

Topics for the Fulfillment by Inkjet Materials of Permanence Requirements for Digital Printing

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1. Abstract

In Europe the standardization-body CEN TC 172 has set up a Working Group for inkjet paper. An important task of this group is to specify and test inkjet consumables for permanence requirements. Light-fastness, water-fastness, smearing resistance and waviness are the important points for a new European Standard. This new standard should establish guidelines for inkjet-prints to be used as photographic prints and also for packaging, especially label printing. The test methods used will be discussed and also results of investigations of light-fastness and water-fastness will be pointed out. Limits will be specified for requirements, which are good enough to permit the use of the inkjet prints for labels and as replacement for photographic prints.

The main factors of this investigation are related to inks, paper and different inkjet technologies.

2. Standardization Situation in Europe

CEN/ TC 172/WG6 formed a working group for "Ink Jet Printing" in October 1998 and a scope for this group was presented:

To propose standards for testing paper printability and print quality using different printing processes like dry toner imaging and ink jet printing. After discussion about the needs for ink jet printing finally three main topics of interest were defined.

- print quality
- drying time
- permanence

In the next group meeting in May 1999 following questions were raised:

1. Who would be the users of these test methods?
2. Is there a bulk market for ink jet papers?
3. Is there enough knowledge available?
4. Is it really possible to develop test methods for measuring paper characteristics without referring to a standard printer?

After a long discussion, the group agreed that there was definitely a need for developing test methods for ink jet printing. Also the group stated that such methods would make a dialogue between customers and suppliers much

easier and that for some properties, standard methods already exist.

As a matter of fact, the aim of test methods should not be to assess the quality of a given paper but to help assessing the performances of a combination of a printer, an ink and a paper in a given configuration.

The working group made a list of test methods that could be of interest for each topic.

- **Printability**
- offset method
- smudge
- drytime
- waviness
- **Print Quality**
- mottle
- edge sharpness
- color variation
- ink bleed
- print through
- color density
- print gloss
- **Permanence**
- Artificial aging
- Light fastness- light fading
- Wet elongation of paper

Out of the listed methods the group decided that following methods are the most interesting one to measure:

- drying time
- waviness
- color variations
- permanence in term of artificial aging
- light fastness

Therefore a new work item in CEN/TC 172 was recommended:

CEN/TC 172/WG6 recommends to develop new test methods or adapt existing ones for drying time, waviness, color variations, artificial aging and light fastness, with the disclaimer that, to compare results from different tests printer, ink and configuration must be matched.

3. Permanence Investigations

Permanence is one of the key factors for ink jet technologies especially in the large format business and also

for photographic prints and display objects. The most systems are using water based inks.

One permanence test was carried out with HP560C and Epson Stylus 800 and as paper samples 2 copying papers were used, 2 Ink Jet papers, matt and 2 ink jet papers, glossy.

The test procedure was developed as follows:

- Printing of solid areas on samples, the color density was measured
- Printed area was brought in contact with deionized water surface in a vessel
- Contact time 10 seconds/or 60 seconds
- Sample taken out of the water and put between two sheets of board
- Metal roll used for Cobb Unger test is rolled 2 times across the samples between the boardsheets
- Sample is taken out and air-dried for one day
- Color density then measured with a Macbeth color Densitometer
- Test was carried out at a standardized climate (23°C/ 50% RH)

Results

Test tables can be seen in an appendix. There is a good correlation between visual judging and the measured values for copying paper and matt ink jet paper for glossy paper this method is not very sufficient.

Another method is the measurement of the wet elongation of paper for characterizing the structural change in the paper due to contact with water based ink jet inks. The measurement were carried out on a WSD-equipment and as testing liquid also deionized water was used also suitable for ink jet inks.. As load 25N/m were used and the paper was brought in contact with the testing liquid only from one side. Waviness could be recognized for copying paper very strongly ,matt ink jet papers for the use of one side showed less strong waviness ink jet papers for use on both sides almost no visible waviness and glossy ink jet paper for use on one side only showed no waviness at all.

For artificial aging the dry oven method 100°C could be recommended and the optical density should be measured before and after aging. 24 h artificial aging should not give more than 0,5 units density changes- changes could be darker or lighter density values.

For light fastness the ISO CD 14358 Part 1 and Part 2 could be used and the results have to be selected in the right way for ink jet based on the knowledge of the intended use of the print samples.

4. Overall Permanence Considerations Using Ink Jet Systems

For the printing process following marking elements are very important:

Storage & Delivery of ink
Addressing of pixels

Transfer of ink to print medium

Fixing of ink on print medium

For permanence following parameters are important:

In storage: Usable quantity
Pressure regulation
Ink level sensing
Material compatibility

For fixing: Optical density
Dot size and dot shape
Color bleed
Ink chemistry
Media chemistry
Drying

Mainly with inks you can differ between high- gamut dye based inks and high-durability pigment inks. Mainly automatic, intermittent refill systems, self pumping is used and normally a kit is consisting of the printhead, ink cartridge and cleaner. And a sap to different ink systems is easy possible. A very important role in transfer of inks is also the droplet size especially for image quality but also for permanence. Sizes from 300pl to 12 pl are common. A picoliter is 1/1 000 000 000 000 liter.

For Fixing a chemical and physical interaction with the paper takes place as mentioned a lot of parameters are very important for permanence.

For the fixing process a stable, solvated colorant is necessary after making contact with paper wetting and kinematic spread takes place. Following interactions are responsible for quality:

Cellulose hydration.....cockle
Diffusion, solubility changes, solvent separation.....spot size, optical density strike through
Surface capillary flow.....feathering, color bleeding
Solvent loss, interdiffusion.....drying

If you are looking for good durability results, UV-durable solutions are needed for advertising, retail photography and graphic arts to produce posters, displays billboards. Therefore two different ink systems a mentioned are available pigment based and dye based.

From suppliers following permanence datas are given and could be proved also with laboratory tests:

Pigmented Inks

3 months on Tyvek outdoor
1 year in a window on heavyweight coated paper
2 years outdoors- 3M MCS media
• 100 years indoor on heavyweight coated paper
• 150 years Legion Waterford DI Paper

Dye- Based Inks:

6 years indoor high gloss photo paper
5 years heavyweight coated paper

For indoor display the typical indoor conditions are 450 lux 12 hours a day before noticeable fading occurs.

Ink systems have to be formulated for UV pigment-based in cyan, yellow, magenta and black for exceptional fade resistance, providing outdoor durability up to 2 years on certain media. The system approach involves chemistry of the ink vehicle and colorants, design of the printhead, ink delivery system, service station, print mode and media. The limitation for applying ink on paper allows some solvent to evaporate between passes and minimize the opportunity for ink to flow between adjacent wet pixels and eliminates therefore cockle and color bleed.

Summary

To maximize water and lightfastness the limits of water-based ink technology has to be extended in sense of advanced molecular structures and allowing use of water-insoluble colorants. Also all paper products, especially the coatings should be free of optical brighteners. To get optimal results the media used for ink jet printing should be tested for a maximum print permanence to find the best ink and media combination for a special ink jet printer.

Color graphs will be distributed during my oral presentation.