PHYSICAL PROPERTY REQUIREMENTS FOR NON-IMPACT PRINTING PAPER

- A Critical Overview and Conceptual Categorization

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Abstract: As the new printing technologies are developed, new paper properties are demanded to produce optimum performance of the printer. As the dpi level and the speed increase, paper properties need to be examined from the standpoint of bulk physical properties, surface properties, and electrical properties. Current test methods were critically reviewed and the need for developing new methods were highlighted. Close coordination and joint effort between the OEM and the papermaker were proposed. Papermakers in the new century should operate under a very tight quality control environment.

Introduction

The new century is just around the corner and electronic printing (EP) has come a long way to become a household word. The resolution of EP has now been well established at the 300 dpi level at a minimum and is moving toward 600 dpi at a rapid pace. Printing speed is also increasing beyond 300 ppm for monochrome and 200 plus ppm for color printers. As the dpi and the speed increase, new paper properties are in demand and new and better

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methods for measuring the paper properties are required. Some of the methods should be newly developed and some old methods should be re-examined. Functional quality and perceived quality should be carefully distinguished. This distinction will make it easy to focus on the functional properties from technical viewpoint and the perceived quality from psychophysical viewpoint. Paper handling after printing is becoming more and more in-line and an integral part of the progress in EP. Stiffness, edge condition, punching, scorability, and folding are some of the key properties that are frequently discussed at the technical conferences in recent days. High speed and high dpi are here to stay and papermakers should be prepared to cope with the paper property requirements for high speed and high dpi. Recycled paper will be used more and more in printer and copier papers. Nationwide quality control standards should be established to handle fluctuations in the recycled fiber properties.

New Perspective

As corporate America approaches the new century, rapid development of communications and computer technologies have prompted globalization of the industry at a rapid pace. Things are changing across the full spectrum of the industry and different industries are crossing each other's paths. To cope with emerging global culture, a broad perspective is needed for managing the changes harmoniously maintaining logical and reasonable equilibrium.

About ten years ago, fax became a reality with the introduction of G3 machine but the installed base of the fax machines was less than one half million. In 1992, the figure reached 7 million and now it has more than doubled. After the fax machine became popular, AT&T surveyed their long distance user pattern and found that 90% of the calls between the U.S. and Hong Kong were fax communications. Samsung in Korea monitored the long distance telephone expense and found that the use of the fax saved a substantial amount of long distance telephone expense, amounting to in excess of a million dollars a year. So teletype became obsolete in no time. Then E-mail was introduced and it took over a fair portion of the fax business. For transient communication, E-mail provides fast and convenient means for distributing the message. Recent prevalence of the Internet globalized the communication network resulting in the world constantly shrinking, overcoming geographic distance. Electronic banking, college registration, personalization of advertisements, and electronic advertisement

through the Internet are some of the examples of what is going on in this electronic age. These areas are likely to progress rapidly as we approach the new century.

Introduction of non-impact printing (NIP) more than a quarter of a century ago expanded the industry horizon by providing the means of personalizing and printing variable information at high speed. The NIP is wide spread in the printing industry, either by itself or in combination with the conventional printing. Tickets and labels and barcodes are printed by laser, ink jet, ion deposition and thermal printing, making it cost effective for small jobs and small printers. It will be well for the paper industry to recognize the impact of the new technologies and utilization of such technologies on the paper performance and property demand. With this perspective in mind, let us look at the paper property requirements for the new century.

Conceptual Categorization of Paper Properties

Paper properties can be categorized into four conceptual categories from utilitarian vantage points:

Category 1: Properties we know how to measure and we know what to do with the results, such as basis weight, caliper, tensile, burst, moisture, smoothness, porosity, stiffness, brightness and opacity.

Category 2: Properties we know how to measure but we really do not know what to do with the results or how to interpret the results, such as static charge decay and the relationship between surface and volume resistivities. Prüfbau, IGT, and Bristow wheel absorption measurements are some of the examples that we know how to interpret partially in limited scope.

Category 3: Properties that we know we need to measure but we do not know how to measure, such as droop, body, crispness, slipperiness, cockle, moisture welt, glazing, and formation. Some of these properties are associated with psychophysical properties and human perception.

Category 4: Properties for which we do not know what to measure or how to measure.

A Brief Review of the Current Status of the Printer Paper Properties

With this conceptual categorization in mind, let us examine the paper property requirements:

Category 1 Properties: These properties are generally well understood. The test methods are well established, and the results are well utilized but there is still room to refine some of the test methods. Smoothness measurements need to be refined to represent flatness rather than the current air-leak approach such as sheffield, bekk, and Parker Print Surf. Printers in the new century will have high dpi exceeding the current level of 600 dpi. Some of the printer manufacturers have already introduced as high as 1200 dpi printers in the market. Toner particle size is also becoming smaller. Average particle size is going down toward five microns from the current range of 7-10 microns. Five microns will become a norm in the near future. As the dpi level increases, and the average toner particle size decreases, there is a need to provide a flat surface to accommodate the smaller toner particles and high dpi capabilities of the printer designs. A method of measuring flatness of the paper surface is needed to characterize the new paper in addition to the air-leak instruments available today such as sheffield, bekk, and Parker Print Surf. Surface profilometry is an example of such an attempt.

There is also a need to improve caliper measurement. Perhaps the current TAPPI method of using an anvil and applying a fixed pressure can be improved by an optical method using laser beams. A laser based laboratory caliper meter will be a useful instrument.

Category 2 Properties: Sometimes, some properties are measured because the methods and instruments are available. Static charge acceptance and decay is an example of such a case. It is good that such a measurement is available and numbers can be generated but interpretation of such data is not clear cut. Eventually a useful theory providing interpretation of such data will allow the papermaker to apply this information to the papermaking process.

Prüfbau, IGT, and Bristow wheel absorption measurements are examples where we know how to interpret the results on a limited scope. These are the tests characterizing ink and toner reception behaviors. However, the correlation of these results to the printer performance and image quality is not always obvious, straight forward, or reliable.

Understanding printability in general is still in its infancy. It is desirable to establish a set of tests that can provide prediction of printability. Many tests are available now today but actual print trials with a production scale press is still the final verdict.

Category 3 Properties: New test methods are needed in this category. Some of the test methods are available but they are not satisfactory. Several formation testers are on the market but the correlation with the human eye is not always consistent and reproducible. Cockle testers have been introduced but the human eye is still the best way to characterize cockle. Many of the properties in this category are related to psychophysical phenomena and a new approach should be applied to tackle such properties from the standpoint of characterizing human perception.[1]

Category 4 Properties: This is an area of meager understanding. Some papers perform better than others given a set of identical physical property test results. Obviously, the test results we measure today provide the required information but do not satisfactorily characterize the printer performance. There are definitely some other properties that we don't understand at this time which need to be characterized with new test method to be developed. Thus, these are the properties that we do not even know if, or how, to measure.

Paper Property Requirements for New Printing Technologies

Bulk properties are closely related to pre-printing and post-printing paper handling. Surface properties are related to producing good image quality, toner transfer, feeding, and release characteristics. Electrical properties are closely related to controlling static and release characteristics and toner transfer. Optical properties can enhance the perceived image quality and utilitarian value judgment of the consumer behavior and preference.

Paper properties for the newly developed printers of the coming century should meet the performance requirements for high printing speed and smaller toner particles. For coping with the high speed printing, it is essential to better understand the image formation, toner transfer, and the release characteristics for producing good image quality, bulk, and surface required for paper handling. Smooth and flat paper is essential to accommodate

smaller toner particles. Surface and volume resistivities should be controlled within a tight window. The relationship between volume and surface resistivities should be incorporated in the quality control specifications. Charge decay pattern should also be included as an important quality control element for controlling the electrical property needed for achieving good printer performance.

As the next generation printer design becomes more and more sophisticated and the operating characteristics more precise, paper properties should be specified with tight quality control windows. Sampling methods should be more refined than the traditional papermaking approach. By the same token, the OEM's should seriously take into consideration the profile of papermaking. Papermaking is a combination of art, science, and technology. It is an art because the raw material is an inhomogeneous natural product. Somehow the inhomogeneity should be handled statistically. Because the papermaking is a statistical process, there is a limit to how much precision and accuracy can be achieved. There is also a practical limitation from the standpoint of economical considerations.

Printer manufacturers and design engineers should take into consideration the papermaking processes and paper property requirements because paper is an integral part of the printing operation. Paper is not something that is simply put into the printer but a vehicle on which the message is displayed. In fact, what the enduser sees is a piece of printed paper, the final product. Therefore, it makes sense for the OEM and papermaker to form a partnership in developing the next generation printers for the new century. Both producers will benefit from such an alliance. While the OEM's should take into consideration the inhomogeneous statistical nature of papermaking, the papermaker should try to understand the need for precision and accuracy demanded in designing the printers for the 21st century.

References

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