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Bursting strength of paper

1. Scope

This method is designed to measure the maximum bursting strength of paper and paper products having a bursting strength of 50 kPa up to 1200 kPa (7 psi up to 175 psi) and in the form of flat sheets of up to 0.6 mm (0.025 in.) thick. Materials that can be tested using this method include newsprint, bag paper, fine paper, packaging paper, and printing papers. It is not intended for use in testing corrugated, fiberboard, linerboard, or hardboards that tend to cut the thin rubber diaphragm of the bursting tester. For testing paperboard and linerboard, see TAPPI T 807 “Bursting Strength of Paperboard and Linerboard”; for testing corrugated and solid fiberboard, see TAPPI T 810 “Bursting Strength of Corrugated and Solid Fiberboard.” For tissue testing, see TAPPI T 570 “Resistance to mechanical penetration of sanitary tissue papers (ball burst procedure)” (withdrawn status at the time of this publication).

2. Summary

The test specimen, held between annular clamps, is subjected to an increasing pressure by a rubber diaphragm, which is expanded by hydraulic pressure at a controlled rate, until the test specimen ruptures. The maximum pressure reading up to the rupture point is recorded as the bursting strength.

3. Significance

Bursting strength is widely used as a measure of resistance to rupture in many kinds of paper. The test is relatively easy and inexpensive to make and appears to simulate some end use requirements.

4. Definition

Bursting strength of a material is defined as the maximum hydrostatic pressure required to produce rupture of the

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material when a controlled and constantly increasing pressure is applied through a rubber diaphragm to a circular area, 30.5 mm (1.20 in.) diameter. The area of the material under test is initially flat and held rigidly at the circumference but is free to bulge during the test.

5. Apparatus

5.1 *Bursting tester*¹, having the following:

5.1.1 A clamp for firmly and uniformly securing the test specimen without slippage during the test. The clamp shall have two annular, grooved, parallel and preferably stainless steel surfaces. The clamping force should be adjustable to accommodate different strength papers without specimen slippage. The minimum force should be used to prevent damage to the specimen under test without specimen slippage.

5.1.1.1 The upper clamping surface (the clamping ring) has a circular opening 30.50 mm (1.2 in.) $\pm$ 0.05 mm in diameter. To minimize slippage, the surface which is in contact with the paper during testing has either a continuous spiral or concentric V-grooves in the surface. The continuous spiral is a 60° V-groove no less than 0.25 mm (0.010 in.) deep with a pitch of 0.8 mm (1/32 in.). The groove starts 3.2 mm (1/8 in.) $\pm$ 0.1 mm from the edge of the circular opening. The concentric grooves are 60° V-grooves not less than 0.25 mm (0.010 in.) deep and 0.9 mm (1/32 in.) $\pm$ 0.1 mm apart. The innermost groove is 3.2 mm (1/8 in.) $\pm$ 1 mm from the edge of the circular opening. The diameter of the upper clamp should be at least 48 mm.

5.1.1.2 The lower clamping surface (the diaphragm plate) has an opening 33.1 mm (1.302 in.) $\pm$ 0.1 mm in diameter. Its surface has a series of concentric 60° V-grooves 0.30 mm (0.012 in.) deep, 0.8 mm (1/32 in.) apart, the center of the first groove being 3.2 mm (1/8 in.) from the edge of the opening. The thickness of the plate at the opening is 0.66 mm (0.026 in.). The lower edge which is in contact with the rubber diaphragm is rounded to an arc of 6.4 mm (0.25 in.) radius to prevent cutting of the diaphragm when pressure is applied.

5.1.1.3 The clamping ring is connected to a clamping mechanism through a swivel-type joint or other means to ensure an even clamping pressure. During tests, the circular edges of the openings in the two clamping plates are required to be concentric to within 0.25 mm (0.01 in.). Use caution when working around pinch points.

NOTE 1: Because the clamping mechanism and clamping surfaces are subject to considerable wear or distortion, they should be examined periodically and repaired or replaced when necessary.

5.1.2 *A circular diaphragm made of natural or synthetic material.* The diaphragm is clamped between the lower clamping plate and the rest of the apparatus, so that before the diaphragm is stretched by pressure underneath it, the center of its upper surface is below the plane of the clamping surface. The pressure required to raise the free surface of the diaphragm 9 mm (3/8 in.) above the top surface of the diaphragm plate is required to be 30 $\pm$ 5 kPa (4.3 $\pm$ 0.8 psi). In testing this, a bridge gage may be used, the test being carried out with the clamping ring removed. The diaphragm should be inspected frequently for permanent distortion and, if distorted, replaced.

5.1.3 Means of applying controlled, increasing, hydrostatic pressure by a fluid, at the rate of 1.6 mL/s $\pm$ 0.1 mL/s to the underside of the diaphragm until the specimen bursts.

5.1.3.1 The recommended fluid is USP (96%) glycerin. Purified ethylene glycol (not the permanent types of radiator antifreeze with additives), silicone, vegetable oil, or other low viscosity materials may be substituted if desired.

5.1.3.2 The bursting resistance of paper increases with increased rate of loading. The rate of strain must be maintained effectively constant to obtain reproducible results. Any air present in the hydraulic system of the tester will lower the rate of distortion of the specimen and must be substantially removed. Air is more commonly trapped under the rubber diaphragm and in the tubes of the gages. A simple method of testing for the presence of excessive quantities of air is given in 6.3.

NOTE 2: The hydraulic system, including the gages or transducers, must be mounted so as to be free from externally induced vibration.

5.1.4 A maximum-reading pressure gage of the Bourdon type, of appropriate capacity and with a graduated circular scale 95 mm (3 3/4 in.) or more in diameter. Bourdon gauge should have an accuracy of $\pm$ 0.5% of final scale value. Pressure sensitive electronic gages as described in 5.1.5 are widely replacing the Bourdon type gages.

5.1.4.1 The choice and characteristics of the Bourdon gage are given in Table 1. The 0-840 kPa (0-120 psi) range

¹ Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.