# ANALYSIS OF EXPOSURE PARAMETER OF FLEXOGRAPHY SHEET PHOTOPOLYMER PLATES

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***ABSTRACT***

*This document aims to explore effects of exposure time variation on flexographic plates. The photopolymer flexographic plates are exposed using ultra violet light from back side and face (printing) side. The Face and back exposure time have effect on relief depth formation. The relief depth is the difference between the plate surface and the supporting floor—the measured physical difference between image and non-image area on a relief plate and change in relief depth has direct effect on quality of printing. The conclusions would be helpful in understanding the significance of proper exposure times under standard*

**KEYWORDS:** flexography printing, photopolymer plates, plate making stages, back and face exposure, relief depth

## I. AN OVERVIEW OF FLEXOGRAPHY

Flexography is Direct Printing Process. It is dynamic, cost effective and versatile printing method.1 It uses flexible printing plates made of rubber or plastic. The plates are mounted on cylinder and inked up through ink metering system. The plates (ink applied) with relief image area are placed on a circulating plate cylinder which transfers the image to the substrate. It uses solvent, water-base or ultraviolet {UV} curable inks which must be fast drying having low viscosity. It can print on absorbent and non-absorbent stock.

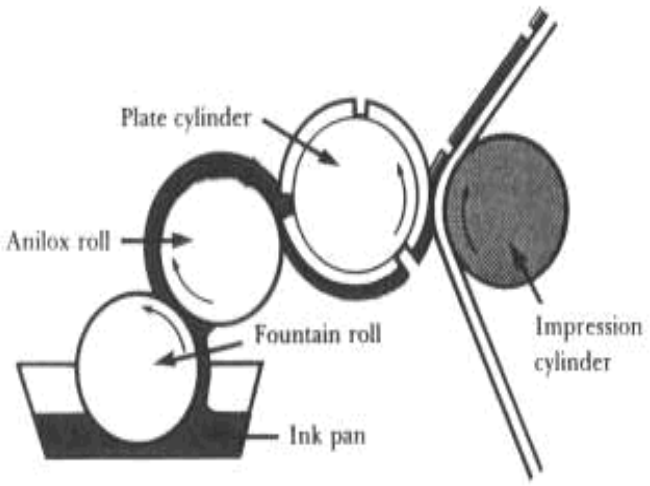



**Fig.1** General Flexography Print Station 1

Process was developed for printing on packaging materials- board, paper web, plastic roll, foil. Most popularly used Flexography press designs are Stack. Inline, Common Impression Sheetfed. Flexographic presses can do many inline operations such as folding, box making, varnishing, lamination etc.

## II. PHOTOPOLYMER PLATES

Photopolymer Plate is one of the innovations in modern flexography. In early days of flexography, the rubber plates did not reproduce fine halftones; particularly in highlight and shadow areas but with the advent of photopolymer wash-off plates; this issue has been resolved. E.g. "Nyloflex" from BASF and "Cyrel" from DuPont. It uses negative and produces excellent image. There are many systems available to produce photopolymer plates.

Liquid Photopolymer Plates – viscous liquid ready to be cast to required plate thickness.

Sheet Photopolymer Plates - The printing plate as a raw material is characterized by two quantifiable parameters: its Shore A hardness and its thickness.

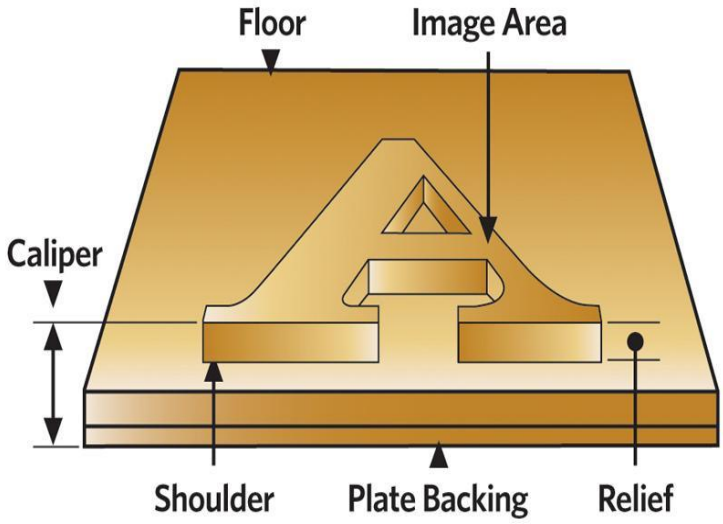



**Fig.2** Typical Parts of Flexo Plate [1]

**Shore Hardness**

Hardness is defined as a resistance of material to indentation when a static load is applied. Hardness is also related to other important physical properties such as tensile modulus. The most common instrument for measurement of hardness is called the Shore durometer. This instrument measures the depth of penetration from zero to 0.100 inches.

Shore A scale is used to test the hardness of soft vulcanized rubber and soft plastics. The hardness of the raw plate is not really relevant for the printer; hence it is usually not controlled. The plate hardness after processing influences the ink transfer and must be considered carefully. Suppliers indicate tolerances within a range of +/- 2 °Shore A. Photopolymer plates are available in 25 to 70 shore A. 12 For corrugated sheets i.e. for rough surface soft plate are used. There hardness is 25 to 40 shore A.12 For other quality printing 45 to 60 shore A hardness plates are used.

**Thickness**: Normally flexo plates are available in 1.4 mm to 6.5 mm thickness. Plate thickness depends upon repeat length. Plate suppliers distinguish tolerances between two productions, two charges and tolerances within a plate or a box. The official statement is a thickness variation of +/- 0.010 to 0.015 mm within a plate or within a box. At the same time they certify variation in the range +/- 0.025 mm between two productions.

## III. PHOTOPOLYMER PLATE CONSTRUCTION

Sheet Photopolymer plate has three main parts.

i. Polyester backing sheet- it provides dimensional stability to the base of finished plate.

ii. Photopolymer layer- It is highly viscous liquid which is dimensionally stable under normal atmospheric conditions

iii. Polyester cover sheet- It is used to protect the upper surface of plate material. Release layer is provided for ease of removal.

## IV. PHOTOPOLYMER PLATE PRODUCTION STAGES

Preparation - Prepare negative and cut photopolymer plate material to proper size.

**1. Back Exposure** – It establish thickness of plate floor (relief depth) by curing part of photopolymer plate with UV light. No negative is used during back exposure. Longer the exposure more UV A energy is absorbed, the thicker the floor becomes. Variables that can affect proper exposure include differences in UV sensitivity and UV energy output especially as UV lamp age. Back exposure test is carried out regularly to establish a rate of cure for particular photopolymer and exposure equipment.

**2. Face Exposure** – It creates cured 3-D image in photopolymer layer with UV light. The exposure transfers the image from photographic negative to the printing face of photopolymer. It is done through UV A radiation. The exposure time decides the shoulder characteristics. The shoulder supports the image area. In case of less face exposure the fine lines in negative will appear wavy. Excess face exposure causes dot gain. Sufficient vacuum is required during exposure

**3. Development** –Due to UV exposure the non-image area becomes soluble. The plate is processed with alkaline developer ( PH – 8 to 11) . The developer is a combination of perchloro ethylene and N butanol in the ratio 1: 2.5 . It removes uncured photopolymer leaving cured image. Short washout time causes less relief depth, tackiness. Longer development time causes excessive swelling

**4. Plate Drying** - Blot rinsed plate with lint free towel (automatic with some equipment) to remove excess solvent. External solvents are required to take away any solvent absorbed by the plate. The detergent washout plate requires less drying time. Before drying operation the straight lines may appear wavy due to solvent swelling. Oven drying can overcome this problem and it can produce sharp image. Time and temperature are also controlled for proper drying. Excess temperature can change plate dimensions.

**5. Post Exposure** - Crosslink (cure) any uncured polymer, increasing press life and resistance to ink solvents (simultaneous with finishing in some machines). It uses UV C light.

**6. Finishing** – It is performed to remove tackiness from the floor of the plate. It increases wear life and prevent surface stickiness.

1 Chemical finishing- it is treatment of the plate by placing it in the solution of chlorine, bromine or iodine. It gives longer storage time.

2. Detackifying spray- The tackiness can affect ink transfer properties of plate. There is possibility of using fine halftone dots.

## V. EXPERIMENTAL SETUP

Temperature- 20 0C

R. Humidity- 55 %

Technical specification of Plate used:

Name: KODAK Flexcel SRM flexographic plate

Nine pieces of photopolymer flexo plate of size 10 cm X 10 cm were used for carrying out pre-decided exposure timings. i.e. Low Back exp. = 15 Sec, Medium (standard) Back exp. = 30 sec, High Back exp. = 60 sec. Low Face exp. = 5 min, Med. (Std.) face exp. = 10 min, High face exp. = 20 min.

**Table 1 :** Experimental Setup

| | |
|---|---|
| Plate thickness | 1.70mm |
| Plate hardness | 60 Shore A |
| Wash-out solution | Compatible with most wash-out solvents at temp: 250 C |
| Ideal Relief depth | 0.8 – 1.0mm |
| Back exp / sec | 150 mj/cm2,30 sec |
| Main (Face) exposure time /min | 4,000mj/cm2 10 min |
| Wash-out | 3 - 6 min |
| Drying at 55°C | 120 min |
| Finishing UVC | 3,000 mj/cm2,10 min |
| Post exp UVA | 3,000 mj/cm2,10 min |

## VI. ANALYSIS

**Table 2 :** Analysis of Plate Exposer

| No | Case | Total plate Thickness mm | Floor thickness mm | Relief Depth mm |
|---|---|---|---|---|
| 1 | Low Face Exp. Low Back Exp. | 1.70 | 0.97 | 0.73 |
| 2 | Medium Face Exp. Low Back Exp. | 1.70 | 0.97 | 0.73 |
| 3 | High Face Exp. Low Back Exp. | 1.70 | 0.98 | 0.72 |
| 4 | Low Face Exp. Medium Back Exp. | 1.70 | 1.24 | 0.46 |
| 5 | Medium Face Exp. Medium Back Exp. | 1.70 | 1.20 | 0.50 |
| 6 | High Face Exp. Medium Back Exp. | 1.70 | 1.19 | 0.51 |
| 7 | Low Face Exp. High Back Exp. | 1.70 | 1.69 | 0.01 |
| 8 | Medium Face Exp. High Back Exp. | 1.70 | 1.68 | 0.02 |
| 9 | High Face Exp. High Back Exp. | 1.70 | 1.63 | 0.07 |

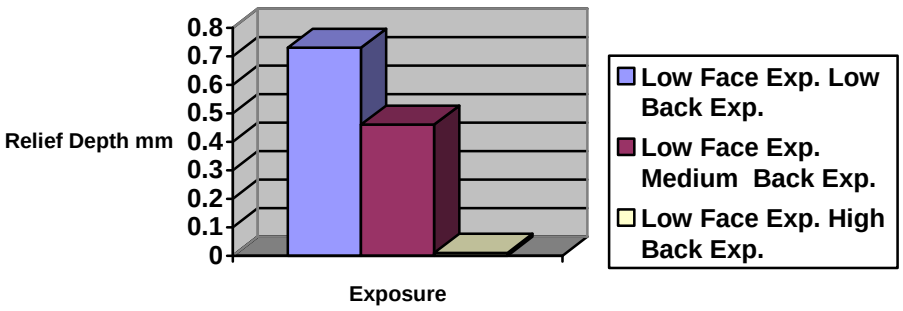
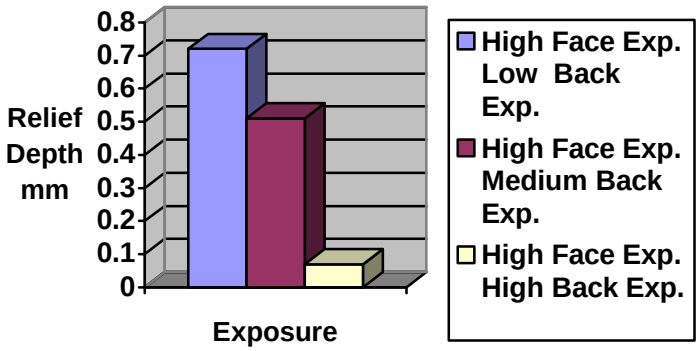



**Fig. 3** Low Face Exposure with variable Back Exposure




Exposure Vs Relief Depth

**Fig. 4** High face exposure with variable back exposure

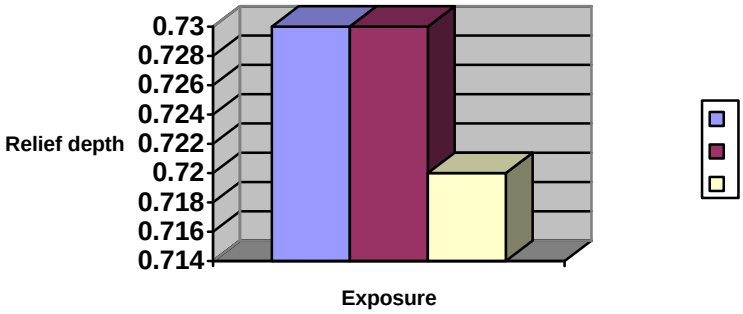



**Fig. 5** Low back exposure with variable face exposure.

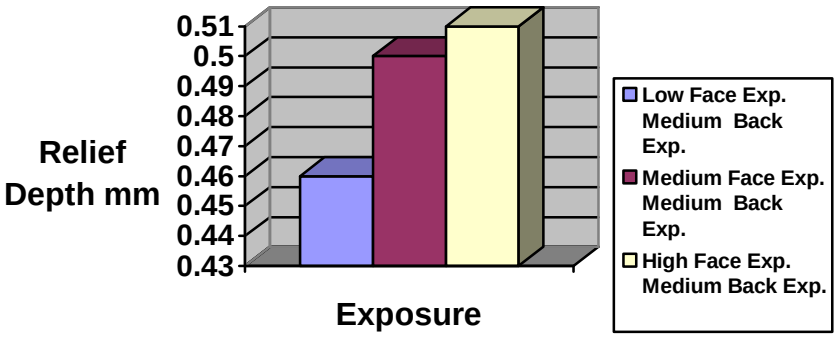



**Fig. 6** Medium back exposure with variable face exposure

## VII. CONCLUSION

One of the most important variables to control during plate making is relief-depth. As noted earlier, this is the difference between the plate surface and the supporting floor—the measured physical difference between image and non-image area on a relief plate. This difference is measured in mm using digital plate micrometer. Generally speaking, the lower the relief, the sharper the printed dot. However, low reliefs also are more difficult to print and require better press controls. Further, low reliefs are most appropriate for smooth substrates and tonal work. Rough substrates and large solids may dictate more impression on press and will "print the floor" if low relief plates are made. For fine

graphics on a smooth substrate, a narrow-web printer might shoot for a relief of around 0.5 mm. The difference between the plate surface and the supporting floor is Relief Depth. The plate floor is thickened via absorption of UV light energy.

Case 1. Low Face and Low back exposure- Because of less back exposure there is uncured photopolymer at back and there is no floor formation. Further the face will be unable to withstand mechanical pressure.

Case 2 Medium Face Exp. Low Back Exp. – Because of less back exposure there is uncured photopolymer at back and there is no floor formation. There is more relief depth.

Case 3 High Face Exp. Low Back Exp - Because of less back exposure there is uncured photopolymer at back and there is no floor formation. It has too much relief depth and weak shoulders.

Case 4. Low Face and Medium back exposure – Cured photopolymer at back. There is proper floor

but the shoulders are not properly formed. Further the face will not be able to take mechanical pressure.

Case 5 Medium Face Exp Medium Back Exp. – There is ideal floor and relief depth formation.

Case 6. High Face Exp. Medium Back Exp. It has proper floor depth but high face exposure resulted in steep shoulders.

Case7. Low face and High Back Exposure- High back exposure has cured more. It has resulted in too much floor height. It has negligible relief depth. It cannot print properly.

Case 8. Medium Face Exp High Back Exp. - High back exposure has cured more. It has resulted in too much floor height. It has negligible relief depth.

Case 9. High Face Exp High Back Exp. It has resulted in too much floor height. It has negligible relief depth. Plate has filled in.

Thus these cases show that medium back and face exposure results in ideal floor and relief depth.

## VIII. FUTURE WORK

With the increasing use of computer to plate technology, the exposure times are becoming standardised. A study can be carried out to explore relation between exposure time and linearized plates.

## ACKNOWLEDGEMENT

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