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Light Scattering Intensity and Viscosity Correlation for the Letters Printed on the Tobacco Cigarettes

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Abstract

The quality of the letters printed on the tobacco cigarettes, brand name "John Player™" is found to be viscosity dependent on the ink used for printing. The viscosity changes of the ink used, cause the printed letters to be smudged and of poor quality. At present selection of bad quality prints are done by visual identification, as no scientific technique is available. We have developed a light scattering technique using a 632.8 nm 20 mW He-Ne laser system to correlate the scattering intensity with the viscosity of the ink used, LogoRed TC2582. As a result, a standard has been assigned and quality of the cigarette prints can be maintained during the manufacturing process.

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1. INTRODUCTION

The print quality of the letters on the tobacco cigarettes John Player "Gold Leaf" is found to be viscosity dependent on the ink used in the printing process. Changes in viscosity result as the nozzle in the printing machine gets warms up hence, making the quality of the

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print “Gold Leaf, John Player” poor and smudged. Apart form the visual identification of such bad prints no scientific method was available to select the poor quality cigarette paper prints. This paper reports a light scattering technique that we have developed to monitor the cigarette print quality of the commercially available John Player tobacco cigarettes. A linear relationship of the ink viscosity and the backscattered light intensity arising from the front illuminated cigarette prints made possible to set a standard for a quality print.

2. EXPERIMENTAL

Figure 1 shows the schematic layout of the experimental set-up designed to monitor the scattering intensity when cigarette papers were subjected to a 623.8 nm, 20 mW laser radiation. The cigarette paper was mounted on a ThroLab™ XYZ 1.0” translating mount and TEM_{00} laser beam was focused to a selected letter, e.g. “J” and the backscattered radiation was monitored with a 180° degrees geometry using 20 cm long 2 mm diameter fiber optic cable. The output of the fiber optic cable was aligned to the input slit (100 μm) of the Oreil MS 125 spectrograph equipped with a 1200 l/mm holographic grating. The intensity of the scattered radiation was estimated (in counts) using thermoelectrically cooled (-40 °C) charge coupled device (CCD) detector. Viscosity variations with temperature were measured using a Brookfield™ Viscometer.

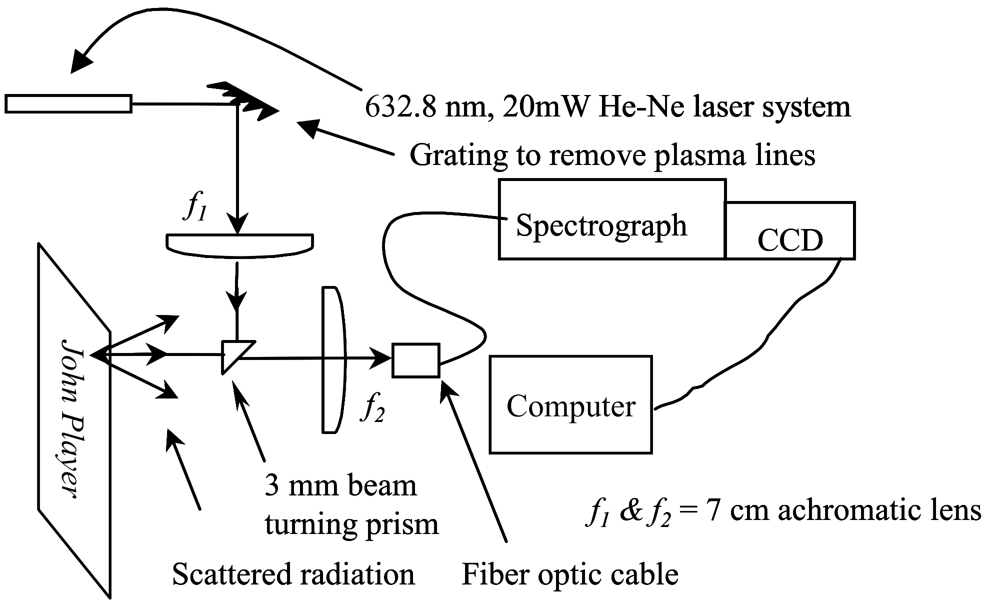

Figure 1: Experimental set-up assembled to examine the viscosity and scattering intensity relationship

3. RESULT AND DISCUSSION

Andor Technology[1], thermoelectrically cooled charge coupled device (CCD) was setup with fully vertical brine (1024×256) pixels and the dark current was subtracted. The detector head was cooled by circulating water around it. Water-cooling technique was selected, as air-cooling does not allow operations at low temperatures. The flow of water through the heat sink removes heat very efficiently, since the heat sink is never more than 1°C hotter than the circulating water temperature. However, with this type of cooling, the minimum temperature of the CCD will be dependent only on the water temperature and not on the room temperature. The temperature was set to –40 °C in this work. The CCD was setup in vertical binning mode so that the charge from rows of the CCD-chip is moved down into the shift register before the charge is read out. Further, full vertical binning method was used in this work as the multi-track and single-track binning methods have their limitations. In the full vertical binning method charge from each complete column of pixels on the CCD is moved down and summed into the shift register and the charge is then shifted horizontally one pixel at a time from the shift register into the output node. Shutter control was set to fully auto mode as it leaves all shuttering decisions to the system. For the real time data acquisition and for the data accumulation modes, the exposure time was set to 0.004 seconds. The number of accumulations used throughout this work was one hundred, as it produced more reliable average values. The accumulation cycle time was set to 1.5 s. The accumulation time is the period (in seconds) between each scan and this parameter has to be used when the shutter is setup for the internal trigger mode. The Oriel® MS 125 spectrograph[2] was calibrated using emission lines generated by an Hg fluorescent bulb (Philips, 20 W). The calibrated emission lines of the lamp are shown in Figure 2. Input slit of the spectrograph was selected to 100 μm and with a holographic 1200 l/mm grating.

Generally cigarette manufactures use LOGA™ machines for printing mechanisms as they are based on duct type and two-nozzle type systems[3]. These types of printing units differ from each other by the drive rollers and ink supply mechanism to the inking cylinders. LOGA R1 has two drive rollers with nozzle type inking mechanism; LOGA R2 and LOGA K3 have three drive rollers with the duct type (i.e. adjusted ink stock bin type) inking mechanism[4]. These machines are generally identified as R1, R2, K1, K2, and K3. Often R type machines are used for the production of Regular cigarette prints and K machines are for the King Size cigarette prints. Experiments carried out in the CTC factor shows that as the LOGA K3 machine, which uses to manufacture King-size John Player Gold Leaf cigarettes get warm up as it operates for several hours. Figure 3 shows the ink temperate inside the ink reservoir with the typical operating hours of the machine. As the temperature of the printing machine increases, ink viscosity deceases causing more ink to release onto the cigarette paper. Figure 4 shows the inks viscosities of the Red and Gold inks with the running time of the K3 machine.

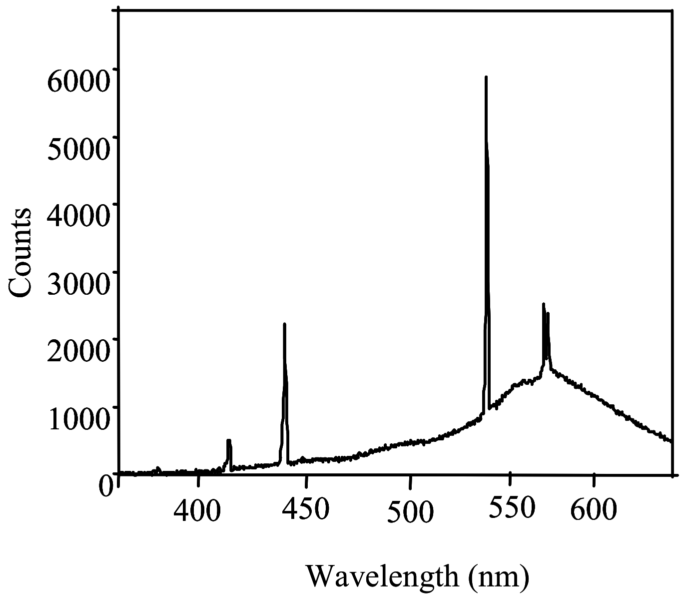

Figure 2: Calibration lines arising from Hg emission by a fluorescent lamp 20 W Philips

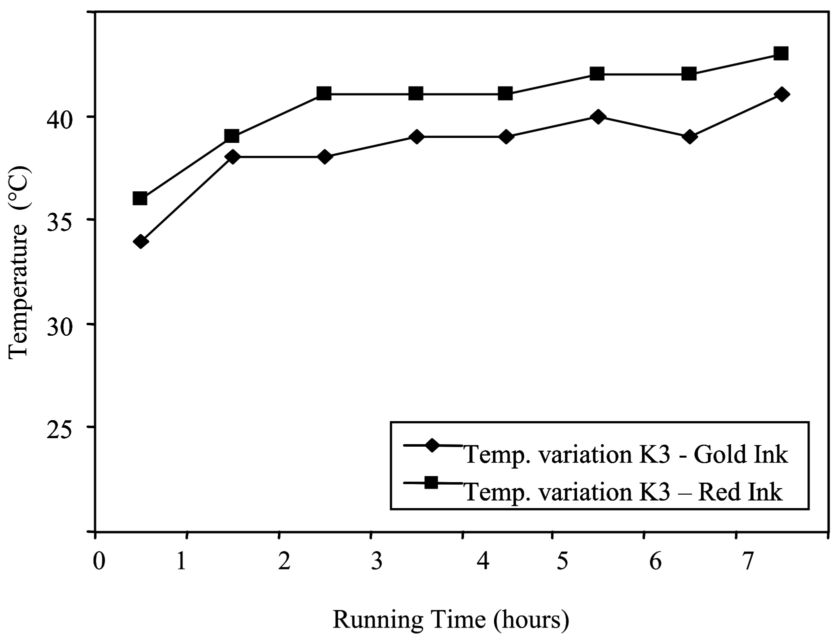

Figure 3: Temperature variation in LOGO K3 cigarette making with running time

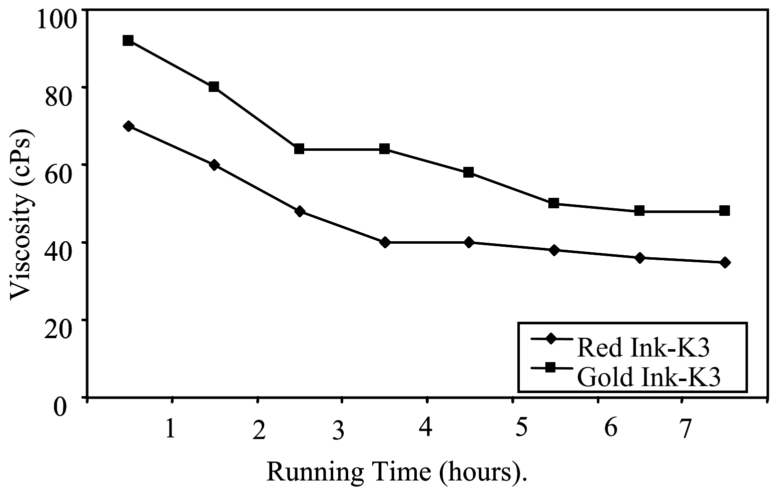

Figure 4: Variation of ink viscosity with the running time of the K3 machine

Seven randomly selected samples of the King Size cigarette print "John Player" were subjected to the light scattering experiments by focusing the laser beam on to the character "J". Backscattered light was accumulated and the height (in counts) of the Gaussian shape peak at 632.8 nm was taken as the scattered intensity. Figure 5 shows the plot constructed using the viscosity of the ink used[5] for printing and the intensity of the scattered light when the laser beam was focused to the character "J", in brand name "John Player".

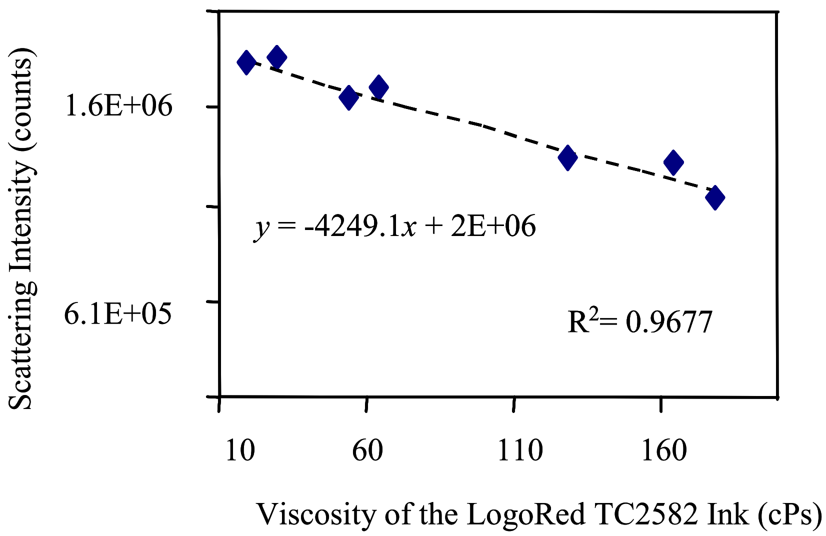

Figure 5: Plot of ink viscosity and scattered intensity of the light for the letter "J"

Figure 5 shows a linear relationship with a least square regression coefficient, r^2=0.968. This indicates when the ink viscosity increases (at low operating temperatures) less ink goes into the die and impression rollers in the printing unit and deformed the characteristic dot structure of the print, thereby resulting lower scattered light intensity. At high operating temperature, viscosity of the ink reduces and more ink goes into the impression rollers and the cigarette prints become thick and bright, resulting higher scattering intensity.

At a temperature range of the printing machine 55-60 °C, having ink viscosity 65-55 cPs, and scattering intensity of 1.6×10^4 counts/sec for the character “J” can be acceptable as a good quality print. Adhering to these limits the quality and uniformity of the cigarettes prints can be maintained throughout the manufacturing process. Ink viscosity and heat generated by the printing machine vary with many parameters such as manufacturer of the ink (i.e. ink supplier) and the running condition of the printing machine. Therefore, setting up quality standard would be practically impossible task using parameters like ink viscosity and operating temperature. On the other hand major advantage of this light scattering method is that samples can be analyzed within a time period of two minuets and if the print quality is poor production can be halted until the problem rectified.

ACKNOWLEDGEMENT

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REFERENCES

1. Andor Technology Ltd., Springvale Business Park, Belfast., *CCD Head Model DV 420-UV*., URL: www.andor-tech.com
2. Oreil Inc., 150, *Long Beach BLVD., Stratford, CT 06615, USA., MS-125™, 1/8 m Spectrograph Model 77400*. URL: www.oriel.com
3. Eley, R.R., *Principles and Methods of rheology in coatings*, Encyclopedia of Analytical Chemistry: Instrumentation and Applications. R.A. Meyers, Ed., J. Wiley & Sons, Ltd., (2000)
4. Eley, R.R., *Rheology and viscometry, ASTM Paint and Coating Testing Manual*, 14 Philadelphia, 1995, Chap. 33, 333-368.