Dynamic Surface Characterization - A Better Approach For Paper Quality Assessment

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ABSTRACT

Increasing web speed during surface sizing, coating and printing are posing lot of quality problems. Static tests like strength, air leakage tests for smoothness and porosity generally used in paper quality grading no longer seem to be effective in present context. This article describes some new methods of evaluating the dynamic response as function of time for improved correlation with experienced problems in production.

Key words: contact angle, fluff, dimensional stability

INTRODUCTION

Surface characteristics of paper play key role in assessing the quality of paper especially for printing, surface sizing and coating. Now a days the demand is for increasing web speed in surface sizing, coating and printing. All these require new perspectives on paper characteristics evaluation. Generally the quality of the paper in most of Indian mills is judged by physical and optical characteristics like Grammage, Thickness, Brightness, Opacity, Gloss, Smoothness, Cobb, Tensile, Tear and Double fold etc. Unfortunately these static parameters do not always show reliable picture of end use problems. Typical such examples are failure of these tests in prediction of

Print mottle, dot gain or bad adhesion

Fibre rising causing linting or coating problems

Dimensional instability causing creep, wrap or cockling

The methodology of static evaluation is far away from the actual situation. So the appropriate test should be such that the production problems could be assessed prior to occurrence. Certain dynamic tests are considered to be quite close to actual performance. These tests need to be considered by Indian paper manufacture as these are being used in other countries.

STATIC V/S DYNAMIC TESTING

The importance of dynamic tests can be explained if we consider Fig 1. Considering $cobb_{60}$ value of 20 g/m^2 for a paper, this implies that 20 gram of water is absorbed during contact time of 60 seconds. For getting this absorption there exist three possibilities A, B, C. In these curves, if we see at 50% of cobb

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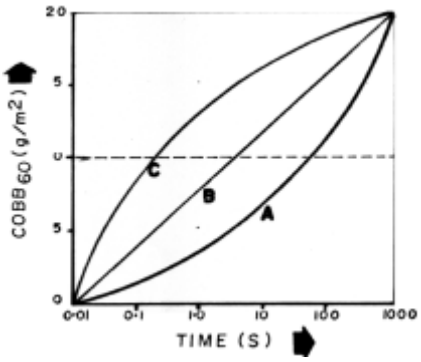


Figure 1: Different response for same cobb

the absorption time is entirely different, the lowest time is shown by C and highest time is shown by A. This indicates that relying on final value the prediction of the quality for end use could be entirely different in all these three cases.

Some dynamic tests have been formulated to get better picture of quality grades (1). In present article following tests are explained

Print quality as function of wetting and Sorping

Linting and gloss reduction caused by moisture & dryness

Dimensional Stability

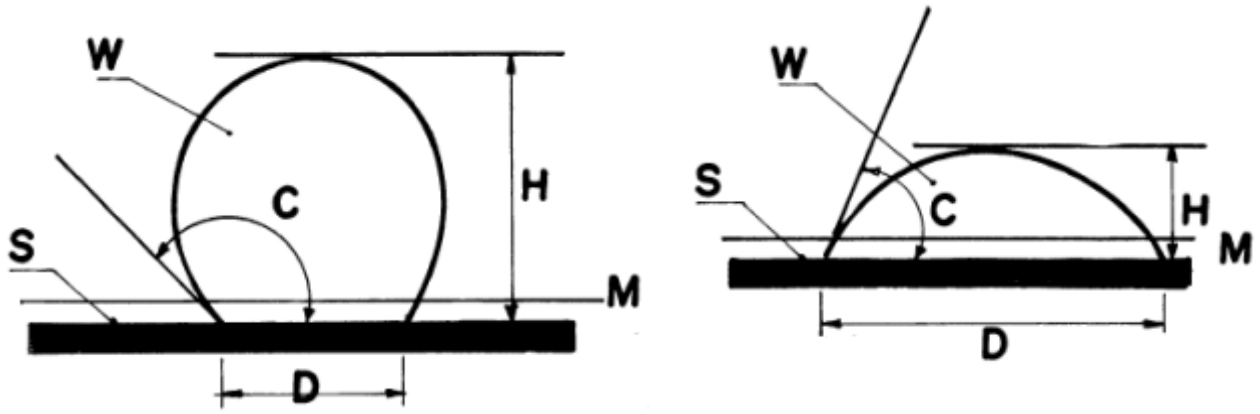
WETTING AND SORPTION BY DYNAMIC CONTACT ANGLEMEASUREMENT

The commonly used test in Indian mills in assessing the wetting and liquid sorption is cobb test. This test represent 'macro test' giving an average value for a relatively large area, which limits its use for evaluation of the homogeneity of surface. This test does not give real grading for converting and printing purposes as in reality the liquid penetration judgement should be at different time intervals i.e, short time wetting and sorption is important. A new test 'Dynamic contact angle' is available. In this test a droplet is applied on the specimen surface in synchronization with video camera useful for capturing image of the changing drop. The contact angle (wetting), volume (sorption) and base diameter of the drop (spreading) is calculated describing these dynamic properties as function of time (2). The principle of measurement is given in Fig. 2. Considering an example of three A,B,C, papers with comparable cobb value but having different contact angle at different time interval (Fig.3) the wetting retardation time (WRT) which is defined as time at which the contact angle curve fall below 90 degree is lowest for sample A and highest for sample C. When these papers were subjected to coating sample B gave best coated paper.

FIBRE RISING

Fibre rising is one of the serious problem in coating and offset printing. The object of coating process is to cover all the fibre extending from the surface of base paper and to get smooth surface. It is therefore very important to characterize the distribution of fibre sticking out from the surface. The manual ranking is not reliable enough for quality control and smoothess tests like Parker Print surf, Bendtson, Bekk measuring the clamped air leakage cannot be used as these tests compress the long fibres.

In printing the situation is more complex as during offset printing paper is exposed to moisture as well as heat. The fibre bonded at one end only may cause linting problem causing deposition on blankes. The ends of fibre firmly bonded in the sheet may cause gloss reduction. The static test like smoothness does not predict printing problem like linting and gloss



W: Water droplet, H: height of droplet, C: contact angle, D: diameter of the surface of contact of the droplet, M: minimum height of drop to be analyzed

Fig. 2; Principle of Measurement

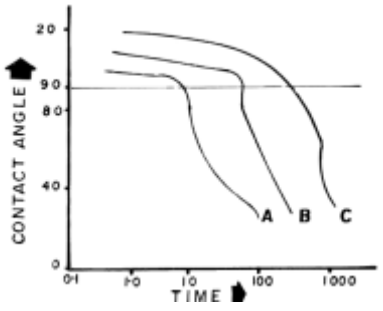


Fig. 3: Water Retardation Time at 90°

Fig.4: Fibre rising in different newsprint

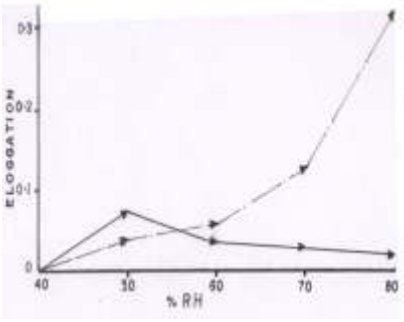


Fig. 5: Hygroexpansion of Paper 'A'

reduction.

The above parameter can be assessed by conducting Fibre Rising test.In this paper is exposed to a controlled amount of moisture at a constant contact time of one millisecond and after which the specimen is dried to a controlled temperature. Finally the specimen moves over the edge with a radius of 0.2mm at which long and short fibres are counted and measured from 100 images along the specimen surface (3).

A typical fibre rising observed for newsprint made from 100% virgin and 100% recycled fibre is shown in fig (Fig.4).

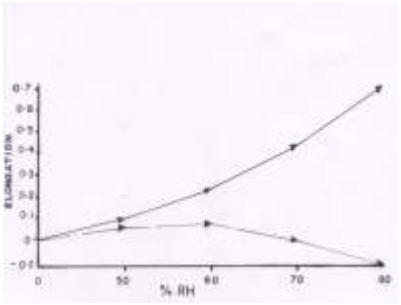


Fig. 6: Hygroexpansion of Paper 'B'

DYNAMIC DIMENSIONAL STABILITY

Dimension changes will occur when the paper structure picks up moisture. This response is very dependent on the dynamic process inside the printing press where press design, web speed, tension and applied moisture and paper grade play significant role. To overcome runnability problems cuased by dimensional changes the paper maker must achieve 'Uniform Quality' enabling the printing press to be run without need for adjustment. Traditionally dimensional changes 'hygro expansion' are measured using specimen specimen stips cut in CD/MD direction (4). The specimen strips are exposed to different relative humidities and the expansion is measured. But this test does not really confirm to actual behavior of paper on the printing press. The web while running inside the press is not likely to reach equilibrium; question has been raised regarding the relevance of such a test. This static value obtained at equilibrium conditions may not correlate all with experienced runnability problem as these problem occur only for dimensional changes appearing while the paper runs inside the press between the printing nips. The more appropriate is **'dynamic hygro expansion' test**. In this test the paper sample is sprinkled with copier toner ink and is kept inside a climate chamber. The climate inside the chamber is cycled between 10% - 90% RH. After equilibrium the in plane displacements are measured with a system based on Electronic Speckle photography (5,6,7,8). The dynamic hygro expansion caused by water vapors is measured from a sequence of image captured at different time intervals. The expansion with relative humidity is depicted in graphical manner.

In Fig. 5,6 the hygroexpansion of two papers are depicted. The paper of Fig. 6 showed creasing problem in printing press. In paper (Fig.5) the hygroexpansion in MD starts before CD. When the delayed CD expansion starts the induced force reduced the MD expansion. Similar to rubber cloth,

which becomes shorter as it is pulled sideways. Fig. 6 the paper expansion in CD is quite high causing MD contraction. This could be the cause of creasing during printing observed for this paper.

CONCLUSIONS

Many problems of surface sizing, coating and printing can be better understood by adopting test method which are dynamic and close to production conditions. Some of such test are Dynamic Contact angle measurement, Fibre rising and Dynamic Dimension Stability test.

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