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Aging of paper and board with moist heat

1. Scope

1.1 This method specifies the procedure for humidified heat treatment of paper or board and the general procedure for testing the heat-treated materials. The purpose is to obtain inferences regarding the long-term aging qualities of the paper.

1.2 The method is based on work done on printing and writing papers but may be used with discretion for other types of papers and boards.

2. Summary

Properties of paper or board are compared before and after “accelerated aging” in a humidified atmosphere at an elevated temperature (50% RH, 90°C).

NOTE 1: Earlier editions of this test method have specified 25% relative humidity at 90°C as this appeared, with very limited data, to correlate better with natural aging. Fifty percent relative humidity at 90°C has been found preferable for three reasons: 1) it has become the standard through usage, 2) paper degrades twice as fast at 50% relative humidity as at 25%, and 3) humid ovens can maintain 50% relative humidity, but not 25%, at 90°C.

3. Significance

3.1 Exposure of paper or board to a hostile environment, such as some types of radiation, elevated temperature, or chemical attack over a period of hours, may provide information concerning 1) the natural changes that may occur in the material over a period of years, and 2) the ranking of similar papers with respect to stability.

3.2 Hostile environments that have been used include exposure to heat, to heat and moisture, to visible and ultraviolet radiation, and to sulfur dioxide, nitrogen dioxide and ozone gas.

3.3 Properties compared before and after such exposure include, but are not limited to, mechanical properties, such as burst, tensile properties, folding endurance and tearing resistance; optical properties, such as brightness, yellowness and opacity; and chemical properties, such as pH and alkali solubility.

3.4 TAPPI T 453 “Effect of Dry Heat on Properties of Paper” is available for evaluating the effect of dry oven treatment on paper. It has been determined that the degradation rate of cellulose is very sensitive to the amount of

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moisture in the sample (1,2). Comparison of accelerated aging with natural aging indicates that some moisture should be present in an accelerated aging atmosphere (3). Dry accelerated aging of cellulose is much less sensitive and probably does not rank papers in order of stability as accurately as moist accelerated aging. While moist aging is more predictive than dry aging, caution must be exercised in applying either method to a wide range of paper grades and end uses.

4. Apparatus

4.1 A system for maintaining the temperature at 90°C and the relative humidity at 50% is required. This may be done through the use of an environmental chamber, or by a two-bath system as shown in Fig. 1.

4.2 Environmental chambers are available that can maintain an experimental atmosphere at 90°C and 50% relative humidity. They have the advantage of convenience, and if their accuracy and precision are carefully monitored, they can be adequate for most purposes, but they cannot control temperature and relative humidity as well as the two-bath system.

4.3 A two-bath system is preferable for research, where it is desirable to control the temperature and relative humidity as closely as possible. The first bath is maintained at 72.8°C and the aging bath at 90°C. The vapor pressure of water at 72.8°C is half of the vapor pressure of water at 90°C, so by saturating air (or other gas) with water vapor at 72.8°C, and passing it through an aging vessel at 90°C, one can easily maintain the relative humidity at 50% with great accuracy. The temperature of an oil bath should be maintained to $\pm 0.1^\circ\text{C}$.

4.3.1 Purified air from a gas cylinder is passed through tandem fritted glass bubblers, as shown in Fig. 1, through a heated (to prevent condensation) glass or plastic tube, to the aging vessel in the second bath. By passing the gas through a coil of glass tubing around the aging vessel, the air attains 90°C before entering the aging chamber.

4.3.2 Approximate dimensions and construction schematic of the humidification vessels and the aging vessel are indicated in Fig. 1.

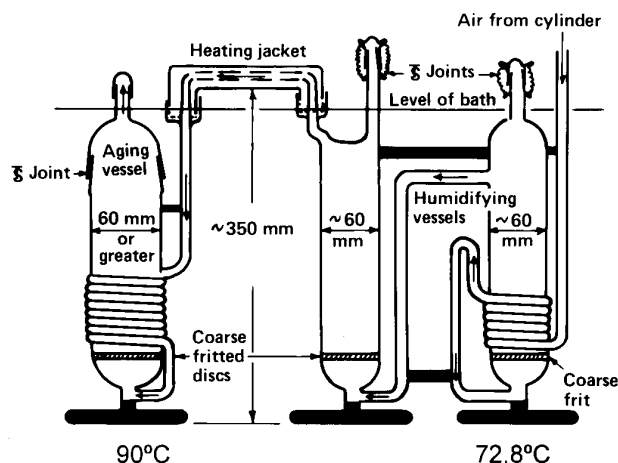


Fig. 1 Apparatus for maintaining temperature of 90°C and 50% RH.

4.3.3 As the vessels are buoyed up by the bath liquid, provision must be made for holding them in place. The preferred approach is to have slots built into the bottom of the bath, and slip the bottom of the vessel into the slots.

4.4 Test instruments, depending on the test, or tests, selected for evaluation.

5. Test methods

5.1 TAPPI Test Methods: one or more of the following methods may be used for estimating the effect of moist heat treatment on papers.

5.1.1 TAPPI T 212 "One Percent Sodium Hydroxide Solubility of Wood and Pulp."

5.1.2 TAPPI T 400 "Sampling and Accepting A Single Lot of Paper, Paperboard, Containerboard, or Related Product."

5.1.3 TAPPI T 402 "Standard Conditioning and Testing Atmosphere for Paper, Board, Pulp Handsheets, and Related Products."

5.1.4 TAPPI T 550 "Determination of Equilibrium Moisture in Pulp, Paper and Paperboard for Chemical