The Investigation of the Physical Conditions of the Printing Environment on the Ink Colour Value

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Abstract

The physical conditions of the printing environment are the most important factors on the quality of the printed image. The humidity in the printing room would affect the physical deformation of the printing paper during the printing and after the printing operation, in accordance with the humidity level whether it is high or low than the optimized conditions. On the other hand, the dryring problems arise in the printing operation using the printing inks which dry physically either by the penetration into the paper or by the absorption. Especially, uncoated hygroscopic papers absorb the humidity in the environments containing high level of humidity and they resist the absorption of oil-based inks.

In this work, the uncoated white paper of 70 g/m^2 was used as a test printing paper. The relative humidity of the printing room was setup at different values, between 50% and 70% and the changes in the humidity level of the paper was calculated. In each 10% increase in the humidity, the solid printings were carried out by an oil-based ink using the IGT Printing Test Instrument.

The changes in the solid-tone densities were measured by Gretag D19C reflection densitometer during the printing and also 1, 3 and 24 hours later after the printing. In addition, the reflectance values of the test prints were measured by the use of Gretag Macbeth SpectroEye spectrophotometer, and CIE Lab values were calculated. It has been investigated that the humidity of the printing

environment has affected the humidity content of the paper, the penetration of the inks into paper and also the colour shade of the prints.

I. Introduction and aims

There are a number of factors which influence the printing quality including the humidity and temperature values of the press room. Paper absorbs humidity or gives it to environment depending on the rate of humidity in its surrounding environment. Thus, it tries to get a balance with the humidity of its environment. Because of this humidity exchange of the paper, the fibres are swollen and deformed. Because of these humidity changes, the gloss and density values of the ink printed into the surface of the paper show some changes, depending on the drying characteristics of the paper.

In the present study, the test papers were kept in a conditioning room in a desired humidity value for a specified time and the papers were conditioned into the moisture of environment following moisture exchange. Then, the background prints were taken under 400N constant force with black process in IGT Test Print Equipment. Density values were measured at zero and with given intervals, the CIE L*a*b* values were calculated. The aim for these tests was to determine the changes in the density and colour values of inks printed different moisture environments and to compare these values with standard values to determine the ideal environmental moisture for the printing with an uncoated 70 g/m^2 white paper.

II. General Information

Absorption (gaining humidity) and desorption (losing humidity) are very important issues. This rate shows some changes with different papers depending on the fibre properties, the type and amount of adhesive substances, the type and amount of fillers and the amount of coating material. Absorption of humidity is quicker than desorption. Paper have to absorb humidity two times more rapidly than drying rate from the same atmosphere. However, when paper become closer to the balance by conditioning with the moisture of environment, absorption rate reaches to a lower value. This trend is same with all paper types. In most paper types, this duration depends on the initial humidity content of paper, its circulation rate and its physical property. For the high grammage papers, the time required for conditioning is around 24-48 hours.

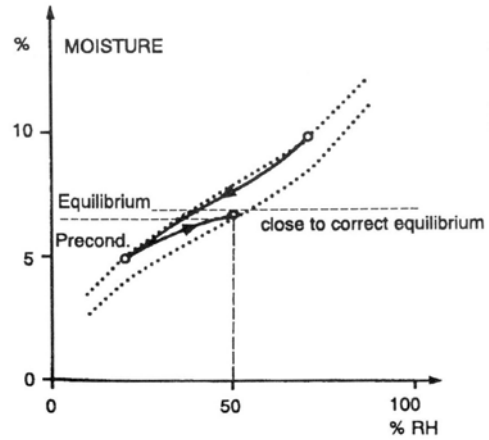
II.1. The climate affects the stiffness properties of the paper

Since paper and board are hygroscopic materials, the stiffness properties are affected particularly by the relative humidity and temperature of the ambient air. It is also important to remember that it is the current moisture content of the sample which affects the stiffness.

The moisture content of the material depends on the current climate but it also depends on earlier climate conditions because of the so-called moisture hysteresis

effect. We can reach different moisture contents and thus different stiffnesses even in the standardized climate of 50% RH and +23 °C, depending on whether the paper has come to this climate from a dry or a humid climate.

To avoid the problem, it is usually required that all testing shall be done in a standardized climate and that the sample shall first be pre-conditioned in a climate about 20% RH and +23 °C. In this way, the test material will, from a moisture content view point, always be tested under the same moisture conditions.



Graph 1: The moisture content as a function of the relative humidity.

II.2. Surface chemistry and printability

Interactions between printing inks and paper involve a great number of surface phenomena. Printability parameters are affected by the physical structure of the sheet surface, as for example roughness and also by physicochemical parameters such as work of adhesion and surface free energy. Many other parameters such as grammage, thickness, opacity, whiteness, brightness, formation and strength also affect printability.

Printing ink is composed by polymers, colored pigments and vehicles which can be water, oil or organic solvent. The lithography printing process uses inks that contain oils as vehicle.

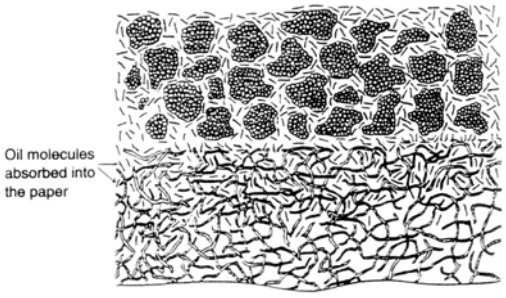


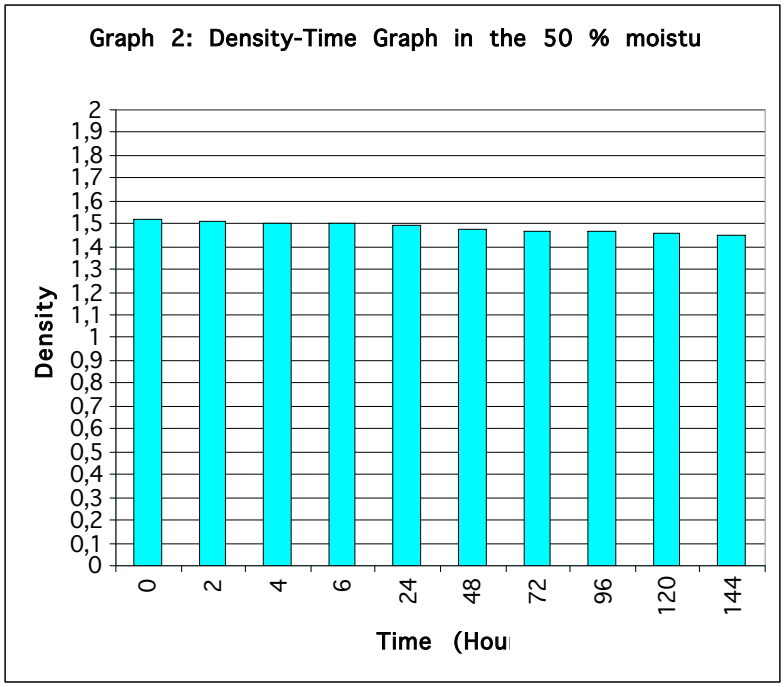
Figure 1: Absorbtion –dying mechanism ink nearly dry.

After printing, the ink is slowly absorbed in to the fibres of the substrate (see figure 1). For this to occur, the subtrate must be as absorbent as possible, but not so absorbent as to cause the ink to be absorbed trough to the other side of the paper and cause strike-through, or to cause the vehicle to be absorbed too much into the fibres of the paper and produce show-through. (figure 1).

III. Test Print Applications

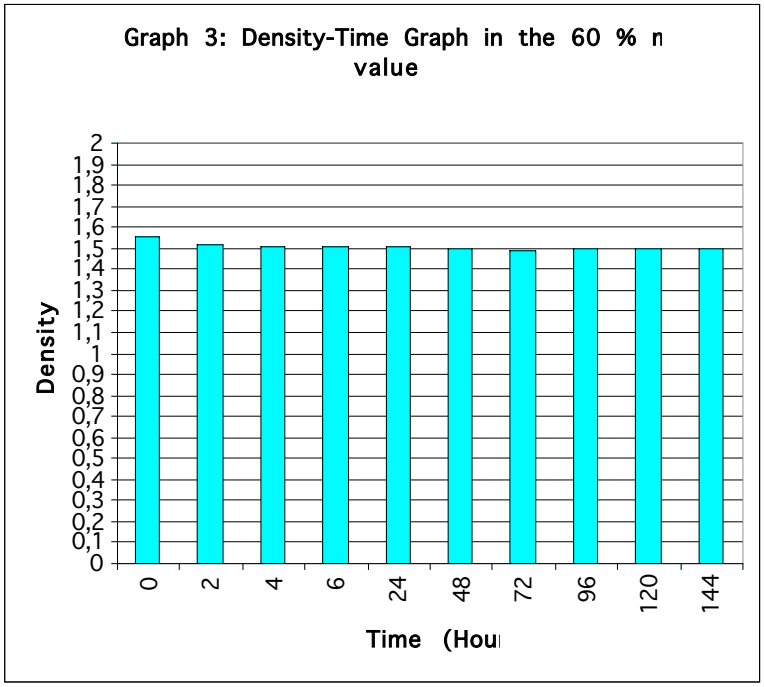
Test prints were performed at 400N constant force, in a wet environment of 50 60 and 70 % moisture with 2 ml black process offset ink on 70 g/m^2 uncoated white paper. Test prints were standed in these moisture environment for three hours before the printing procedure. Test print papers were conditioned with the specified humid environment by standing them for three hours prior to printing procedure. The density and color value measurements of test prints were performed by 48 hours in the values mentioned above. All the measurements after 48 hours were performed in ambient temparatures and in a 60 % humid environment.

The apparatus used and the measurement conditions:
IGT C1 Offset Test Print Apparatus
Gretag Macbeth SpectroEye Spectrophotometer
Gretag D19C reflection densitometer
HI 8064 Thermo-Hygrometer from Hana Instruments
Density Measurement Conditions:
Physical Filter: Pol
White Base:Abs.
Illuminant: D_{65}
Observer Angle:2^o
CIE Lab Measurement Conditions:
Physical Filter:Pol
White Base: Paper
Density Standart:DIN



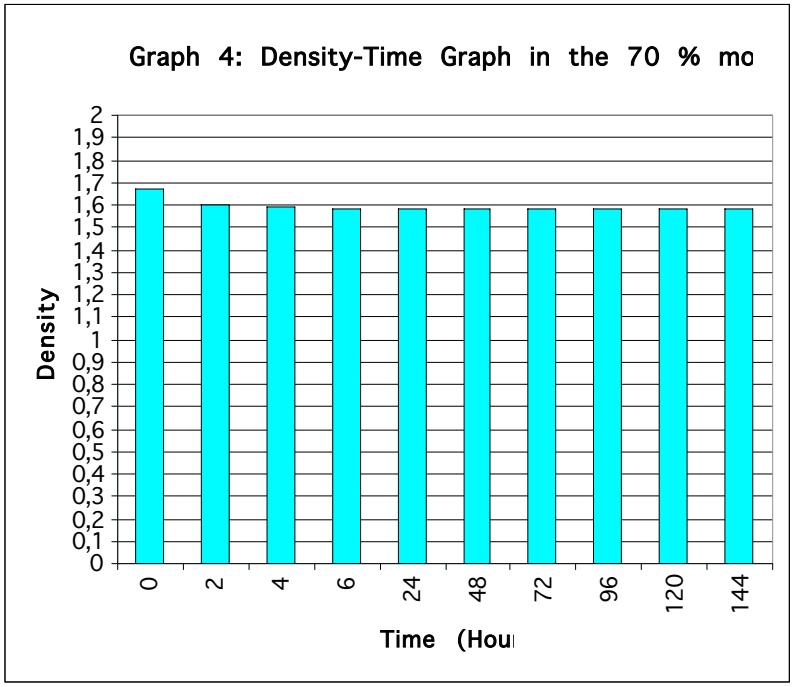
	Relative humidity	L	a	b	Density	Difference
1st measurement	50%	14,28	0,48	-1,11	1,52	0
2nd measurement	50%	15,36	0,51	-0,99	1,51	2
3rd measurement	50%	15,44	0,48	-0,88	1,5	4
4th measurement	50%	15,73	0,48	-1,06	1,5	6
5th measurement	50%	15,8	0,48	-0,87	1,49	24
6th measurement	60%	15,88	0,49	-0,83	1,48	48
7th measurement	60%	16,01	0,49	-0,91	1,47	72
8th measurement	60%	16,28	0,45	-0,87	1,47	96
9th measurement	60%	16,67	0,5	-0,95	1,46	120
10th measurement	60%	17,1	0,53	-1,23	1,45	144

Table 1: The density and L*a*b* values depending on time in a 50 % humidity environment



	Relative humidity	L	a	b	Density	Difference
1st measurement	60%	17	0,43	-1	1,55	0
2nd measurement	60%	17,09	0,52	-0,99	1,52	2
3rd measurement	60%	17,51	0,49	-1,03	1,51	4
4th measurement	60%	17,53	0,59	-1,13	1,51	6
5th measurement	60%	17,66	0,58	-1,12	1,51	24
6th measurement	60%	17,87	0,6	-1,1	1,5	48
7th measurement	60%	18,02	0,57	-1,07	1,49	72
8th measurement	60%	18,12	0,6	-1,03	1,5	96
9th measurement	60%	18,1	0,54	-0,98	1,5	120
10th measurement	60%	18	0,52	-1,02	1,5	144

Table 2: The density and L*a*b* values depending on time in a 60 % humidity environment



	Relative humidity	L	a	b	Density	Difference
1st measurement	70%	15,35	0,43	-0,96	1,67	0
2nd measurement	70%	15,32	0,53	-1,09	1,6	2
3rd measurement	70%	15,52	0,44	-0,9	1,59	4
4th measurement	70%	15,81	0,51	-0,99	1,58	6
5th measurement	70%	15,79	0,44	-0,96	1,58	24
6th measurement	60%	15,71	0,43	-0,93	1,58	48
7th measurement	60%	15,81	0,42	-0,81	1,58	72
8th measurement	60%	15,81	0,47	-0,87	1,58	96
9th measurement	60%	15,61	0,44	-0,78	1,58	120
10th measurement	60%	15,65	0,55	-0,89	1,58	144

Table 3: The density and L*a*b* values depending on time in a 70 % humidity environment

IV. Results and Discussions

- Oil based inks are dried by absorption on white paper as an example of a porous substrate. The total solidification of this type of inks sometimes takes one week. Therefore, the densitometric measurements were performed for 144 hours until the ink completely solidify. The densitometric measurements of these prints were taken at 50, 60 and 70 % humidities being the humidity conditions in which they were previously printed. Then, the densitometric changes of test prints between 48-144 hours were established in their final usage conditions (Graphs 2, 3, 4 and tables 1, 2, 3).

- Following measurements, the mean densitometric value of black ink printing of 48 hours in 50 % humidity was found to be 1.59 (Table 1). However, the standard value of black colour printed on uncoated white paper in DIN norm is 1.55. The deviation between these two values is 3.2 % and it is in tolerance values.

- In the measurements carried out in 60 and 70 % humidity values, the deviations are 1.93 and 3.1 % respectively (table 2 and 3) and these values are also in standard values.

- According to these data, there is no any unaccepted effect of 50 % and 70 % humidity values according to 60 % humidity value which is an optimum press room humidity value.

- The L*, a*, b* value measurements for black ink were performed in the above conditions (Table 1, 2 and 3). However, a comment could be done only for the L value since this value is a parameter corresponding to lightness value of the colour.

- The deviation rate of L value is much more high in 50 % compared to 60 and 70 %. Then, it was established that the optimum L value has to be fixed in between 60-70 % moisture values.

V. References

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