir wall, or tend to plug the drain. The tissue web fabricated as indicated above may be provided in roll form divided into the usual sheets by spaced transverse perforations, or may be in the form of a pack of interfolded or otherwise folded sheets. In addition, the tissue as assembled for use may comprise single or multiple plies.

The following description of preferred embodiments along with the accompanying drawings will make apparent additional features and advantages of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a plan view of a portion of one embodiment of a tissue web in accordance with this invention showing a typical pattern for the wet-strength chemical.

FIGS. 2 and 3 illustrate other suitable patterns.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the embodiments illustrated by the drawings, FIG. 1 shows a fragmentary plan view of a tissue web **10** comprised of absorbent wood pulp fibers and bonded by a wet strength binder in the shaded patchwork areas **12**. It will be noted that the shaded areas cover the major portion of the total web area. Unshaded narrow portions **14** separate patchwork areas **12** from each other and are untreated with a binder. The fibers in these untreated narrow portions **14** of the web **10** are held together only by the usual hydrogen bonds inherent in conventional tissue and paper webs. As shown in FIG. 1, wet-

strengthened patchwork areas **12** are in the form of large, spaced squares which comprise the major percentage of the total web area and are isolated from each other by narrow spaces **14** in which the fibers are substantially free of binder.

In web **20** of FIG. 2 the wet-strengthened areas **22** are in the form of a brick-like pattern isolated from each other by untreated portions **24**.

In web **30** of FIG. 3 the bonded wet-strengthened areas **32** are in the form of triangles isolated from each other by untreated portions **34**.

The fibers used in the web may comprise any suitable absorbent fibers of papermaking length. Preferably these fibers are mixtures of bleached hardwood and softwood pulp fibers which are of the type most commonly used for bathroom or facial tissue as well as for paper towels. While it is also preferred that the tissue be of the well accepted soft facial tissue grade, this is not essential to the invention, and any absorbent tissue may be used.

The wet strength binder may be selected from among the many binders normally used to provide various degrees of wet strength for paper webs. Among these are urea formaldehyde, melamine formaldehyde, polyamide-epichlorohydrins, vinylamide polymers, polyethylene imines, and other similar wet strength materials. In the prior art, such resins are commonly used to provide overall wet strength in absorbent tissue and other paper webs. Such webs maintain their integrity in water even when submerged therein for a long period of time. However, the webs do eventually disintegrate since most of these resins are either biodegradable or are slowly hydrolyzable. In selecting the resin binder, it should also be kept in mind that the resin used should not detract materially from the absorbent properties of the tissue.

In this invention, it is desired that the resin be applied in an amount sufficient to prevent the treated areas of the web from disintegrating into component fibers for at least 24 hours and preferably for a period of several days. Accordingly the amount applied is generally within the ranges commonly used for the various types of wet strength tissues now on the market. Such resins are usually applied in an amount of between about 0.2% and 0.8% solids on a fiber weight basis.

The wet strength binder may be applied in the form of a clear solution, or it may contain selected dyes, pigments, or other colorations to suit various needs, or for aesthetic reasons.

The overall size of each of the wet strengthened areas has been found to be most satisfactory when the area of each patch is in the neighborhood of about 900 square millimeters, with the binder free spaces between wet-strengthened portions having a width of about 3 millimeters in longer fibered webs, and being of lesser width in shorter fibered webs. However, the treated tissues will still minimize clogging of the filters, if the size of the individual wet strengthened areas is as large as about 10,000 mm.$^2$ or as small as about 25 mm.$^2$. As this size is reduced, the percentage of free fibers per unit area increases, accordingly the smaller sizes are not as desirable as the larger sizes. It is most important that the size of the wet strengthened areas be sufficiently large so as not to cause clogging of the filter media, or result in entanglement of the pieces around the working parts of the filtration unit with resultant mechanical fouling. It is equally important that the freed patches not be so large as to plug the drain.

It is also important that the binder free portions be as small as possible so as not to produce an excessive amount of free individualized fibers in the circulating aqueous fluid. Since in the manufacture of webs the fibers are usually aligned in the machine direction the width of the binder free portion measured in the machine direction should be slightly larger than the average length of fibers present. Softwood fibers average about 3 mm. in length and hardwoods are much less. Accordingly, the preferred minimum width of the binder-free areas is about 3 mm. for a product containing softwood fibers.

In the preferred embodiment the wet-strengthened areas comprise from about 75% to about 95% of the total web area with the higher percentages being preferred. Bonded areas as small as 50% of the total area have been found to be effective in reducing filter plugging, but again, the higher percentage ranges for total wet-strengthened areas are preferred for reasons discussed above.

The methods used for applying the binder to the web may be chosen from a number of known techniques. For example, the binder may be printed on the web in the form of a wet strength resin-containing solution, using a cameo or intaglio printing roll with the desired pattern. Presses now used for printing tissue webs may be readily adapted for this purpose. Flexographic printing and wet strength inks may also be used. In another method of application, the binder may be sprayed on the web through a patterned template or stencil. Silk screen techniques are another possibility. In any event, the non wet-strengthened spaces between the pattern areas should be minimized, and these spaces should be of a width which permits rapid weakening and rupture of the web in those portions when agitated in aqueous media.

It will be seen that the general style of the pattern used in applying the wet strength binder to the web may be of an almost infinite variety. For example, it may assume the form of repeated geometric patterns including polygons such as triangles, rectangles, hexagons, octagons and the like, or it may be in the form of various regular or irregular ornamental designs such as trademarks, service marks, or other distinctive insignia as may be elected. A wide selection of colors may also be used. However, when highly aesthetic or curved line patterns or other irregular patterns are used, it should be remembered that the binder free spaces between the wet-strengthened areas of the pattern should be minimized so that upon disintegration of the web by the aqueous media only a minimum amount of individual fibers are released.

In a specific example of this invention, a creped tissue web of absorbent facial grade stock having an uncreped basis weight of about 7.6 pounds per 2880 sq. ft. was printed on a flexographic press with an 8% aqueous solution of a wet strength resin, then dried and cured. The fibers used were about 80% softwood and 20% hardwood. The resin used was a polyamide-epichlorohydrin. The pattern used was similar to that shown in FIG. 1 except that the spaces between printed areas were staggered rather than aligned. The sides of the squares **12** in this instance were about 25 mm. long. The resin-free portions **14** were about 3 mm. wide. The amount of resin solids pickup in the treated tissue was about 0.5% by weight.

About 560 4" x 4" sheets of the dried and cured web were deposited in the aqueous medium of a recirculating toilet, which contained approximately 8 gallons of fluid. Upon agitation during the recirculating process, the sheets rapidly broke up into squares of approximately the same size as the printed pattern. Very few individualized fibers were noted. No excessive hangup of fibers or web pieces were found in the filtration system, even after extended operation.

Other sheets were dropped into a beaker of water and agitated to simulate the action of a recirculating toilet for a period of about one minute and then allowed to stand. These sheets were broken up into small squares by the agitation and these squares retained their integrity after agitation. The broken up material was left in the beaker, agitated and checked again at 12 hours, at 24 hours, and then after several days. In each instance, the integrity of the pieces was substantially maintained.

In another example, two plies of the same sheets as in the first example were assembled in perforated roll form. Similar tests were run on these sheets with substantially the same results.

What is claimed is:

1. An absorbent tissue with controlled wet break-up characteristics, said tissue comprising a web of absorbent fibers of papermaking length in which all the fibers in selected portions of said web are bonded to each other by a wet strength binder, said portions comprising a multiplicity of patches of predetermined size arranged in a closely spaced pattern, said pattern covering the major area of said web, and the patches in said pattern being isolated from each other by narrow spaces which comprise binder-free web areas which rupture easily when wetted, said patches being wet-strengthened sufficiently to retain their integrity when agitated in water, wherein the majority of said fibers are aligned in the machine-direction of the web and the width of said binder-free areas measured longitudinally of the web is slightly greater than the average length of the longest fibers in said web, and wherein said selected portions comprise at least 50% of the total area of said web.

2. The tissue of claim 1 wherein the width of said binder-free areas measured transversely of the web are less than the average length of said longest fibers.

3. The tissue of claim 1 wherein the average width of said binder-free areas is about 3 mm.

4. The tissue of claim 1 wherein said selected portions comprise between about 75% and 95% of the total area of said web.

5. The tissue of claim 1 wherein said binder is selected from the group consisting of urea formaldehyde, melamine formaldehyde, polyamide-epichlorohydrins, vinylamide polymers and polyethylene imines.

6. The tissue of claim 1 wherein the average area of each of the selected portions is in the range of about 25 mm.$^2$ to about 10,000 mm.$^2$.



7. The tissue of claim 1 wherein the average area of each of the selected portions is about 900 mm.$^2$.

8. The tissued of claim 1 wherein the selected portions have a color distinct from the color of the narrow binder free areas.

9. The tissue of claim 1 in which said tissue is in the form of a roll divided into perforated segments.

10. The tissue of claim 1 in which said tissue comprises folded sheets.

11. The tissue of claim 1 in which said tissue comprises interfolded sheets.

12. The tissue of claim 1 wherein said tissue comprises multiple plies of said web.

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