

Printing Processes And Their Demand On Coated Paper As A Substrate. A Case Study. Influence Of Coating Weight Thickness Variation On The Print Evenness.

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ABSTRACT

This is an overview on different printing processes and their demand on coated paper (substrate) to achieve best print quality. All the printers stress more on print evenness as one of the key parameter of quality printing. To understand coated paper as a substrate in offset printing, a study was carried out by varying coat weight/thickness influences on print evenness, i.e. Double coated matt board (board 1), Triple coated Matt board (board 2).

The term print evenness is an important attribute of offset printing. This depends on uniform ink transfer to the paper and controlled spread of ink (in case of dots it is called dot gain.)

In consideration of this, we have studied the influence of different coat weight/thickness on the print evenness by printing two different coat gsm/thickness boards in sheet offset printing. As a result we found that lower coating thickness board showed print unevenness in comparison with highly coated board. We have confirmed these results with the help of SEM observations of coated board cross sections.

In addition, we found that print evenness is a result of back trap mottling and which is a effect of base paper formation, type of coating application and total coating gsm/thickness applied on base paper.

INTRODUCTION

There are five main types of printing processes (Litho, offset, Gravure, Flexo, screen and digital), and Offset printing is the dominant printing process in paper and paperboard applications. Offset is a planographic printing process with image and non-image areas on the same plane, in which oil based paste type of ink is applied on paper via a rubber blanket surface in the form of binary transfer, i.e. ink or no ink. In case of pictures this takes the form of tiny dots to create the impression of a photograph. The print image sharpness and image clarity depends on controlled ink transfer to the paper with no excessive spread of ink (in case of dots it is called dot gain) by the paper surface and/or coating thickness and its uniformity. Hence one of the main reasons why triple coated papers are preferred by Art printers than low coated papers.

Print evenness depends on ink splitting pattern in multicolour printing machines. The print evenness or unevenness is more pronounced in the halftone areas where two or more primary colour dots are combined to form secondary or tertiary colours.

A controlled ink spread (called dot gain in case of halftone) is a key factor in offset printing, simultaneously back

trap mottling is an important issue in multicolour offset printing. Coating thickness, coating thickness uniformity and coating formulations are the major key factors affecting these.

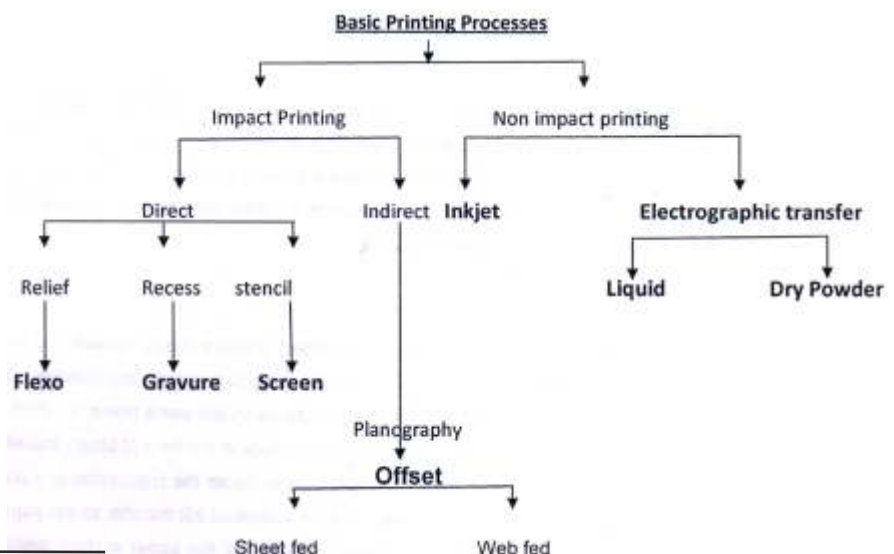
Introduction of Printing

Printing is a process in which multiple copies of the same image are made at a very high speed. The printed images of high quality are perceived and enjoyed by us through our visual sensation, i.e.

eyes. All printing products produced using all the modern technology and its science are ultimately enjoyed by us through our visual sensation.

History:

Earliest known attempts to produce printing is more than 30,000 years old, perfected by the Egyptian around 2500 B C. Printing from movable type made from hardened clay was practiced by



Printing market scenario:

Market share in Europe

Market developments in the USA by value

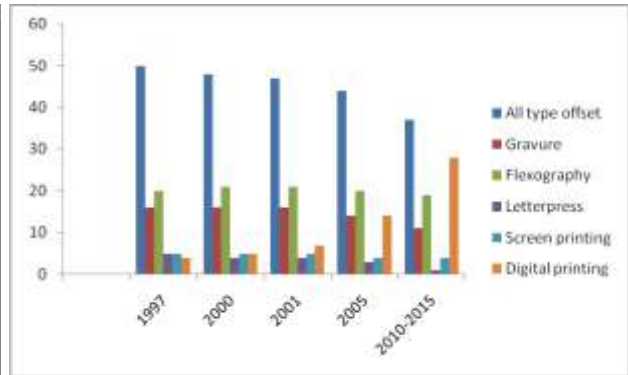
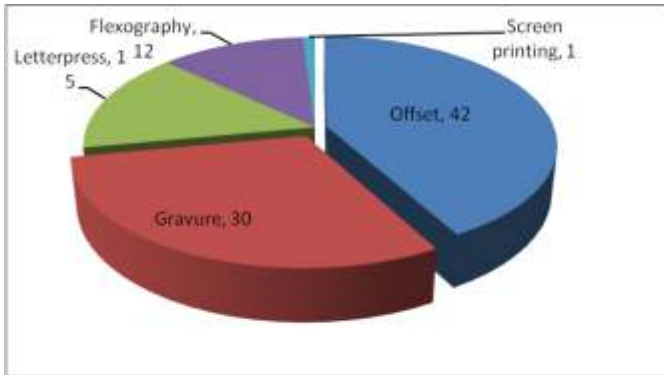


Fig.1

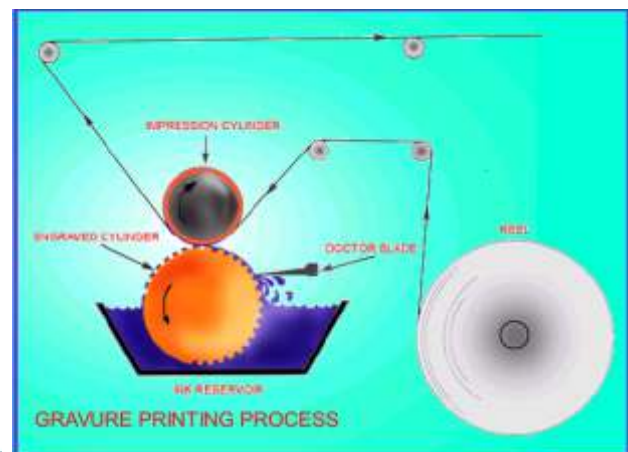
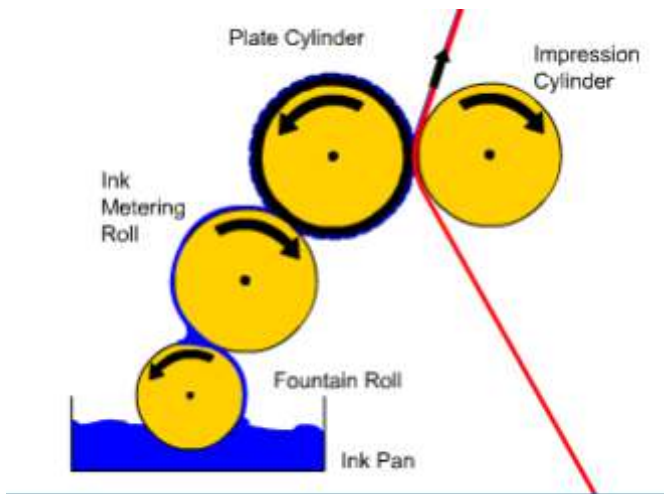


Fig.2

Fig.3

Chinese in the 11th century and Johannes Gutenberg introduced printing ink on paper using movable metal type in 1445.

Observations :

The volume of print orders for commercial printing (number of copies) is shrinking, whilst the multiple copies with variable information or personalized information is growing. The manufacturers of printing machines offer solutions to reduce makeready times, increase flexibility to add value to printed product, such as coating, varnishing, etc. with increase in production speed and reduced wastage. Digital print market is staging a growth, but since the technology at present is limited to relatively small size sheets the principal demand is for small size jobs and, therefore, the increase paper volume not significantly

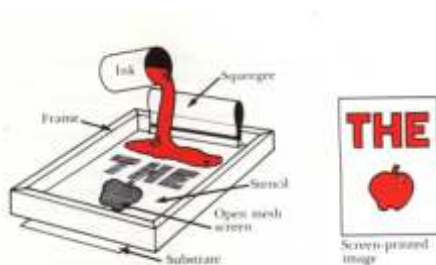


Fig.4



striking.
Printing processes and its demand on substrate :

a) Flexography : Direct rotary printing using flexible relief image printing plates and rapid drying fluid inks on a variety of substrates, absorbent or non-absorbent. Major substrates used in flexo printing are mainly polyethylene in various

forms and paper to some extent. Good ink adhesion, good ink absorbency, fast ink drying and water resistance coating for water based flexo inks are the important paper characteristics.

b) Gravure : Gravure is a printing process where image is chemically etched or engraved below the copper surface and ink is metered by doctor blade. Gravure is mainly used in

packaging (variety of plastics and foils) and publications (paper) printing. Smoothness, compressibility, and consistent moisture content of paper are the important characteristics.

c)Screen : It is the most versatile printing process for transferring ink and coating on any type and shape of the substrate. The image carrier is a stencil attached to the mesh that consists of open areas to enable ink to pass through and opaque areas made up of mesh material. The ink is forced through the

mesh opening and open areas of the stencil is transferred on substrate.

d) Digital Printing : It is the reproduction of images to be printed on a substrate directly from the computer. It is generally used for short print runs, and for the variable and personalized printing. There are broadly two variations of digital printing. Ink jet and electrographic. Both the methods have different demands on substrate. Electrographic process can be a dry powder or liquid toner based.

Future of printing Industry, Asia market is fastest growing market.

Size is limited at present ie.A3. This technique is economical up to 500 copies.

Cost is higher than offset for copies over 500 but economical below this quantity.

Variety of substrate can be printed depending on the type of digital printing machine, e.g. Plastic, coated and uncoated paper, PVC etc.

e)Offset printing : Offset printing is a commonly used printing technique where the inked image is transferred (or "offset") from a plate to a rubber

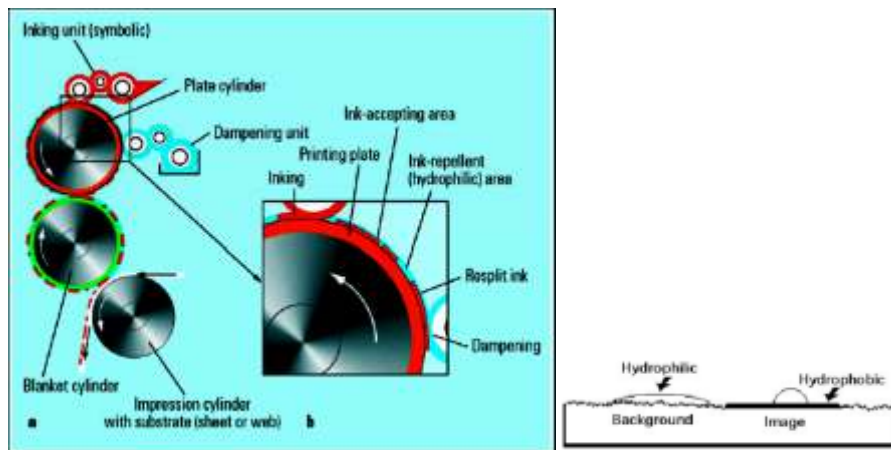
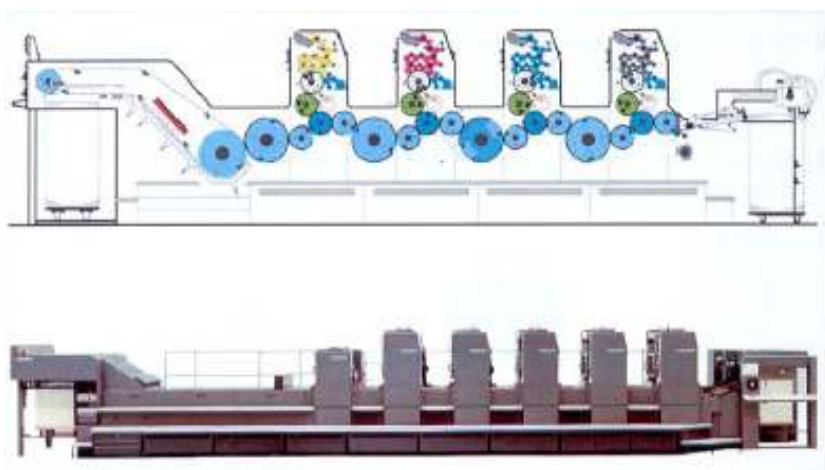
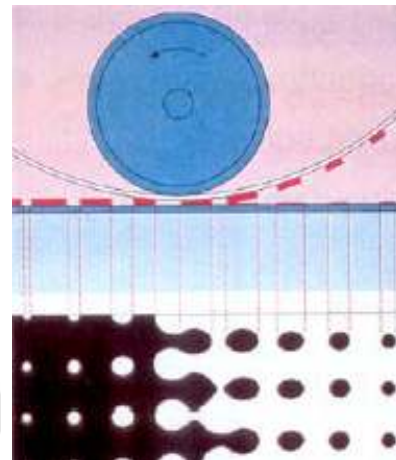
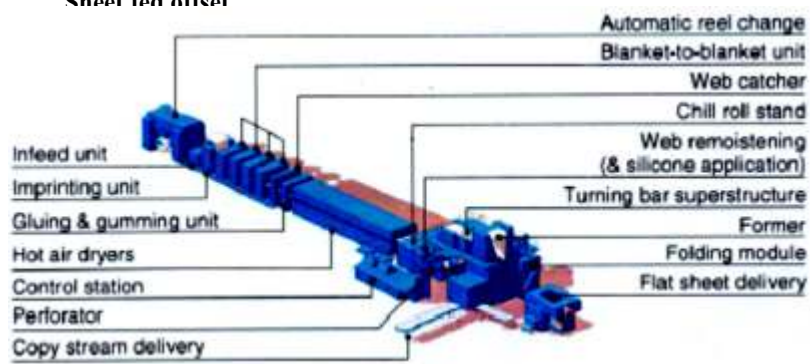


Fig.5



Sheet fed offset



Web fed offset

Fig.6

blanket and then to the printing surface. It is a lithographic process based on the repulsion of oil and water. The offset technique employs a plane (image and non-image areas on same level) image carrier on which the image to be printed takes ink from inking rollers, while the non-printing area pick-up a water-based film (called "fountain solution"), keeping it ink-free.

The fountain solution keeps the non-image areas of the plate moistened so that they do not accept ink. It is based on the principle that ink(oil) & water do not mix.

Offset printing can be Sheet fed offset or web fed offset printing.

Web fed offset

In both the methods printing mechanism is the same. But paper feeding and delivery of printed paper is different. Actual printing mechanism is same, however unlike sheet fed printing, many of the web fed machines print both sides of the paper through the same set of cylinders, blanket-to-blanket.

Demands on substrate (paper): Fig.8 explains sheet fed offset and web fed offset requirements on paper. For sheet offset Bonding capacity, ink

Fig.7

Demands on substrate (paper):

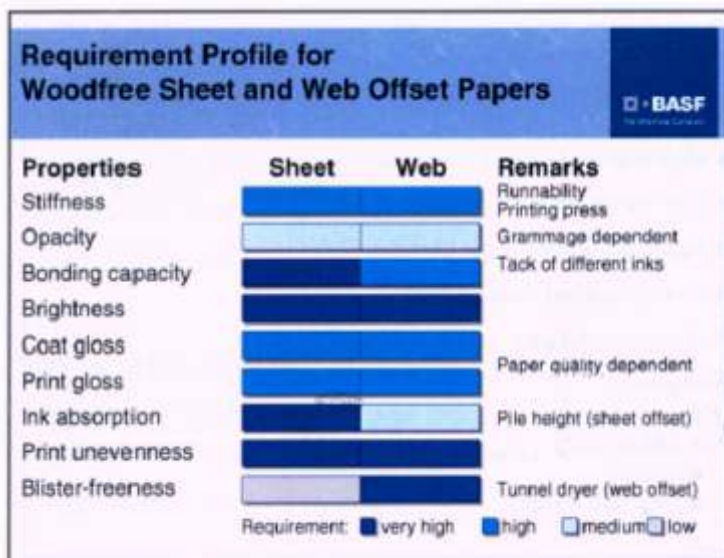


Fig.8

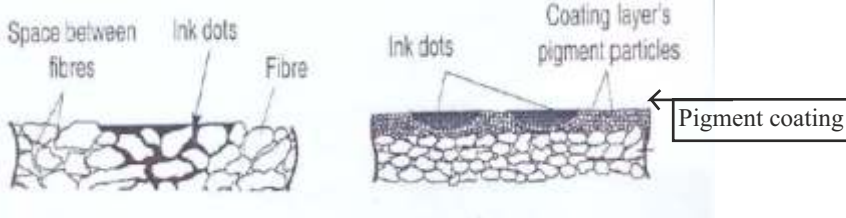


Fig.9 Maplitho paper

Coated paper

absorption, print evenness and brightness are the key characteristics of paper, where blister freeness, print evenness and brightness are the key characteristics of paper.

The faithful dot reproduction(print quality) depends on following conditions:

- a. Type of Blanket- Compressible and Conventional. Compressible distorts less, thus less dot gain.
- b. Roller condition- Worn out rollers may result in uneven distribution of ink.
- c. Pressure Settings- Heavy pressure results in more dot spreading, thus higher dot gain.
- d. Machine Speed- Higher machine speeds results in lower dot gain.
- e. Paper coating thickness and its surface uniformity (Fig.no.9)

2. Case study of coating thickness variation and print evenness relationship.

History Feedback from market, that brown patch is not printing well on board 1

Analysis : Lot history checked for quality/production data, but everything is normal, hence decided to reprint the

Comparison of Matt board no. 1 & no. 2:

	No.1	No.2
Gsm	250	250
PPS (microns)	2.5	2.0
ISO Gloss at 75 angle	54-58	30-35
Coatweight/side	30	45

halftone combination patch, which is very sensitive to dot gain and resulted into unevenness (mottling) and ink roller bands - mainly due to uncontrolled inking unit (Manual operations).

Step 3- Decided to take same trial on Auto inking (CPC) printing machine and with two different Matt boards with different coat thickness (Board 1 and Board 2)

Conclusion : Print evenness is very good in matt board no. 2 and unevenness observed in matt board no. 1

Step 4- To understand the difference in print quality samples send for SEM analysis at Ciba (China).

Observation : Print evenness/unevenness difference is mainly because of coating thickness and its uniformity difference. I.e. Ink dot spread in vertical and horizontal direction was controlled by higher coating thickness in Matt board 2.

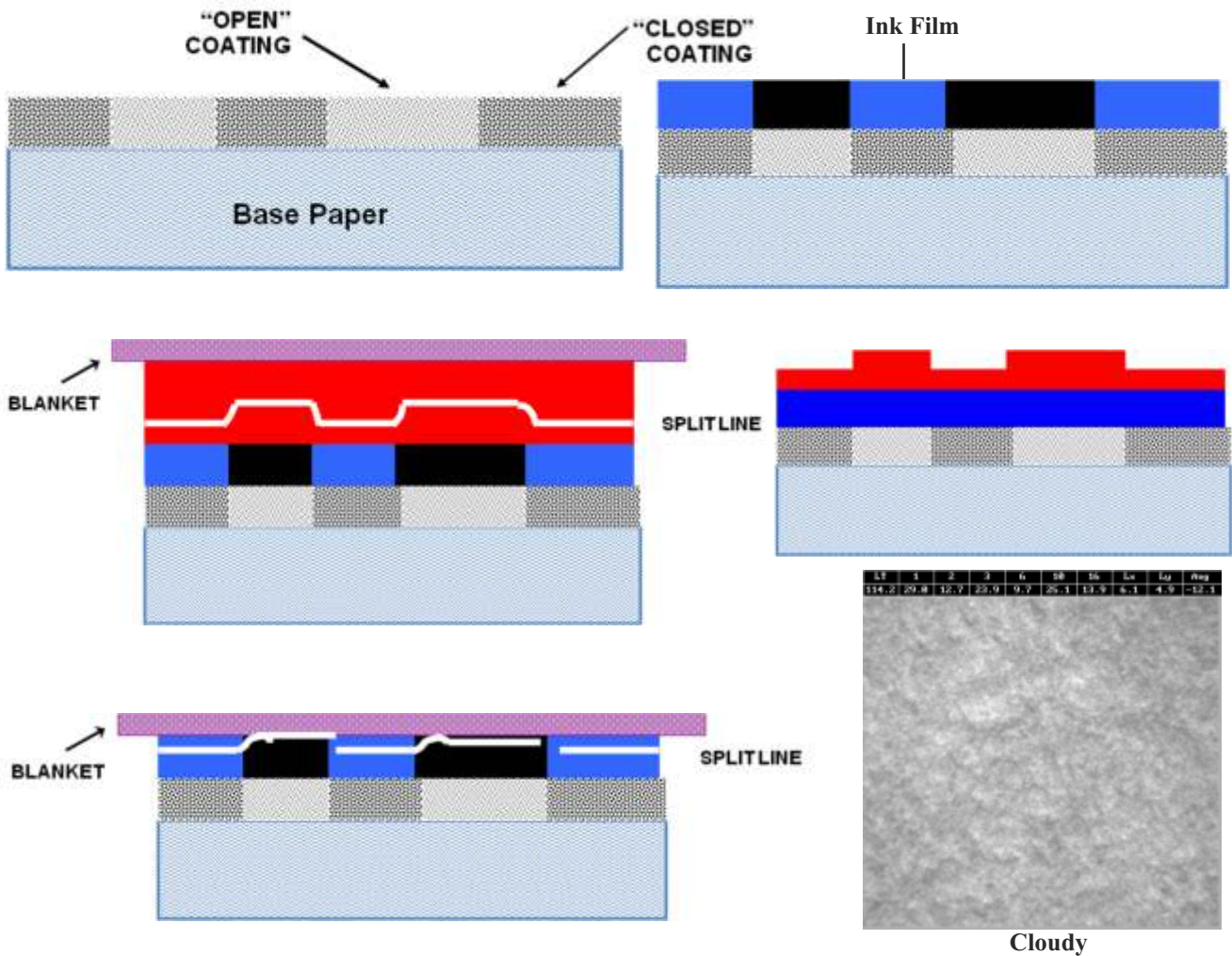
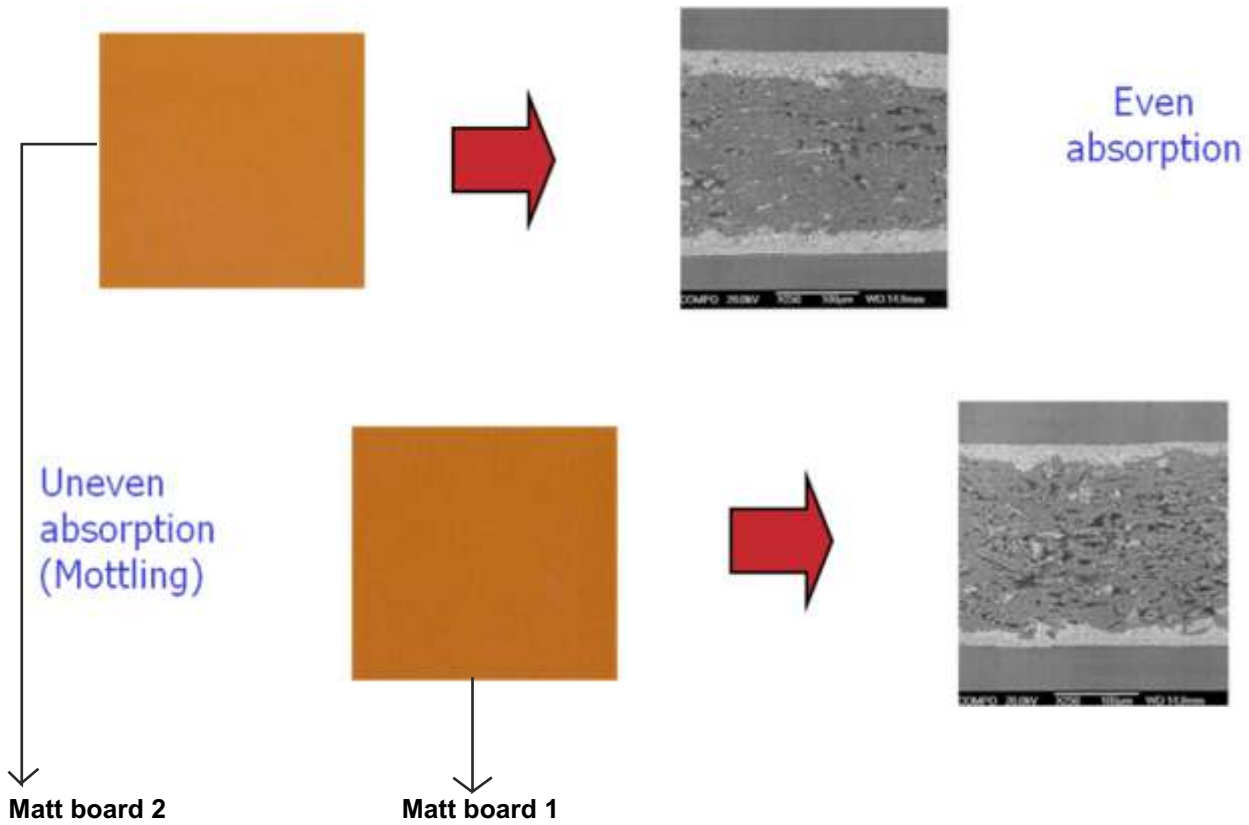
Press Trial

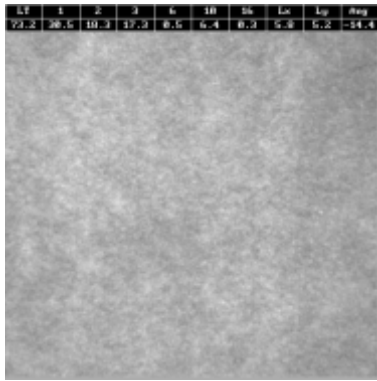
The printing was carried out on 2 sets of board on 4 color Mitsubishi. The papers which were used for the press trials were Matt board 250gsm no.1 and no.2.

Experiment Conditions

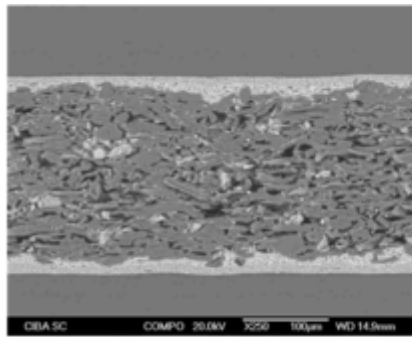
3. Press details

Machine	4 colour Mitsubishi
Machine Size	600 mm × 730 mm
Machine Speed	8000 iph
Plates	CTP 200 lpi
Plate Size	600 mm × 730 mm
Fountain Solution	8% IPA
Press Room Temperature	23 degree Celsius
Sequence of colours	K, C, M, Y.

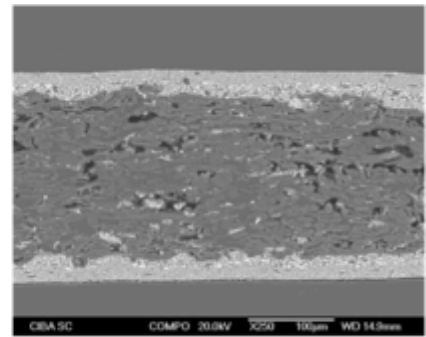




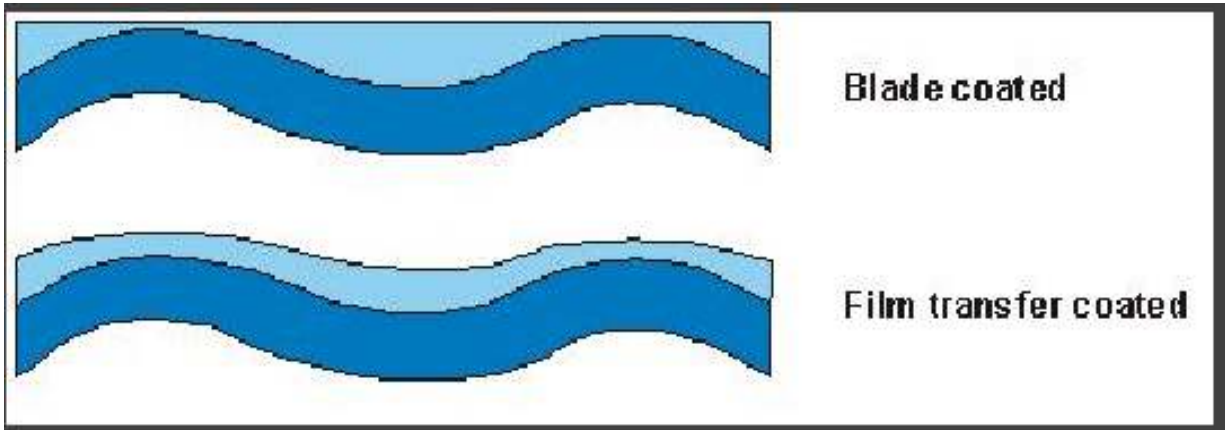
Uniform



Matt board no.1



Matt board no.2



Blade coated

Film transfer coated

1. Target Ink Densities:

Cyan: 1.47 Magenta: 1.54
Yellow: 1.1 Black: 1.7

2. Ink Used- Sicpa

3. Brown patch percentage : C,M,Y,K :
39,73,100,13 and 30,60,100,10 resp.

Printing results :

- Visual Print evenness is very good in Matt board no.2 and mottling observed in Matt board no.1
- SEM analysis at Ciba (China) 75X/250X/5000X magnification:

Observation :

Coating thickness and coating evenness of Matt board 2 shows better print evenness than Matt board no.1.

This is a backtrap mottling happened during printing with Matt board no.1, where coating thickness was not enough and uniform to control the ink dot splitting.

Backtrap mottling mechanism

- Coated Paper : (Surface influenced by base paper formation)
- Printing in first unit : (Ink solvent is immediately absorbed by the coating, but irregularly and followed by uneven ink receptivity of the coating. On open areas, the

- ink film may be thinner and tacky.
- If an image area follows on the subsequent unit, the theoretical 50/50 split will occur within inks of similar tacks.
- Lower optical density in closed coating areas.
- If a non image area follows on the subsequent unit, a secondary ink transfer can occur onto the blanket.
- Lower optical density in closed coating areas. The ink transferred to the blanket may then be retransferred to a closed coating area of the following sheet.

Above all steps resulted into a mottled image in four colour printing.

To solve this problem following steps are important.

- Uniform base sheet formation- for uniform coating application and even binder/functional additive migration, which creates open and closed coatings.
- On the other hand coating thickness (coat weight) increase will minimize the base paper influence on final coating
- Also size press coating provides even coating film on base paper and which reduces unevenness of final

coating thickness, which will be applied by blade coater.

Conclusion:

Uneven formation of base paper and the lower coat weight/thickness resulted into back trap mottling which disturb print evenness. However, it is possible to overcome uneven base paper formation and uneven pre-coat application limitations by applying higher gsm/thickness of top-coating.

References

- BASF coating and printing seminar 2007 manual.
- Heidelberger Druckmaschinen AG, Expert Guide, An Introduction to Screening Technology, 2002