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Title: " A New and Novel Test Method for the Measurement of Absorbency of Paper Towels and Nonwoven Wipes"

[Format: Introduction, Objectives, Methods, Results, Discussion, Conclusions]

Introduction:

Test methods used for the evaluation of the liquid load and wicking rate of solid substrates such as paper hand towels and nonwoven fabric wipes are mainly empirical. Typically the weighed substrate is dipped into a liquid for a specified time and then removed from the liquid and allowed to hang vertically in a controlled humidity atmosphere while draining by the action of gravity. The wet substrate together with its retained liquid is then reweighed after a specified time, and the net retained liquid mass is divided by the original dry mass of the specimen. For a paper towel an average result of greater than 3g/g toweling is considered acceptable.

As a measure of the wicking rate of a paper tissue, a specimen of the tissue is spread flat over the mouth of a glass beaker and a specified small volume of liquid is placed on the tissue in the central part. A stopwatch is started and the time for the specular reflection of the liquid to disappear due to absorption into the sheet is measured. A value of less than 10 seconds is generally considered to be satisfactory for hygienic paper tissue products.

Attempts at network modeling of a porous structure based on a series of cells and channels for which separate mass and momentum equations are solved has not been successful. The basis of this theoretical approach is an oversimplification that a porous media can be considered as a series of cylindrical channels connected to spherical reservoirs.

A revised practical test where the measurements are made on a substrate in a steady dynamic equilibrium state is described. The new test method allows a direct measurement of wicking rate and absorption capacity for bibulous substrates in sheet form and with any fluid of interest.

Objectives:

The objectives of this paper are to propose a new test method for the measurement of the absorption of water and other liquids by paper towels and nonwoven fabric wipes. It may be used to evaluate the quality (defined here as *fitness for use*) of 1-ply and 2-ply tissue paper towels and nonwoven wipes as well as bibulous core papers required for decorative laminates.

Methods:

The new test method employs a descending chromatography tank which is saturated with the vapour of the liquid being employed for the absorptive capacity and wicking rate measurements.

Specimens of the sheeted substrate of interest are cut to strips measuring 50 mm wide by approximately 300 mm long. At one end of the test strip a 45 degree angular cut is made to facilitate drainage. A 10ml glass measuring cylinder fitted with a small glass funnel to

direct the flow from the test specimen to the measuring cylinder is placed on the base of the tank immediately below the test strip. The test strip is placed in the upper liquid reservoir and weighted with a glass retainer. Several strips may be accommodated in the apparatus at the same time. The liquid being tested is placed in the base of the tank and after sealing the tank with a glass cover, the strips are allowed to equilibriate for a period of at least 4 hours before commencing the test. The test is started by adding the liquid to the upper reservoir making sure that the tails of the substrate are hanging in the glass funnels. Then the lid of the tank is replaced, a stop clock is started and the progress of the wicking is observed.

When the measuring cylinders have received at least 5 to 8 mls of liquid the test is stopped and the elapsed time noted. The test is stopped by the following procedure:

The tail of the strip is gripped with rubber-tipped tweezers and the entire tail that has been hanging down passed the antisiphon glass suspension rod is cut off with sharp scissors and weighed on a 3 d.p. top loading balance situated conveniently close to the tank. The tail portion is then allowed to dry in a circulated air oven to constant weight.

The volume of liquid that has accumulated in the measuring cylinder is noted. The wicking rate may be reported as: "*mls liquid per gramme test substrate per hour"* The absorptive capacity may be reported as: "*grammes of liquid per gramme of test substrate"*.

Results:

TABLE 1

Test Substrate	Wicking Rate	Absorptive Capacity
Apertured blue rayon nonwoven wipe sample No.	mls/hr Water	G Water/g substrate
1	15.72	5.30
2	14.90	4.99
3	13.08	5.22
4	13.08	5.69
5	12.96	5.26
6	16.32	6.34
7	14.74	5.36
8	13.71	4.83
9	11.31	5.01
10	14.74	5.30
Average:	14.06	5.33
Std. Dev.	1.50	0.43
Coeff. Variation:%	10.67	8.07

TABLE 2

Test Substrate	Wicking Rate	Absorptive Capacity
47 gsm 1-Ply tissue paper toweling- recycled fibres Sample No.	Secs/10microlitre Water	G Water/g substrate
1	7	2.39
2	4	2.16
3	4	2.23
4	5	2.29
5	8	2.32
6	8	2.58
7	7	2.18
8	5	2.25
9	8	2.19
10	7	2.17
Average:	6.3	2.276
Std. Dev.	1.636	0.1298
Coeff. Variation: %	25.97	5.7

Discussion:

The results collected in Table 1 above were obtained using the new proposed method while the results reported in Table 2 reflect the method specified in SABS 707 for paper towels.

Considerable dexterity was required when handling the saturated paper tissue specimens for the SABS 707 absorptive capacity test, whereas the new test was comparatively simple. Difficulties in suspending the 75 x 75mm test specimens for drainage were experienced and the two “wings” of the square tended to adhere to each other and had to be physically rearranged to present an open diamond shape. This caused delays during which the specimen continued to drain and therefore created an imprecise “30 minute” draining time.

The wicking rate test (SABS 707) relies on the accurate observation of the disappearance of the specular gloss of a drop of water on the tissue sheet. The endpoint is subjective and will tend to vary depending on the light source employed to view it. This is illustrated by the large coefficient of variation listed in Table 2.

The new proposed method employs a more fundamental approach to the wicking tendency of the substrate resulting in a flow rate through the test specimen under standard conditions.

The coefficient of variation listed in Table 1 above verifies that the new method is more precise than the wicking rate of Table 2.

The slightly larger variation reported for absorptive capacity by the new method in Table 1 may be due to the difference in sheet structure between the nonwoven fabric and the continuous tissue sheet. Further work will be done to establish the reason for this.

Conclusions:

The new test method for the wicking tendency of a liquid in an absorbent substrate provides a simple and direct method for the measurement of the rate of diffusion of the liquid of interest through the porous material.

In addition, the new method provides a stable weighing form for absorptive capacity measurement that is independent of manual manipulation and variable drainage conditions previously experienced in other test methods.

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July, 2009

References:

1) ASTM 1177 Absorptive Capacity (Dip and Drain for 10 seconds).
2) SANBS 707 Test method for tissue towels. (Dip and Drain for 30minutes).
3) TAPPI UM 451 Capillarity of paper (time for vertical 25mm rise of water in a substrate).