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Resistance of paper to passage of air (high-pressure Gurley method)

1. Scope

1.1 This method is used to measure the air resistance of approximately 6.4 sq. cm. (1 sq. in.) circular area of paper using a pressure differential of approximately 3 kPa. The recommended range of this instrument is for papers that require 10 or more seconds for 10 mL of air to pass through. Refer to the manufacturer's instructions for the upper range limits. For more permeable papers, other techniques are preferable. Instruments are available with automatic timing devices.

1.2 This method measures the time it takes for a given volume of air to pass through the test specimen, along with any possible leakage of air across the surface; therefore it is unsuitable for rough-surface papers which cannot be securely clamped so as to avoid significant surface and edge leakage.

NOTE 1: If increasing the compression force on the lower clamp decreases the air leakage rate, this can indicate air leakage through surface roughness or through the edge of the specimen, then the selected clamping force is too low.

1.3 For a similar method of measuring air resistance that tests paper at a lower pressure (approx. 1.22 kPa), and has higher volume capabilities, refer to TAPPI T 460 "Air Resistance of Paper." For a similar method of measuring air permeance at pressures up to 9.85 kPa, using both smaller and larger test areas, refer to TAPPI T 547 "Air Permeance of Paper and Paperboard (Sheffield Type)."

2. Summary

This method measures the amount of time required for a certain volume of air to pass through a test specimen. The air pressure is generated by a gravity-loaded cylinder that captures an air volume within a chamber using a liquid seal. This pressurized volume of air is directed to the clamping gasket ring, which holds the test specimen. Air that passes through the paper specimen escapes to atmosphere through holes in the downstream clamping plate.

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3. Significance

The air resistance of paper may be used as an indirect indicator of Z-directional fluid permeance, as well as other variables such as: degree of beating, absorbency (penetration of oil, water, etc.), apparent specific gravity, and filtering efficiency for liquids or gases. In electrical insulating papers, air resistance may be used in predicting dielectric strength.

Air resistance is influenced by the internal structure and also the surface finish of the paper. Internal structure is controlled largely by the type and length of fibers, degree of hydration, orientation, and compaction of the fibers; as well as the type and amount of fillers and sizing. The measurement of air resistance is a useful control test for machine production; but due to the number and complexity of factors outlined above, careful judgment should be used in the specification of limits for air resistance.

4. Definition

Air resistance is the resistance to the passage of air, offered by the paper structure, when a pressure difference exists across the boundaries of the specimen. It is quantified by obtaining the time for a given volume of air to flow through a specimen of given dimensions under a specified pressure, pressure difference, temperature, and relative humidity.

5. Apparatus¹

5.1 Fluid Column Instruments

5.1.1 Air resistance apparatus, consisting of a vertically positioned outer cylinder which is partly filled with a sealing fluid, and an inner cylinder that can slide freely in the outer cylinder. Air pressure, generated by the weight of the inner cylinder, is applied to the specimen which is held between clamping plates. Refer to Appendix A.1 for the detailed description of apparatus designed specifically for using mercury for the sealing fluid, and Appendix A.2 for the detailed description of apparatus specifically designed for using oil for the sealing fluid.

NOTE 2: The mercury-type instrument is no longer manufactured. The oil-filled instrument described in this method is a direct replacement for the mercury-type instrument.

5.1.2 The clamping plates are located at the bottom of the apparatus, and a center feed tube directs the pressurized air to the clamping plates. The top of the floating inner cylinder is closed.

5.1.3 An elastomeric gasket is attached to the clamping plate on the side exposed to air pressure to minimize the leakage of air between the surface of the paper specimen and the clamping plate. The gasket is 28.58 ± 0.13 mm inside diameter and 34.93 ± 0.13 mm outside diameter. A satisfactory material is Thiokol, grade ST, polished plate molded, 0.8 mm thick, 50-60 (IRHD) International Rubber Hardness Degrees. Other materials may be recommended by the instrument manufacturer. Since the hardness of the elastomer will change with age, this gasket must be replaced on a periodic basis to ensure optimum sealing characteristics. For alignment and protection, the gasket is cemented in a groove machined in the clamping plate. The groove is concentric with the aperture in the opposing plate. The groove is $28.45 + 0.000 / -0.08$ mm inside diameter and $35.18 + 0.08 / -0.000$ mm outside diameter, at a depth of 0.50 ± 0.03 mm.

5.1.4 A stopwatch or electric timer, capable of recording time to the nearest 0.1 second, is required. Some instruments are available with automatic timing devices.

5.2 Electronic Instruments

5.2.1 Electronic instruments are available on the market that measure the flow rate of air through the specimen with a known area under a controlled pressure differential. Mathematical algorithms then determine the air permeance of the specimen.

5.2.2 The measurement area and gasket materials shall be equivalent in hardness to those specified for the fluid column instrument as discussed in section 5.1.3.

5.2.3 The electronic instrument shall be set-up and calibrated in accordance with manufacture's instructions.

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.