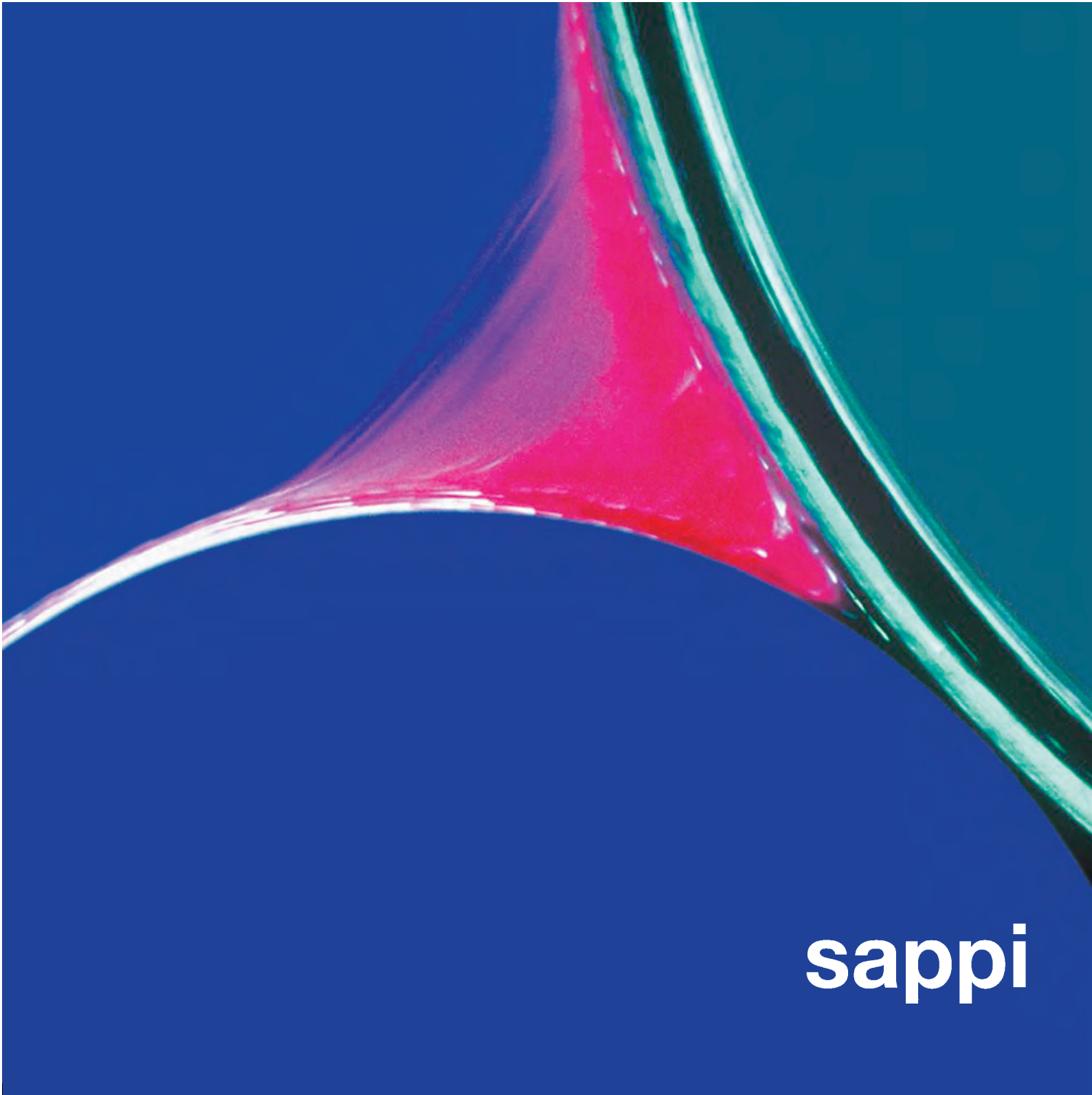


# Mottling – Mottled impression



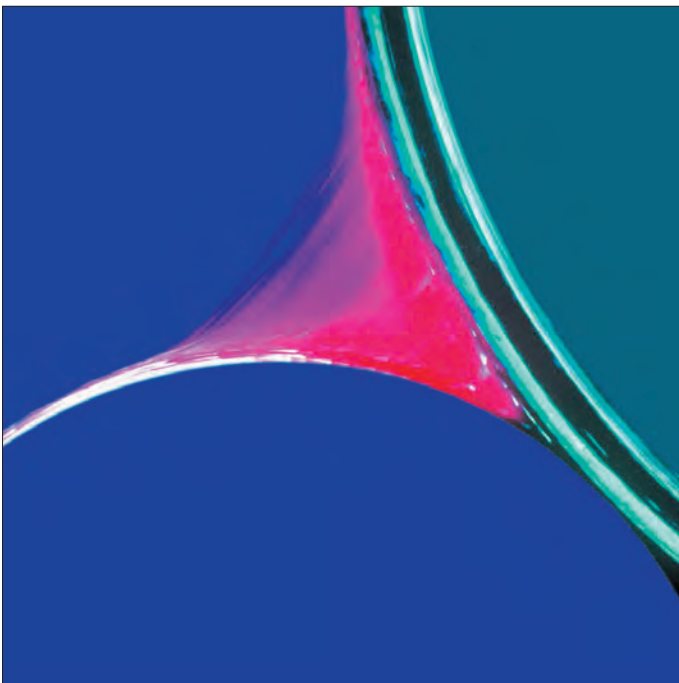
sappi



# Mottling – Mottled impression

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## I Introduction

Today, four colour printing is a routine part of the printing industry's repertoire – a process which most printing firms are very comfortable with.

But when longer presses are used or when perfecting techniques are applied, a more detailed insight into the technical aspects of the process is called for.

When processing large numbers of spot colours the technical demands increase steeply. Here frequent ink splitting can easily lead to mottling and uneven solids. The interactions between the various components – such as paper, ink, fountain solution and printing blankets makes the process increasingly difficult to master.

The demands made of print and paper quality have increased correspondingly. Faults in the printed image such as the blotchy or uneven impression of the sky (Fig.1) fail to meet our demand for quality and we expect a uniform and even impression (Fig. 2).

We have known of the problem of faults in the printed image in offset printing for years. Internationally it is known as mottling referring to terms such as marbled, speckled or blotchy. In this brochure we will restrict our use to the term "Mottling".

With this brochure we want to bring clarity to the subject. In doing so it is important to highlight the differences between the individual types of mottling. This makes it easier to recognise the causes of mottling and, if possible, to get help on site.



Fig. 1



Fig. 2

## II The Printing Process

### Perfect printing requires perfect alignment of paper, ink, fountain solution and press.

The research carried out clearly indicates intensive interactions between the major components involved in the printing process. Optimisation of just one of the individual components does not necessarily produce the desired end result. It is the correct balance of the mutual interactions between the components which is needed for an optimization of the entire printing process that actually produces measurable improvement.

#### Test series

To reach a clearer understanding of the total printing process in all its complexity, Heidelberger Druckmaschinen AG, Flint Group, BASF AG and Sappi Fine Paper Europe conducted extensive tests to investigate the individual components and their interactions.

Using inks with different colour intensity, rheology, drying characteristics and fountain solutions with differing emulsifying properties, the test series consisted of a combination of commercially available off-the shelf inks and specially produced test inks.

Beyond this additional press parameters such as inking, dampening solution dosage and pressure were extensively varied and evaluated.

## Test results

Based on the new insight into the process resulting from this work, individual components were developed further along controlled and targeted guidelines.

Their optimum combination gave measurably improved results on a number of important issues.

- Ink setting
  - Mottling
  - Evenness of solids
  - Two-sidedness on the perfecting press
  - Dimensional stability throughout the whole process
- The most important variables were determined (Fig. 3).

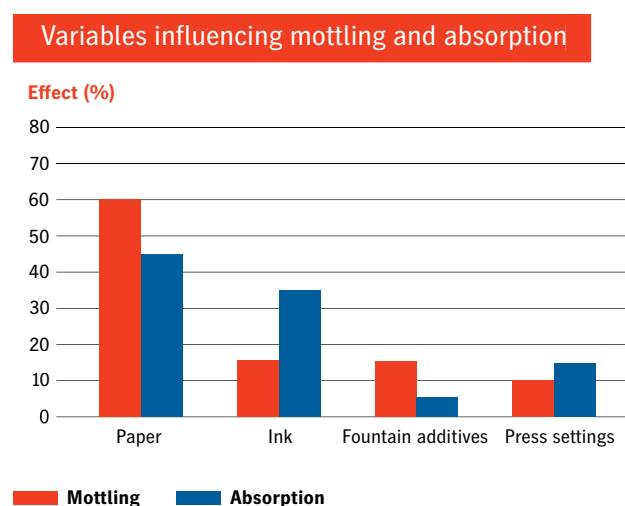


Fig. 3

1. **Black unit**
2. **Cyan unit, back-split 1 x**
3. **Magenta unit, back-split 2 x**

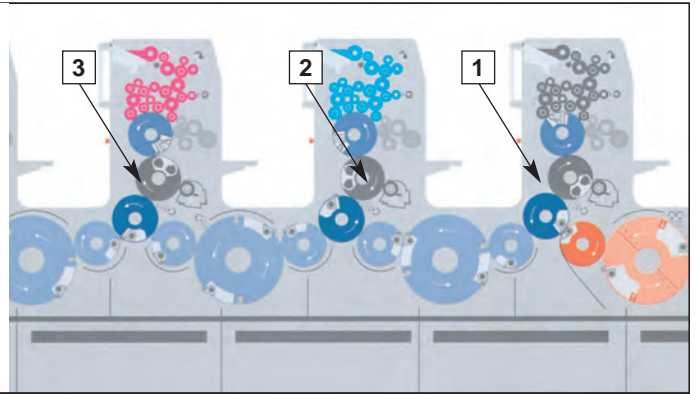


Fig. 4

### III Backtrap Mottling

Backtrap mottling is most frequently seen in the ink printed in the first or second printing unit of a multi-colour offset printing press.

The cause lies in a partially variable absorption of ink into the paper. The partially variable immobilisation of the ink leads to a variable splitting of the ink on the following blankets. (Fig. 4)

An uneven (thicker/thinner in various areas) ink film remains on the paper surface, which the human eye sees as mottled.

The partially variable ink absorption is configured differently on each of the following sheets, as a result of which the mottling effect increases rather than diminishes as experience shows.



Fig. 5

Fig.5-printed on unit 2 and back-split four times

Fig.6-printed on unit 2 without back-split

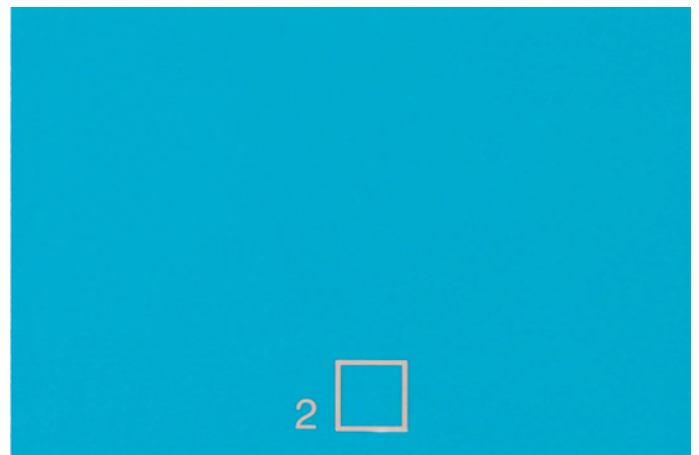


Fig. 6

Backtrap mottling can be triggered by an uneven formation as early as in the base-paper stage and/or by a binding agent migration in the applied coating.

Fig.7 shows a cross-section of paper with a partially variable distribution on pulp and coating, which can cause mottling.

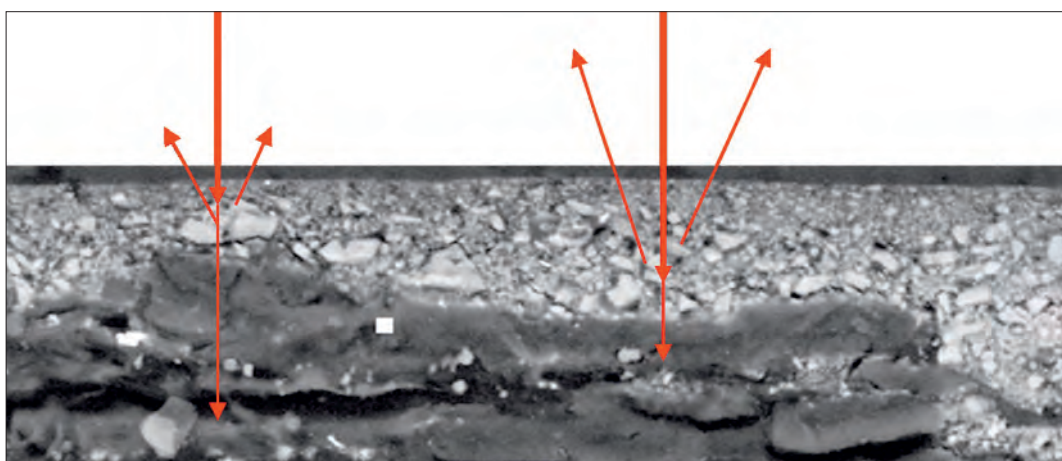


Fig. 7

Base Paper

Coating

## Surface energy

### Influence on paper

Another cause for backtrap mottling can be the surface energy on the paper. If this energy is too high it can influence the ink setting in a negative way as shown in the graphic (Fig. 8). 4 papers with different surface energy values.

Analogous to higher surface energy values the results for backtrap mottling on paper 24 and especially on paper 27 were worse (Fig.9).

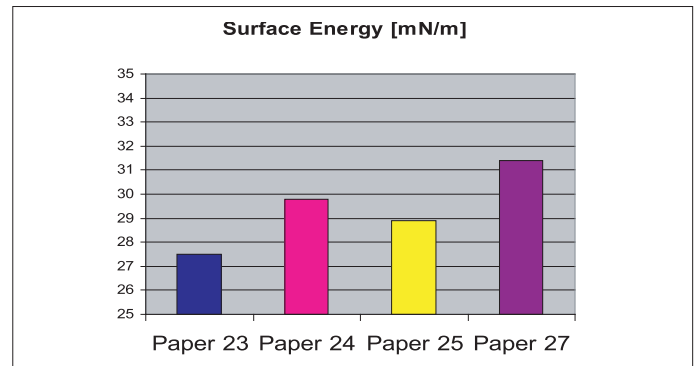


Fig. 8

### Influence on ink

There is a similar situation as far as ink is concerned (Fig. 10).

A higher surface energy value changes the rheology and the tack value (Fig 11+12). Faster ink setting with different tack values does also have an influence on back trap mottling.

**Faster ink setting and faster setting behaviour of the paper usually influences backtrap mottling**

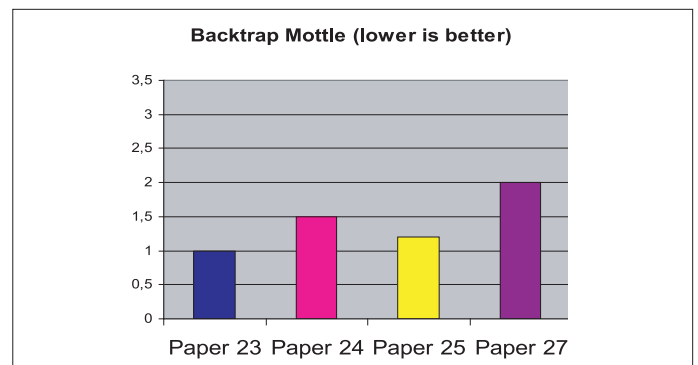


Fig. 9

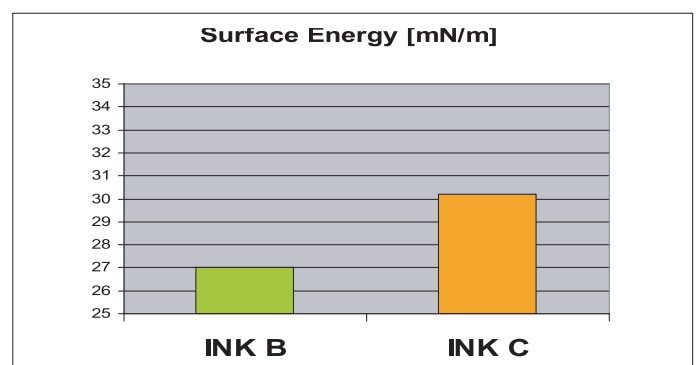


Fig. 10

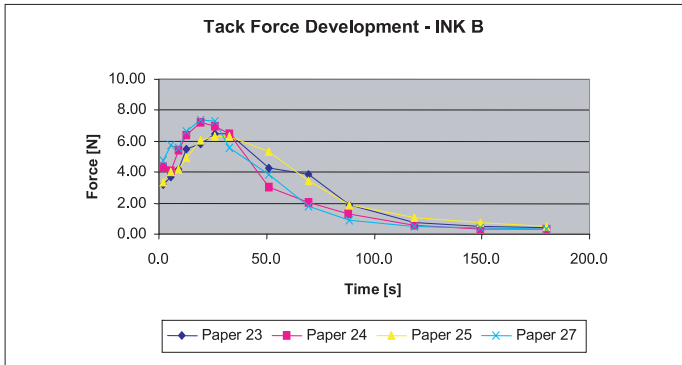


Fig. 11

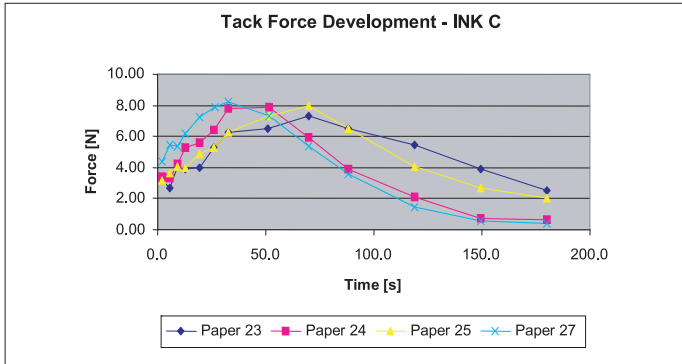


Fig. 12

## Finding the cause for the printer

**Check whether all print and machine settings comply with the standard, if yes:**

Switching off the printing units following the 'problem' unit (where the uneven image is being produced) clearly shows whether backtrap mottling is the cause. If good printing results are seen in the colour affected in the trial, backtrap mottling is very probably the cause.

### Remedy

- The ink affected should be printed as far back as possible, in order to reduce the back-splitting processes to the absolute minimum.
- Test the bottom side of the paper and, if a better result is achieved, use that side providing there are not subjects of equal difficulty and liable to mottling on both sides.
- Use inks with slow absorption
- Use quick-release rubber blankets.
- Replace the paper



## IV Water Interference Mottling (WIF)

The surface of the paper must fully absorb the fountain solution applied in the first printing unit by the time it reaches the next printing unit. If fountain solution is still present on the surface, ink transfer to the paper is hindered in the second or even in subsequent printing units. The impaired ink acceptance, which could almost be termed an “aquaplaning effect”, leads to mottled printing of solids and uneven screens.

The causes of Water Interference Mottling may be technical in nature, to do with the paper or printing. An undesired interaction with the paper can be produced due to a less than optimum formulation of the coating pigments or too dense compaction of the surface. However, similar effects can also be seen in the case of improper ink-water balance, i.e. as a result of wetting being set too high (Figs. 13 + 14).

Where the level of fountain solution is high and/or the ink absorption characteristics of the paper are bad compared with water, the formation of a water film on the surface of the paper causes repulsion of the ink in the following printing unit respectively. This is associated with a reduction in colour intensity and colour saturation.

If these repulsion effects occur with varying degrees of intensity, an uneven print-out can be seen in complete solids and above all in large surface-area screen prints. The screens show slightly uneven sharpness of the dots (Fig. 12) and a reduction of the area covered.

Broken and indistinct screen dots show too much water emulsified in the cyan ink, which lead to a mottled impression. In comparison, the same screen with normal, reduced water supply.

No WIF Mottling

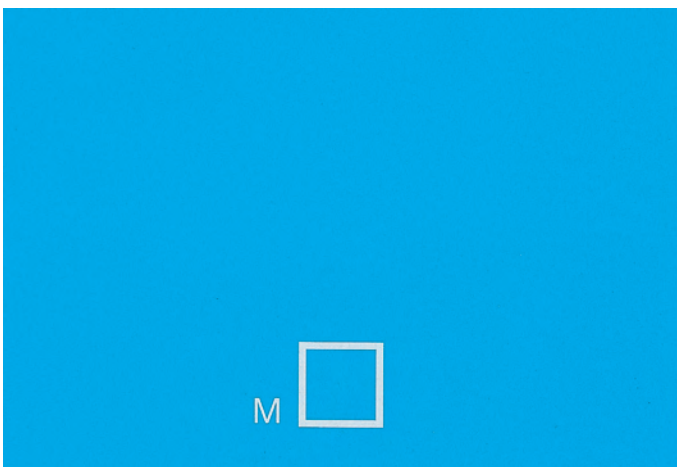


Fig. 13

WIF Mottling

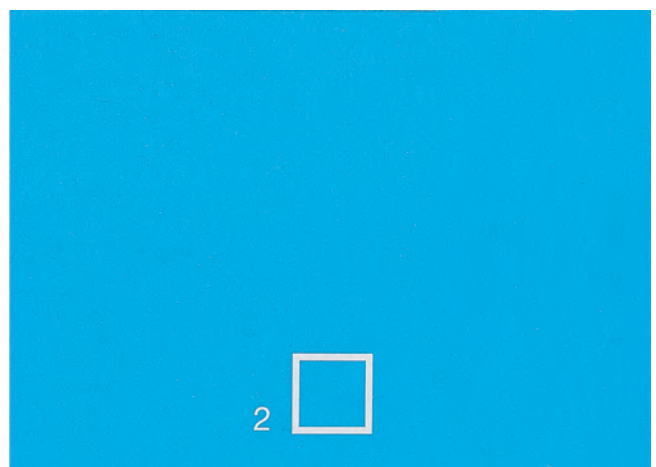


Fig. 14

Compared with Backtrap Mottling, Water Interference Mottling is not so complex, therefore easier to recognise and correct.

The main factors from the paper-manufacturing viewpoint are:

- surface porosity and roughness
- surface chemistry
- the solubility of the surface

Of equal importance as the surface of the paper in the context of Water Interference Mottling is the fountain solution, depending on its quality and the quantity applied. Fountain solution and paper surface are very closely related to each other.

The contact angle of a drop of the fountain solution used is an important parameter in measuring this.

## Influence of the fountain solution

### Surface tension of the fountain solution

Surface tension is the force of contraction between the molecules, which acts within the drop of fountain solution and ensures that the water molecules remain bonded to each other.

### Contact Angle

If a drop of fluid is applied to a solid material an angle, known as the wetting or contact angle (Fig. 10), is formed between the drop and the solid (surface of the paper).

Fountain solutions with high surface tension have a larger contact angle, penetrate more slowly into the surface of the paper and can therefore encourage Water Interference Mottling.

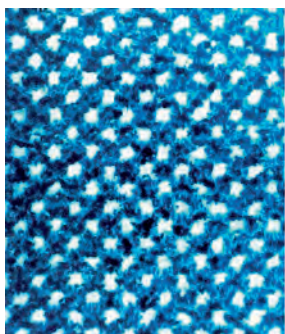


Fig. 15

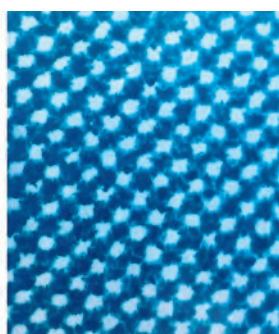


Fig. 16

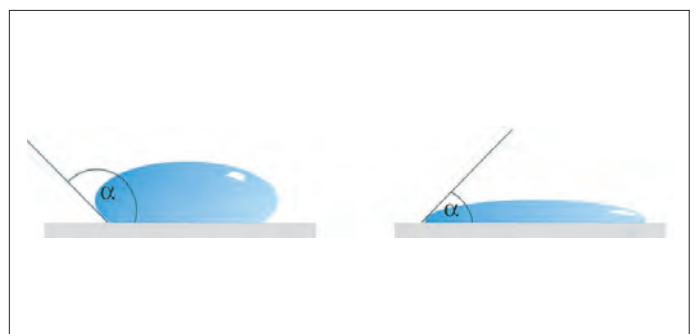


Fig. 17

## Influence of Paper Surface

Similar to surface tension, the free surface energy can be described as an “attracting force”, which is active on the surface of a carrier (paper) and attracts molecules of liquid.

The wetting characteristics always depend on the interaction of paper and fountain solution. The surface tension of the fountain solution can be reduced (by the addition of isopropyl alcohol or tensides) or the free surface energy increased by a Corona treatment to reduce the contact angle.

The spot test is one method of testing the paper.

## Spot Test

A drop of fountain solution is applied by micropipette to the test strip and it is then immediately printed on the test-bench printing press.

The assessment is made by measuring the ink density values in the pre-wetted and dry-printed areas with a densitometer. The result is expressed as a percentage of the ink density in the pre-wetted area relative to the dry-printed area. The higher the value, the lower the tendency of the tested paper to repel ink.

Figure 12 shows the results of spot tests on three types of paper, on the front and back of the paper in each case. The two test strips on the left show the best values in the spot test, those in the middle have a reduced acceptance of water and the strips on the right show very bad acceptance of water. The printability was graded from very good to very bad. (Fig.19)

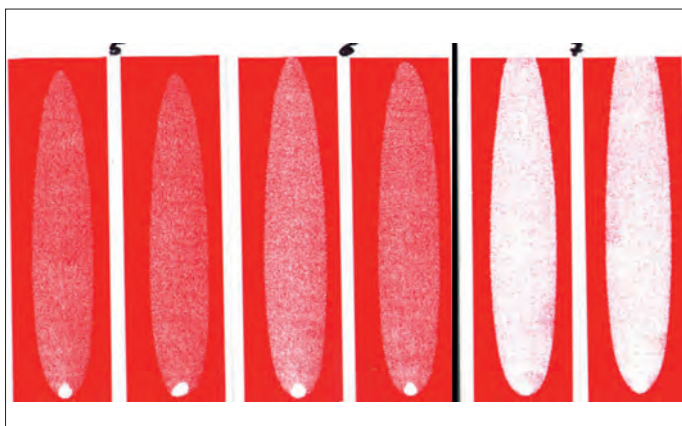


Fig. 18

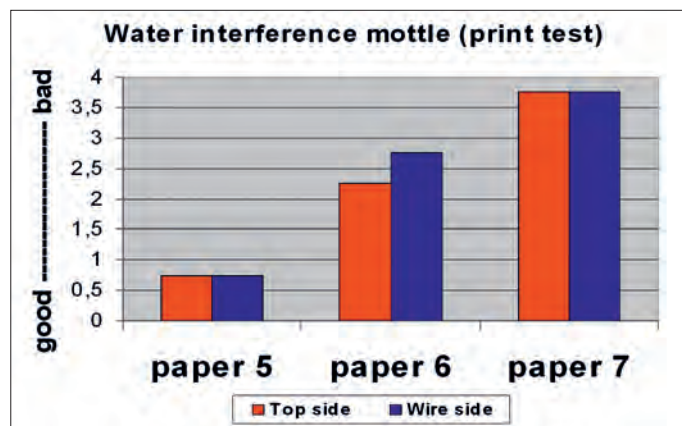


Fig. 19

## **Finding the cause for the printer**

### **Check whether all print and machine settings comply with the standard, if yes:**

By switching off the printing units preceding the unit where the uneven image is being produced, one can see whether water interference mottling is the cause of the problem. If good printing results are seen in this trial, water interference mottling is very probable.

### **Remedy**

- Reduce the fountain solution to the point of catching up!
- Check the fountain solution (pH-value, isopropyl alcohol, cooling).
- Check the paper, compare with another production of this quality or one with a similar type of surface.

## V Screen Mottling (Midtone Mottling)

Mottled impression in screen values of 30 – 60% is caused by an uneven distribution of the base paper (formation) and an uneven distribution of the coating. As with backtrap and water interference mottling ink and damping water react to the partially varying given characteristics of the paper surface by uneven acceptance of ink and water. Interestingly, this type of mottling can occur in both single-colour and multi-colour printing. The omission of pre-wetting and subsequent back-splitting in single-colour printing with imbalanced screen printing illustrates that there must be other factors influencing screen mottling besides water-absorption characteristics, water acceptance and wetting. Experiences and trials showed an imbalance in the screen, with the screen dots evenly formed and of equal size, that could be attributed to the effect of the light trap, and have correlated with opacity and formation of the paper. This type of mottling could almost be called an optical illusion (Fig. 20-good, Fig. 21-bad).

## Finding the cause for the printer

**Check whether all print and machine settings comply with the standard, if yes:**

Ensure that no other negative influences are making mottling visible, and backtrap mottling or water interference mottling can be excluded.

## Remedy

Either the same paper from another production, or if unavailable another paper with a similar surface quality should be taken for comparison in the machine.

The reduction and irregular distribution of high-definition screens leads to another interaction between the paper and the visual effect. Following previous experiences complaints about midtone mottling are almost unknown. It is possible that the limited use of this technology contributes to this positive development. We will observe this and report on it in a future issue.

**without Screen Mottling**



Fig. 20

**with Screen Mottling**



Fig. 21

## VI Paper Surface Mottling

In the introduction mottling was defined as “marbled, speckled or flecked”. These visual impressions can be present on the surface of paper even prior to printing. They arise for different reasons and can result from wanted or unwanted causes. Printing on such surfaces quickly appears mottled because the human eye cannot always differentiate clearly between a specifically desired surface characteristic or a surface effect. (Fig. 22-good, Fig. 23- bad)

### Finding the cause for the printer

#### **Check whether all print and machine settings comply with the standard, if yes**

Ensure that no other negative influences are making mottling visible.

#### **Remedy**

Either the same paper from another production or, if unavailable, another paper with a similar surface quality should be taken for comparison in the machine. The impression on rough paper surfaces can be improved by the use of harder blankets and/or setting the printing pressure higher.



Fig. 22

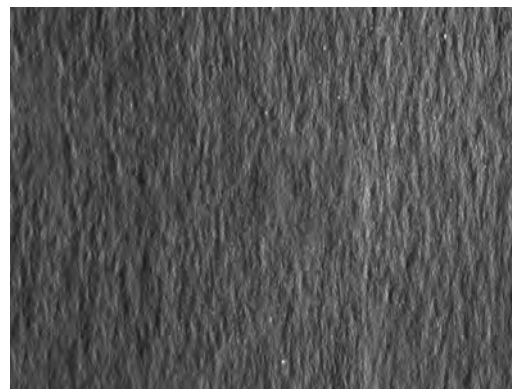


Fig. 23

## VII Other Causes of Print Mottling

### Printing Machine Mottling

Mottled, uneven printing can also be caused by incorrect settings of the printing machine such as:

1. Faulty print plates
2. Faulty blanket or faulty packing
3. Uneven roller setting (ink/fountain solution)
4. Damaged rollers (ink/fountain solution)
5. Dust (paper/powder)
6. Faulty setting of the fountain solution
7. Faulty setting of the impression cylinder

and other innumerable possibilities that occur day-to-day in a print shop.

#### 1. Pre-Press Stage – Printing Plates

- Check whether data is in order in the pre-press stage
- Whether pre-press stage matches printing image (Moiré)
- Whether plate adjustment is correct (packing, setting of the printing pressure to the blanket)

#### 2. Blankets

- Check that blankets and their packing are not damaged
- Whether blankets are correctly mounted and packing height and printing-pressure setting are the same (kisspoint)

#### 3. Inexact/incorrect Roller Setting

- Check whether all rollers are set correctly; if not carry out basic setting in accordance with the rules.
- If a correct setting cannot be achieved, check whether damage or wear is present (diameter too small)

#### 4. Bad Trapping Characteristics when Overprinting a Minimum of 2 Inks (Cyan/Magenta)

- place second ink, if possible in a printing unit located further back
- change the tack value such that it is considerably higher in the front printing unit.

#### 5. Ink Density too high – Emulsified Ink

Reduce ink density and fountain solution to standard process values; if no improvement occurs, Section 3 will probably have to be applied (basic setting).

Check fountain solution setting (pH-value, isopropyl alcohol, cooling); where the temperature or the pH-value is too high there is a risk of emulsifying too much fountain solution into the ink (see Section 3)



## VIII Sappi Test Procedure

Print tests are carried out at regular intervals in all Sappi mills in Europe. These tests apply in general to ensuring the printability of the latest productions. Since printability is dominated most frequently by the types of mottling described, the most important parts of the printing test procedure are aimed at this.

The practical experiences of product specialists in all the Sappi mills were also included in designing the printing test procedure. Special products and trial productions were selected for the printing tests and the conclusions drawn from them. The printing tests were accompanied by studies done in the laboratories by Sappi Research and Development. This showed that the surface energy of the paper also affects mottling; the higher the energy, the worse the mottling.

Moreover, the water-absorbing characteristics of the ink and the paper jointly determine the end result.

The ink sequence of the test sheet is:

**1st Black**  
**Cyan**  
**Magenta**  
**Yellow**  
**Blue**  
**2nd Black**

The design of the test procedure is explained below:

By cutting out the blankets in printing units three to six on the test areas marked "2+3" (first black and cyan) we are able to simulate a two-colour printing press in these fields.

Unit 1: black, ink splitting in the second printing unit

Unit 2: Cyan, normal wetting in the first unit and cyan printing in the second unit, then no further ink-splitting in these fields.

Contrary to this there are comparable colour areas, labelled 1, and the rest of the test sheet which reproduce the situation of normal 6-colour printing, including all contacts with the blanket after the colours black and cyan have been printed.

The difference in the impression of the 100% cyan field (1), which is back-split four times to field 2, which is not back-split, can always be seen.

Dependent on the paper quality and other subordinate parameters (machine-setting, e. g. water supply), mottling can more or less always be seen in field 1.

On the other hand, where the surface of the paper in field 2 absorbs water too slowly, a disrupted ink acceptance can be made visible because there are no further contacts with the following blankets and no ink can further affect/balance this field.

- 1 Back-split mottling**
- 2 Water interference mottling**
- 3 Midtone mottling**



Fig. 24



## **IX Summary**

The trials and tests described in this brochure have confirmed our experience from practice.

Given optimum conditions in the print-room and in the printing press, printability faults can be avoided to the greatest extent.

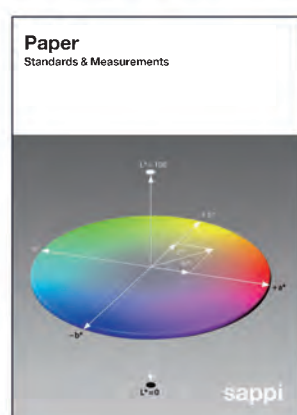
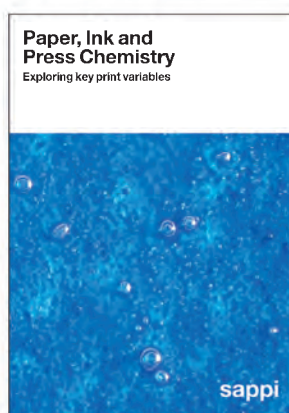
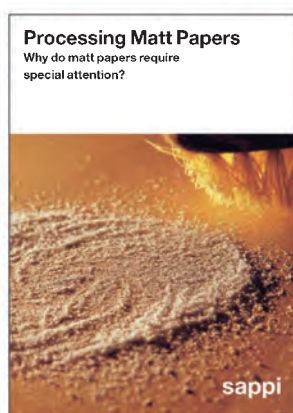
Naturally all items involved, and that includes paper, ink and pressroom chemistry (fountain solution additives) must be attuned.

In a world that is becoming ever faster and, at the same time improving quality, all those involved in the process are partners.

Only by working together even more closely can we offer the best for our printers and consequently for their customers as well.

This brochure "Mottling – Mottled impression" is one in a series of Sappi's technical brochures. Through them we share our paper knowledge with our customers so that they can be the best they can be.

The series also comprises the following brochures which are freely available at [www.sappi.com](http://www.sappi.com):



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The word for fine paper

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