CHAPTER 3

EXPERIMENTAL

3.1 Materials

3.1.1 Printing plates : 3 photopolymer plates with two different thickness was used

a) Nyloflex ACE (1.14 and 1.70 mm)

b) Nyloflex FAH (1.14 and 1.70 mm)

c) Nyloflex Sprint (1.14 and 1.70 mm)

3.1.2 UV Flexo inks : 2 types was used

a) Radical ink : Zeller + Gmelin ; Y CYAN Y7-S1300 A

b) Cationic ink : Zeller + Gmelin ; Q CYAN Q 1645 C

3.1.3 Printing substrates : 3 self adhesive (SA) materials with different surfaces was used

a) Uncoated paper

b) High gloss white (HGW)

c) PE

3.1.4 Scapa tape Y572 (380 μm)

3.1.5 Scapa tape Y644 (550 μm)

3.1.6 Ethanol

3.1.7 Ethylacetate

3.1.8 Hydrosolv

3.1.9 Tesaprint 52506

3.1.10 Tesaprint 52916

3.2 Apparatus

3.2.1 Combi F1 Super : A solvent washable plate making machine (For ACE and FAH)

3.2.2 Nyloprint : A water washable plate making machine (For Sprint)

3.2.3 Thickness gauge

3.2.4 Hardness gauge : Hätermeßgerät von Bareiss

3.2.5 Video-print

3.2.6 Printing press : Nilpeter, Model F 2400, Mask Nr. 4670, Serie Nr. R O 671

3.2.7 Anilox roll : 320 l/cm (800 lpi) ,60°screen ruling and 3 cm^3/m^2 pick-up volume

3.2.8 Print simulator

3.2.9 Roughness guage : Hommelwerke LV-50

3.2.10 Densitometer : TECHKON R 410

3.3 Procedure

3.3.1 Evaluation of plate making parameters: A test was made for each plate type in order to specified the suitable processing time used in the plate making.[11]

3.3.1.1 Wash out test

3.3.1.1.1 Trim not yet pre-exposed plate material to pieces about 12 x 17 cm (0.472 x 0.67) in size.

3.3.1.1.2 On each piece of raw plate, place a covering plate, expose full-face for 10 minutes.

3.3.1.1.3 Wash the plate pieces in the continuous-flow washer, using different flow times (e.g.): 3 min for the first piece, 6 min for the second, 9 min for the third, 12 min for the fourth.

3.3.1.1.4 The plate segments must be dried for about 15 minutes (a drying time which applies only to this test)

3.3.1.1.5 After drying, measure the thickness of the washed-out parts.

Regard as the optimum wash-out time the point at which the desired relief depth is exceeded by 0.2 mm (0.008). If a relief depth of 1 mm is desired, for example, you choose the wash-out time that produced a wash-out depth of 1.2 mm.

The diagram (Figure 3-1) shows the relationship between relief depth and wash-out time. The values indicated represent the difference between the originally measured raw plate thickness and the remaining thickness of the wash-out plate segments.

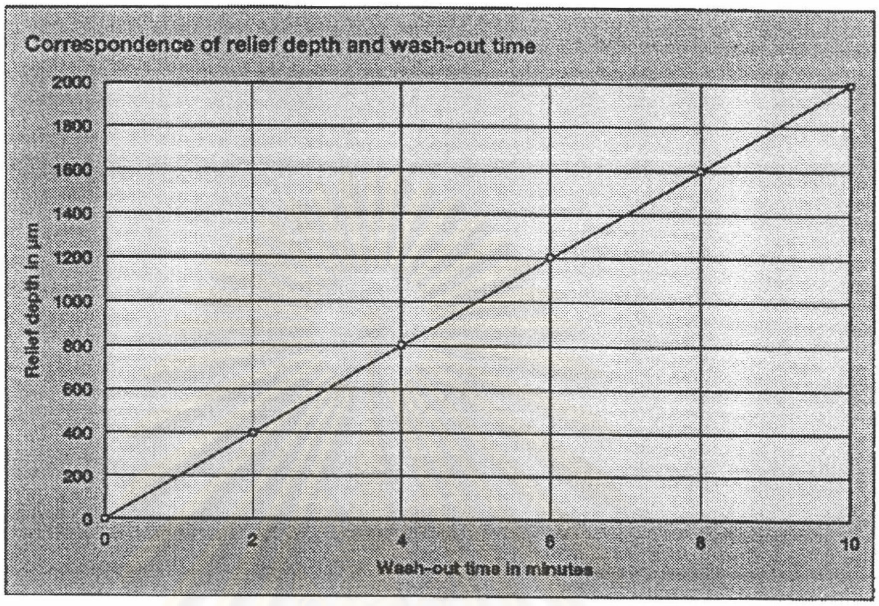


Figure 3-1 Wash out curve

The curves showing wash-out can only be regard as examples. Since the relationship between wash-out time and wash-out relief depths differs according to the type of washer and plate, all products have to be test-determined accordingly.

3.3.1.2 Back exposure test

3.3.1.2.1 First of all, cut a nyloflex monolayer plate to a size of approximately 20 x 48 cm (0.787 x 1.89), and place it on the vacuum plate of the exposing unit with the relief layer facing downwards. Plate face and back are easily told apart by trying to lift one corner of the foil. This is possible only with the protective foil. However, for the time being, the protective foil has to remain on the plate. Vacuum is not required for the pre-exposure test

To avoid reflection, it is advisable to use a suitable base material in pre-exposure and main exposure (e.g. black board, red plastic sheet).

3.3.1.2.2 Before exposing, cover the plate with pieces of opaque material the size of the rest sections of the test negative. Keep the first field covered throughout; step exposure begins with the second field (Figure 3-2)

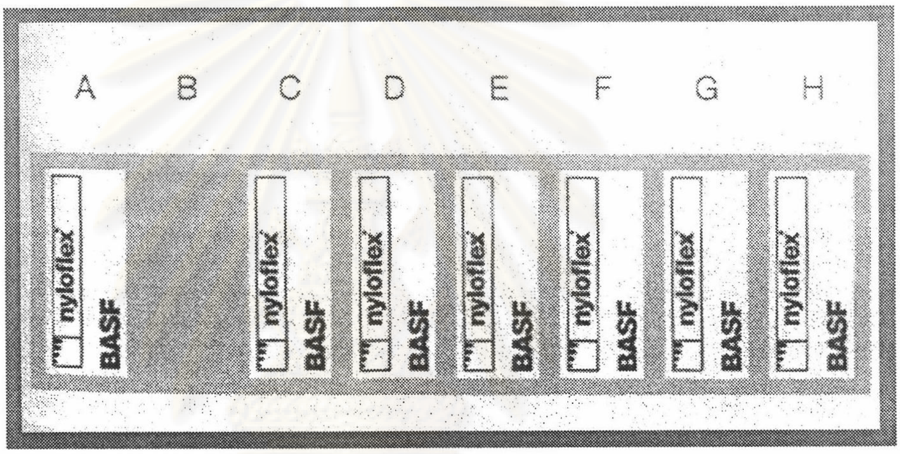


Figure 3-2 Back exposure test

3.3.1.2.3 Expose the second step (e.g.10 seconds for plate thickness 2.84 mm/0.112), then move the cover piece from position C to position B se that the third section is uncovered. Expose this for 20 seconds.

Now move the cover piece from position D to position C and expose for 30 seconds. In this way, you obtain a series of exposures with 10-second increments. Usually, 8 steps are exposed (Figure 3-3). The basic length of exposure varies according to the plate type (plate thickness).

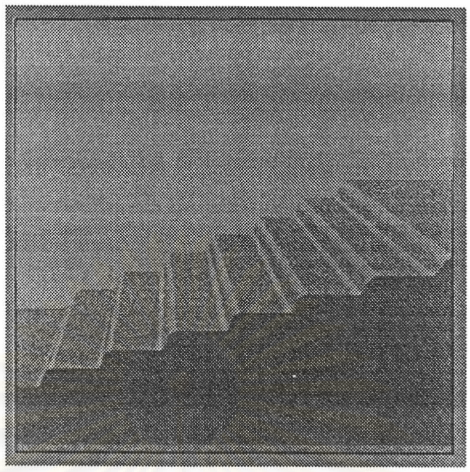


Figure 3-3 Profile of test plate from different back exposure times

Next, wash the exposed nyloflex plate for the length of time previously determined as necessary for the desired relief depth. For measurement of the different steps, it is essential that the plates are subsequently dried for approximately 15 minutes.

The foregoing reveals the interrelationship between pre-exposure time, wash-out time and relief depth:

- Long pre-exposure and short wash-out time = shallow relief
- Short pre-exposure and long wash-out time = deep relief

The time for plate-back pre-exposure and wash-out have always to be correlated in such a way that the plate is washed out right down to the polymerized base.

The recommended added time for 0.2 mm (0.008) extra relief depth is explained by the following:

Between the pre-exposed and thus polymerized bottom part of the layer and the non-polymerized upper part, there is a transitional phase in which the material is partly polymerized. This partly polymerized material should be washed off as far as possible so that the relief base and the foundation material will be in a thoroughly polymerized zone. Since this material takes longer to dissolve, the wash-out time is to be prolonged accordingly.

The relief depth should be chosen according to the following criteria:

- screen of line
- printing stock and
- press conditions.

Fine-screen work, especially one with gradation, is more easily reproduced with a shallow relief (e.g.0.7 mm or 0.028) since a deeper relief will lead to dot loss. Stock that is uneven, rough and maybe linting requires a deeper relief.

Plate-back pre-exposure has to be carried out for each new batch of plates.

3.3.1.3 Main exposure test

3.3.1.3.1 For this test, trim a nyloflex raw plate to 20 x 48 cm (0.787 x 1.89)

3.3.1.3.2 Pre-expose the back for the length of time determined by your tests.

3.3.1.3.3 Turn the nyloflex plate over (relief upwards) and remove the protective foil. Lay the nyloflex test negative on the plate, matt emulsion side down. Cover the edges of the nyloflex plate with profile foil strips to ensure perfect vacuum and prevent the vacuum foil from sticking to the cut edges of the plate. Now switch the vacuum pump on and unroll the foil over the plate, pulling evenly. For quick removal of entrapped air, it is advisable to roller-squeegee the vacuum foil or wipe it with an antistatic cloth. This will make any enclosed dust particles located in transparent film areas visible. These particles must be removed to prevent exposure faults.

The two nyloflex FA II/FAR II/FAH/MA II as well as FAC II/FAC II S test negatives contain four identical strips of test elements. They are available from BASF Drucksysteme Gmbh.

It is advisable not to copy this negative but to order new ones as needed, in order to avoid tonal deviations and faulty assessment.

The test elements of the test negatives serve to determine the main exposure time and the exposure latitude. For plate thickness of 0.76 – 3.18 mm (0.03 – 0.125), the nyloflex FA II/FAR II/FAH/MA II test negative is to be used.

3.3.1.3.4 The correct main exposure time is determined - like the back exposure time – by a step test (Figure 3-4)

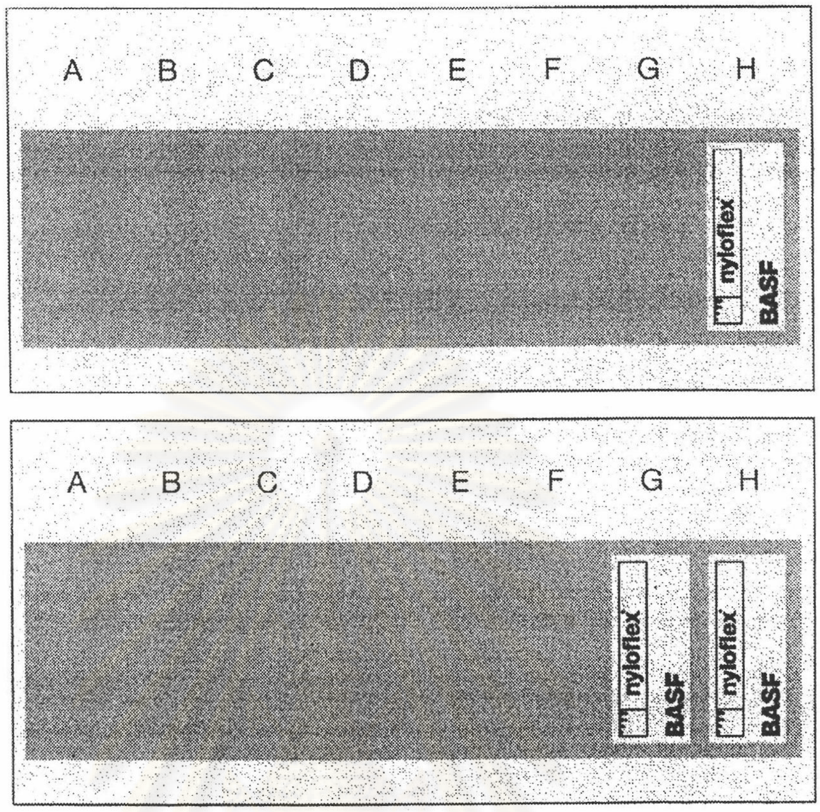


Figure 3-4 Main exposure test

3.3.2 Plate Making

For each plate type and thickness, following plate samples was made :

- A solid plate of A4 size
- A plate with screen area
- A plate for a print simulator (Dynamic swelling test)
- A plate for a printing test (using a test negative as an original)

Solvent washable plate making[12] : The photopolymer plates was made through 6 steps

1. Back exposure (with 360 nm UVA)

   Back-exposure of base to ultraviolet light to harden (cure) floor and establish relief depth

2. Main exposure (with 360 nm UVA)

   Face exposure of surface to UV light through the negative to harden the relief printing image

3. Wash out : a washing solvent (nylosolv II) was used

   Wash out in appropriate solvent or water to remove unexposed polymer and leave printing image in relief

4. Drying (at 65°C)

   Drying of the plate either to remove absorbed solvent and restore gauge thickness, or remove surface water and render plate pressready

5. Post exposure (with 360 nm UVA)

   Post-exposure to finally cure floor and character shoulders

6. Aftertreatment (with 254 nm UVC)

   The plate surface is detacked by exposing the plate surface to UVC light.

Water washable plate making : The photopolymer plates was made through 5 steps

1. Back exposure (with 360 nm UVA)
2. Main exposure (with 360 nm UVA)
3. Wash out : a water was used
4. Drying (at 65°C)
5. Post exposure (with 360 nm UVA)

3.3.3 Swelling test

3.3.3.1 Static swelling test

In order to know the stability of each plate/ink combination and to compare the amount of swelling occurred in different surface area, this test was conducted in a laboratory by applying the amount of UV ink onto the plates' surface, then the samples were stored in the oven of 40 C for 24 hours.

3.3.3.1.1 Sample preparation

First, the plate sample was cut into 4x4 cm. Each plate sample was then written with number. With 2 UV inks and 6 photopolymer plates, 12 combinations between plates and inks was made.

Table 3-1 Combinations of plate samples and UV inks

Sample number	Plate type	UV Ink applied
1	ACE 114	Radical ink
2	ACE 114	Cationic ink
3	ACE 170	Radical ink
4	ACE 170	Cationic ink
5	SPRINT 114	Radical ink
6	SPRINT 114	Cationic ink
7	FAH 114	Radical ink
8	FAH 114	Cationic ink
9	FAH 170	Radical ink
10	FAH 170	Cationic ink
11	SPRINT 170	Radical ink
12	SPRINT 170	Cationic ink

3.3.3.1.2 Measuring plates' properties

Each plate sample was measured for physical properties including weight, thickness, and hardness.

3.3.3.1.3 Applying inks onto the plates' surface

For each plate sample, UV ink was applied on the plate surface relevant to the combination of each sample number.

3.3.3.1.4 Storing the plate sample

After ink was applied, the plate samples was stored in the oven of 40°C which is supposed to be the temperature in the printing nip for 24 hours.

3.3.3.1.5 Cleaning the plate sample

After keeping in the oven for 24 hours, the plate samples was taken out of the oven and the plates' surface was cleaned.

3.3.3.1.6 Measuring plates' properties (After swelling)

Each plate sample was again measured for physical properties including weight, thickness, and hardness.

3.3.3.1.7 Analysis

The swelling behaviour of each plate-ink combination was then analysed for the following criteria:

- For each plate type, a comparison of the amount of swelling occurred using Radical and Cationic UV ink
- Comparison of the swelling occurred in different plate types
- Comparison of the swelling occurred in the same plate type of different thickness

3.3.3.2 Dynamic swelling test

For each plate and ink combination, printing for 35,000 impressions (7,000 m) was conducted using a print simulator and printing substrates was printed at every 5,000 impressions (1,000 m).

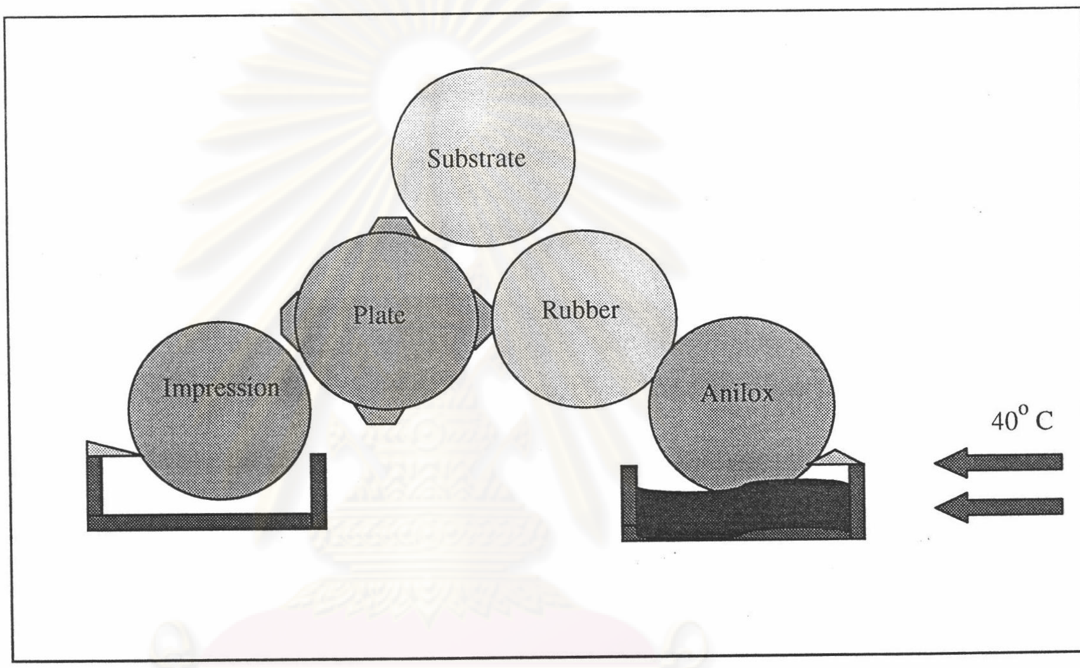


Figure 3-5 Diagram of the transfer rollers in the print simulator

3.3.3.2.1 The plate was cut into the printing size for the print simulator (5x 18cm)

3.3.3.2.2 Each plate sample was measured for thickness and hardness

3.3.3.2.3 The plate was cleaned using ethanol for FAH and ACE and hydrosolv for SPRINT.

3.3.3.2.4 To ensure a good adhesion, the edges of the polyester base of the plate was cleaned with ethyl acetate

3.3.3.2.5 The temperature was set and kept constant at 40°C during printing using a hot air blower

3.3.3.2.6 The plate was then mounted ; on the printing cylinder with Tesaprint 52916 for the 1.70 mm plate ,and with Tesaprint 52506 for the 1.14 mm plate

3.3.3.2.7 The pressure of 100 μm was set between the steel impression roller and the plate cylinder

3.3.3.2.8 For each combination, the printing was conducted using a print simulator and the substrate was printed every 5,000 impressions

3.3.3.2.9 After 35,000 impressions, the plate was demounted from the print simulator

3.3.3.2.10 The plate was again measured for thickness and hardness

3.3.3.2.11 The tone reproduction of the print sample was measured and the print quality was evaluated

3.3.4 Printing test

From the available materials, 36 combinations of inks plates and substrate was printed using the Nilpeter, Model F 2400, Mask Nr. 4670, Serie Nr. R O 671

3.3.4.1 First, the plate was cut into the printing size (20 x 30 cm)

3.3.4.2 The plate was cleaned using ethanol for FAH and ACE and hydrosolv for SPRINT.

3.3.4.3 The plate was then mounted; on the printing cylinder with Scapa tape Y572 (380 μm) for the 1.70 mm plate, and on the hard sleeve with Scapa tape Y644 (550 μm), to fit the print undercut.

3.3.4.4 For each combination of plate, ink, and substrate, printing was accomplished on the Nilpeter press.

3.3.4.5 The printed samples were taken for each combination.

3.3.4.6 In order to evaluate the print quality, tone reproduction curves, dot gain, solid density, as well as visual assessment was then analysed.

3.3.4.6.1 Visual assessment

In order to evaluate the print quality, the visual assessment of the print samples is necessary. In this test, the following criteria were evaluated relevant to the printed image.

Table 3-2 Criteria for visual assessment

Sample					
Screen	O Good coverage		O Poor coverage		
Reverses	O Open		O Not open		
Solid/line	O Homogeneous		O Not homogeneous		
Picture	Best ←				Worst
Penguins	O 1	O 2	O 3	O 4	O 5
Fruit	O 1	O 2	O 3	O 4	O 5
Wedge	O 1	O 2	O 3	O 4	O 5
Vignettes in wedge	O Smooth		O Hard		
Gear mark	O Yes		O No		

3.3.5 Effect of the printing substrate

The quality of printing, which is achievable, is strongly dependent on the surface properties of the printing material. In this case, measurement of the roughness and absorbency stand as highly influential factor.

3.3.5.1 Roughness

For 3 substrates used in the test, each substrate has to be characterized by their roughness and absorptivity.

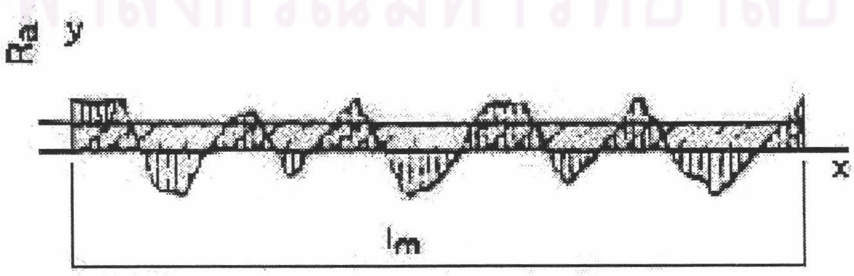
The surface roughness of each substrate was measured 3 times using a roughness gauge; Hommelwerke LV-50 which can measure an average roughness of the substrate using equation:

$$R_a = \frac{1}{l_m} \int_{x=0}^{x=l_m} |y| dx \qquad (3.1)$$

Where :

Ra is Average roughness

Lm is length of the measuring area



3.3.6 Absorbency

In this test, the relative absorbency of the substrates is compared by gravimetric evaluation together with a consideration of the solid ink density.

3.3.6.1 For each substrate, cut a piece of pure printing substrate and a piece of substrate covered with full solid.

3.3.6.2 Check for the weight of each cut sample.

3.3.6.3 Measure the solid density of the ink film on each substrate.

3.3.6.4 In order to compare the absorbency of each printing substrate, the weight change in % of each substrate and a comparison of the solid density was considered.