U. S. DEPARTMENT OF COMMERCE
DANIEL C. ROPER, Secretary
NATIONAL BUREAU OF STANDARDS
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CIRCULAR OF THE NATIONAL BUREAU OF STANDARDS C407
[Supersedes Circular C294]

STANDARDS FOR PAPER TOWELS

By

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[Issued March 21, 1935]

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1935

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

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ABSTRACT

Further study relative to Federal specifications for purchase of paper towels revealed that the rate at which they absorb water may decrease greatly in 6 months. As the decrease was approximated sufficiently well for purchase purposes, by heating the towels at 100° C for 1 hour, a test of their absorptiveness after such treatment is desirable. No constant relation between the initial properties of the towels and their absorptiveness after 6 months' storage was found. The tensile and bursting strengths did not decrease during this period of storage. Tests of water absorptiveness after heat treatment and of tensile strength, together with inspection for cleanliness and other visible properties, are recommended for the evaluation of towels. A discussion of the properties of towels relative to their serviceability is included.

CONTENTS

I. INTRODUCTION

In 1924, at the request of the chairman of the paper technical committee of the Federal Specifications Board, the National Bureau of Standards made a study of the properties and the testing of paper towels for the purpose of developing a specification to be used for their purchase by the Government Departments. A report of the results of this investigation was published in 1925 as Bureau of Standards Circular C294. This revised edition of that circular reports the results of a further investigation, which was prompted by the discovery that the absorptiveness of some towels decreased so much during a few months' storage as to render them unserviceable. This additional study, like the previous one, was made with the cooperation of paper towel manufacturers.

II. PROPERTIES

Paper towels are composed of wood fibers produced by the acid-sulphite or the alkaline-sulphate pulping process, by grinding the wood, or by repulping waste paper. Both bleached and unbleached sulphite and sulphate fibers are used. The unbleached sulphate fibers are commonly termed kraft fibers. The fiber components given in table 2 are quite representative. The best grades of towels are made

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wholly or largely of virgin wood fibers produced by the chemical pulping processes. The rate of absorption of water by towels is dependent primarily on the absorptiveness of the fibers and the amount of pore space in the paper, therefore rapid absorption is obtained by special treatment of the fibers to make them as absorptive as possible, by the use of bulky and long fibers to obtain high porosity, and by minimizing pressure on the paper to conserve its porosity. Rosin sizing, in small amount, is used in some towels to retard the absorption of water somewhat and thus prevent excessive localized wetting and consequent breaking.

Paper towels come under the classification of bibulous papers, which are characterized by absorptiveness, loose formation, and softness. Blotting paper is a well-known example of a paper in this group. Towel and blotting papers are similar in their absorptive requirements, but the former must possess much greater strength than blotting papers. Unlike the latter, they must be comparatively thin to have the required flexibility, and yet must possess much greater strength than blotting paper so that they will not break under the severe conditions of usage. A good grade of paper toweling has two or three times the strength of blotting paper of the same fiber composition. In evaluating paper towels, therefore, the main consideration, in addition to absorptiveness and softness, is the strength. It is difficult to secure such a combination of desirable properties in the same sheet of paper.

The natural softness and absorptiveness of wood fiber are considerably lessened by the usual treatment given to develop its maximum strength for paper making. Generally, at one extreme, are associated in paper towels rapid absorption, softness, and weakness, and at the other extreme, slow absorption, hardness, and high strength. Those of the first class must be used as a blotter, or they may tear, while those of the second class require considerable rubbing to complete the drying operation. Either extreme is undesirable, as time is an important factor in the use of towels, and the care taken to avoid breaking the very absorbent towels or the prolonged rubbing required by the less absorbent but stronger towels may consume more time than is desirable. It is true that some towels have the two desirable properties of high absorptiveness and strength combined, but they are usually relatively high priced.

Cleanliness, of course, is necessary. The use of repulped paper stock is somewhat objectionable from sanitary considerations, and while it would seem that the use of miscellaneous waste papers from unknown sources is undesirable there can be no valid objection to the use of clean waste papers, such as overruns of newspapers secured directly from the publishers. Although a high white color is generally associated with purity, from a practical standpoint it is of little importance, and any natural fiber color should be acceptable. Towels are generally creped, and this is desirable because it lends much additional resistance to the strains incident to use, and increases the bulk.

The towels are made in a variety of sizes but mainly about 11 inches in width. Folded towels are commonly 13 inches and roll towels 15 inches in length. No valid reason for this difference in size is known.

III. TESTING

All known domestic manufacturers of towels were invited to submit samples representative of their usual products for experimental testing. From the samples received, 13 were selected as being thoroughly representative of the various commercial products.

The samples were tested for fiber components, weight, bursting strength, tensile breaking strength, resin, acidity, and rate of absorption of water, by the standard methods of the Technical Association of the Pulp and Paper Industry.[1] Because of the importance of the absorption test, some representative data are given in table 1, which show its reproducibility. It will be noted that the differences between the average test values for 10 specimens is usually within 5 percent.

TABLE 1.—*Maximum deviation of averages of absorptiveness tests made by 2 observers*

Sample	24A		24B		41A		41B		43A		43B		71A		71B	
Observer	C	W	C	W	C	W	C	W	C	W	C	W	C	W	C	W
Time (in seconds) of absorption of 0.1 ml of water	125	120	120	113	150	144	149	142	200	216	185	207	21	20	25	24
	126	128	120	133	127	155	134	155	182	170	140	165	23	24	25	25
	111	125	136	117	141	144	124	151	185	210	217	226	21	25	22	26
	140	139	127	131	147	139	128	150	175	188	174	171	25	27	25	20
	137	136	134	127	161	166	140	126	205	205	209	190	20	21	20	21
Average	127.8	129.6	127.4	124.2	145.2	149.6	135.0	144.8	189.4	197.8	185.0	191.8	22.0	23.4	23.4	23.2
Deviation (%) of averages, 5 samples	1.41		2.58		3.03		7.26		4.44		3.68		6.36		0.86	
Grand average	C 127.6 W 126.9				C 140.1 W 147.2				C 187.2 W 194.8				C 22.7 W 23.3			
Deviation (%) of averages, 10 samples	0.55				5.07				4.06				2.64			

Since decrease in rate of absorption of water during storage is a very serious problem, a convenient and reliable method of predicting such deterioration was needed. A study was made of heating the samples in air at a temperature of 100° C (±1°) to find if this would serve as an accelerated aging test with respect to loss of absorptiveness. Extensive studies made at the Bureau of the aging qualities of record papers have indicated that this test is a valuable means of measuring the stability of papers.[2] [3] [4] Absorption tests were made after heating for ½ 1, 2, and 3 hours, and after storage for 1, 2, 4, and 6 months from date of manufacture. No tests for loss of strength on aging were made, as preliminary testing had shown that little loss of strength occurred during a normal storage period. The towels for testing the effect of normal aging on their absorptiveness were packed in cardboard cartons and stored in steel lockers under normal atmospheric conditions.

[1] Copies can be secured from the association at 122 East 42nd Street, New York, N. Y.
[2] BS J.Research **7**, 466 (1931) RP352.
[3] BS J.Research **11**, 727 (1933) RP620.
[4] Paper Trade J. **95**, 28 (July 28, 1932).

Other tests mentioned by manufacturers as being used variously by them are wet tensile breaking strength, softness as indicated by flexibility, pressure absorptiveness by pressing the specimen against a wet screen, stretch, tear, number of dirt particles, lateral absorption by a strip of the paper, and use of 1.0 ml of water instead of 0.1 ml, the amount specified in the standard method. Considerable effort was made to develop a suitable procedure for measuring the wet tensile strength because it is obviously more closely related to the use requirements than testing the paper dry, but the data secured were too erratic to serve for relative grading of the different types of towels. The use of 0.1 ml of water appears to be a satisfactory test for absorptiveness. This is more in accordance with service conditions than a larger amount because only a little water comes in contact with any small area of a towel.[5] The other tests mentioned would seem to needlessly complicate the evaluation of towels for purchase, although they may be desirable for research and manufacturing control.

IV. DISCUSSION OF TEST DATA

Test data for the towels as received and for their absorptiveness after 6 months of normal aging are given in table 2. These reveal a wide range of values in all of the properties and no constant relation between any of the properties and the absorptiveness of the towels after normal aging. With respect to the fibers, however, clean, long fibers were associated with good quality. The resin contents of the towels are not an indication that rosin sizing was used, as the resin may have been derived entirely from the natural resinous matter which is normally a component of wood fibers. In figures 1 and 2, the change in rate of absorption of water during natural aging is compared with the change under the heat test, for each sample. The identification numbers of the towels appear at the bottom of each graph. In both cases the change in the absorptiveness of most of the towels is considerable. Because of the extremely variable nature of towel tissue and the wide differences in the fiber components of the different samples, a regular relation between the change in absorptiveness caused by heating and that which naturally occurred during storage could hardly be expected. In most cases, however, the agreement is good and possibly would have been better had the tests been continued over longer periods of time. As a practical matter, the results show that the heat test will foretell whether a towel is likely to lose much of its absorptiveness during storage, and therefore this test is considered suitable for inclusion in purchase specifications. A heating period of 1 hour, at a temperature of 100° C, appears to be sufficient.

[5] For some tissue products having a slow rate of absorption, the use of as little as 0.01 ml of water has been found desirable. Carson and Worthington have described a special pipette device for accurate delivery of a very small amount of water in making absorption tests. See Paper Trade J. **95**, 59 (Oct. 20, 1932).

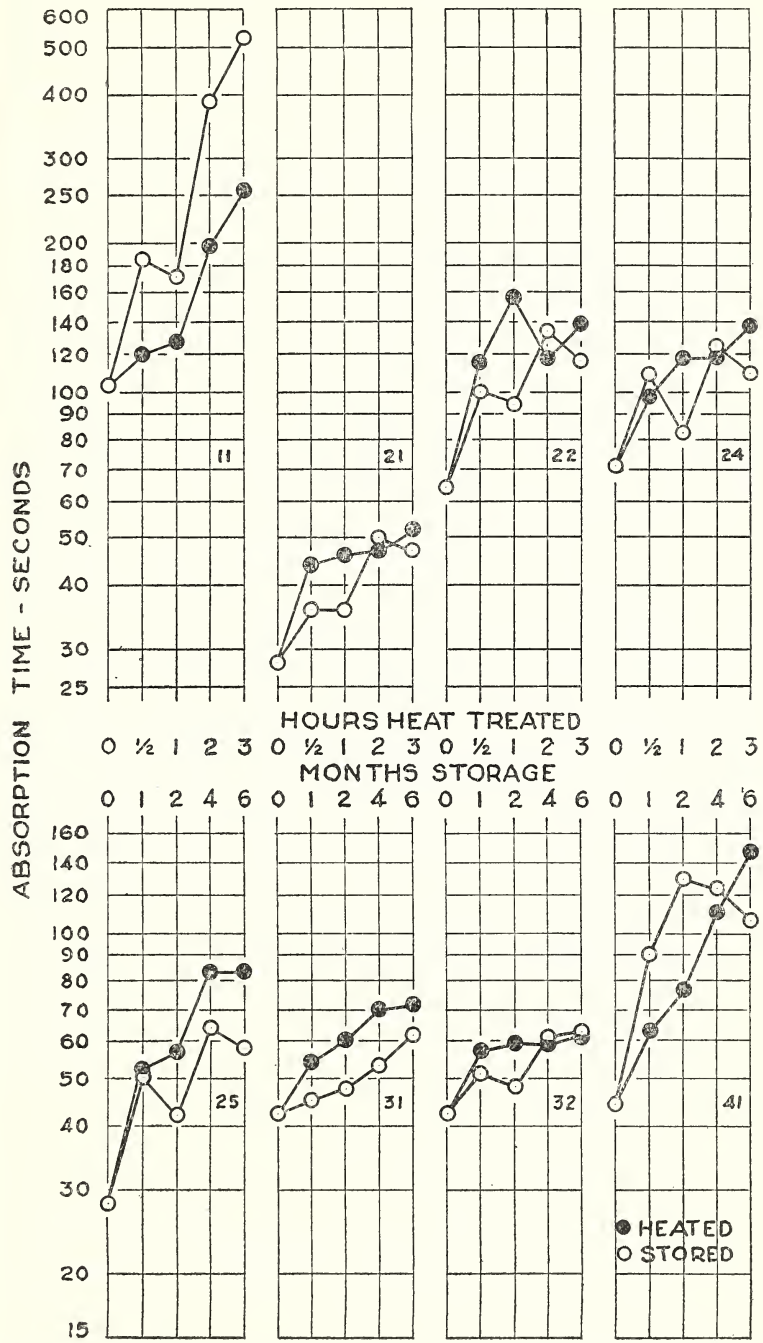

FIGURE 1.—*Change in absorptiveness of paper towels on heating and on normal aging.*

Samples 11, 21, 22, 24, 25, 31, 32, and 41.

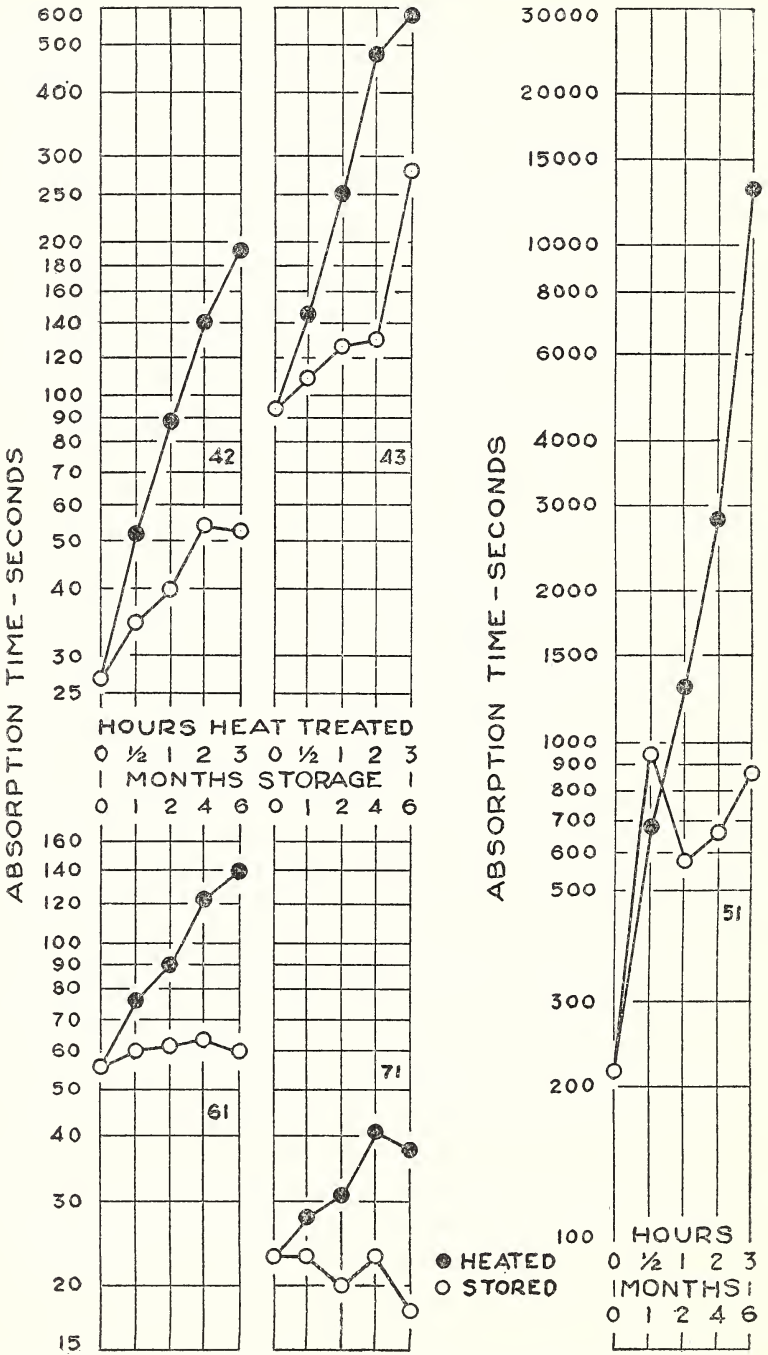

FIGURE 2.—*Change in absorptiveness of paper towels on heating and on normal aging.*

Samples 42, 43, 51, 61, and 71.

TABLE 2.—*Test data for paper towels*

NBS sample number	Weight 25 x 40, inches 500 sheets	Bursting strength (1)	Tensile breaking strength [2]		Resin	Acidity as SO_3	Fibers				Time of absorption of 0.1 ml of water [3]
			Machine direction	Cross direction			Ground wood	Sulphite		Sulphate	
								Unbleached	Bleached	Unbleached	
	Pounds	*Points*	kg	kg	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Seconds*
11	43.5	8.3	1.6	1.1	0.49	0.021	50	50			513
21	48.0	8.4	1.6	1.3	.62	.020		100			47
22	44.4	8.1	1.8	1.5	.81	.027	30	70			117
24	44.0	7.8	1.6	1.4	.69	.031	30	70			108
25	46.0	9.1	1.6	1.3	.66	.029	20	80			59
31	43.1	6.5	1.4	.8	.73	.006		50	50		62
32	49.4	6.8	1.5	.9	.79	.011	25	75			62
41	38.5	8.2	1.8	1.0	.67	.043	50	40	10		106
42	48.4	9.1	1.8	1.2	.42	.054	30	20	50		53
43	46.9	7.5	1.4	1.0	.67	.024			100		276
51	42.5	7.4	1.3	1.0	1.05	.072	35	40	25		856
61	45.8	6.4	1.5	1.4	1.18	.054	35	60	5		60
71	45.9	34.2	5.0	2.0	.33	.006				100	18

[1] Bursting pressure in lb/in.[2] through a circular orifice 1.2 in. in diameter.
[2] For test specimen 15 mm wide and 100 mm between jaws.
[3] After 6 months' storage.

While there was no constant relation between the initial absorptiveness and the decrease in absorptiveness during normal storage, the greatest decrease was found in the three samples which were initially the least absorbent. It may be well to mention here that the chemical changes in paper which cause its deterioration are generally accelerated by excessive heat and dampness, and by light; therefore stored towels should be protected against such influences.

The tensile breaking strength test of towels is a better criterion than the bursting strength test as the latter gives erratic results with this type of paper and is subject to more variables in general.

The Federal specification for paper towels (UU–T–591) [6] was formulated by the paper technical committee of the Federal Specifications Board, with consideration of the information developed in this study and of the suggestions of manufacturers and consumers.

WASHINGTON, November 27, 1934.

[6] Complete copies can be obtained from the Superintendent of Documents, Washington, D. C., for 5 cents.

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