

Interaction between Surface of a Master Cylinder and Ink Jet Imaging for Computer-to-Press Applications

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Abstract

In production printing normally a master form, e. g. a printing plate, is used in the print process to manufacture cheap copies. To make this plate by computer-to-plate, some applications are known which use ink jet technologies for imagin. Future developments in computer-to-press solutions will eliminate physical plate changes from the process, using insteed a cylinder as a master, which will be fixed in the printing press and which could be imaged directly in the press. After the print job, the master image on this cylinder must be erased for the next job.

In this paper some investigations are presented which illustrate the interaction between the ink, the cylinder surface and the conditions of erasing and their impact in print quality and run length of the printed jobs.

Introduction

In todays industrial printing techniques, three different directions in developing new technologies are known:

Direct Digital Printing "DDP"

Ink jet, electrostatic, electrophotographic and other NIP printing processes are going through a period of explosive growth, which offers cost-effective, high-quality imaging with much shorter turnaround times. Due to this, the industrial production of short run printing will be done more and more with DDP. Very short make ready times becomes possible because of the masterless print process.

Computer-to-Plate "CtP"

For larger run lengths a print master, usually an offset plate, is needed to obtain high speed printing (e.g. 15 m/s). At higher run lengths the make ready times including the job changing, loose their importance in comparision with the long printing times. In this field the master will be produced off-press and a mechanical plate changing takes place afterwards.

Todays modern plate making technologies use laser exposure sources (YAG, Argon-Ion, IR or Red Laser Diode) for direct imaging the presensetized plate (photopolymer or silverhalide). It has become accepted that computer-imaged plates reduce make ready time and waste because they are imaged in better registeration. Also, because these plates have a sharper dot, the tonal range and other print quality features are expanded.

New trends in plate making are focused in so called “processless technologies” which do not need any further chemical treatment of the imaged plate.

One new way for processless plate making is the application of ink jet imaging systems. The imaged ink layer onto the plate surface could be used as a mask for the exposure of a photosensitive plate (e.g. Polychrome). On the other hand it could be used directly as the ink-conducting areas for the offset ink (e.g. Hitachi, Iris).

Computer-to-Cylinder "CtC”

For printing with shorter run length mechanical plate changing as it has to be done with CtP becomes unproductive but, on the other hand DDP does not provide enough speed. In this range “Computer-to-Press” technologies are preferred which still use a master for the print process. But this master is imaged inside the press. Today there are some systems available (Heidelberger Druck, Karat) which put the Computer-to-Plate concepts inside the machine. The imaging is done on a printing foil (Presstek) by laser ablation (see also [1]). After finishing the print, the foil is feed forward to get a new section for imaging the next job. There is also a type of digital screen printing with an unrollable foil known (Riso).

Future developments are interested in solutions without the necessity for mechanical changing procedures, either foils or plates. Therefor a reversible imaging process directly on the printing cylinder is needed. Today it is not known to the authors that there are any commercial CtC techniques available, but some concepts where presented in the past (e.g. MAN Roland, [2])

CtC with Hot-Melt Ink Jet

In the paper, we discuss a new CtC approach by using hot-melt ink jet technology as imaging system which writes the printing areas on a master cylinder. The printing itself has to be done by a standard offset process from this hot-melt coated master form.

Hot-melt ink jet is a well known DDP technology, widely used in office printers (e.g. Tektronix [3] etc.). Some of this systems use a cylinder for transferring the hot-melt-ink on the paper to improve print quality [4].

The main characteristic feature of solventfree hot-melt (or 'solid' or 'phase change') ink jet is the ability to be solid at ambient temperature but molten at a higher (hot) temperature maintained in the ink jet head. Therefore it can be ejected as droplets that will resolidify on contacting the substrate to produce an image. So hot-melt ink has to meet mutually stringent requirements for it's physical properties in two different phases.

The basic ingredients of hot-melt inks which is necessary to meet the requirements of phase changing are waxes or similar substances. The hydrophobic properties of waxes are a benefit for the CtC process. It could be used in the same way as in conventional applications to attract the offset ink and reject the damping water.

However, for our purposes waxes had one big disadvantage, where most higher melting waxes tend to be brittle or crumbly and are not ductile during the compressive yielding experienced by the ink during cold fusing. Some approaches are known how to modify the formulations to meet better conditions [5,6,7,8]. So amorphous polyamides could serve as low viscosity parts of the formulation that where likely to be chemically compatible with potential oligomers. Another ingredient often is added to the formulation which is necessary to serve as a solid plasticizer. This made the ink ductile enough at room temperature [9,10].

When applying this phase changing ink at a CtC process, really new requirements occure. First, the ink has to be fixed not on paper but on a cylinder surface. This surface may be a selected metal, in the first approach anodized Aluminium, or any other material with a damping capacity.

This combination of hot-melt ink coating and cylinder surface has to meet two contradictory requirements:

1. Durability for long run length. For thousands of revolutions under pressure the ink coating has to be firm enough to maintain a stable print quality. The ink layer must be highly resistant to rubbing and mechanical influence.
2. Suitability for erasing. The ink coating on the cylinder has to been cleaned off without any remainder after complete printing.

Description of the CtC Components

The basic functions of a computer-to-cylinder process with hot-melt ink jet imaging is been showed in Fig 1. The following steps are involved:

1. Imaging the Master

Using a ink jet printing head for hot-melt inks, the printing master image is applied on the rotating cylinder. Conventionally 600 dpi heads are available today, in the next year 900 dpi may be possible. There may be either an array print head or a transversal sliding head.

After this step, a coating of hot-melt ink covers the master cylinder whereby this coating becomes the print area and the uncovered surface of the cylinder is the nonprint area.

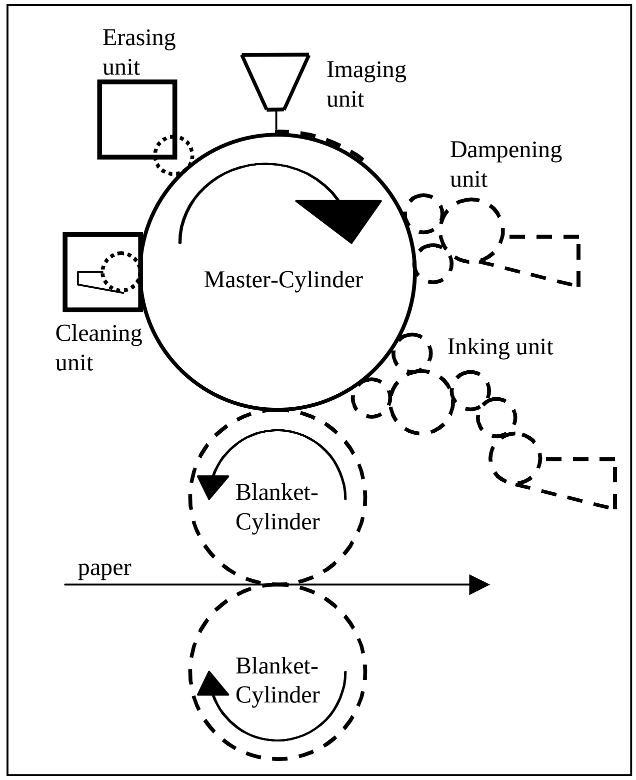

Figure 1. CtC process with ink jet imaging and offset printing

2. Offset Printing

After the imaging of the whole cylinder is finished, the print process starts. Typically for offset print, the non image areas are desensitized, i.e. made to repel ink and accept water. The most common means of desensitization is by using an acidified gum arabic solution or other material with hydrophilic properties. During printing, the master is first moistened by dampening solution, which is carried on the dampening roller. The inking rollers then contact the plate, transferring ink to the image area. Finally, this ink is transferred to the paper. The printing cyclus is repeated until the print volume is reached.

3. Cleaning

After the printing process is finished, with a suitable solvent the residual offset ink and fountain solution has to be cleaned.

4. Erasing

To image a new job onto the cylinder, the old image area on the surface has to be erased. This erasing could be done by heating and by mechanically removing of the hot-melt layer.

Results of Printing Tests

For printing tests a system with a standard Tektronix Phaser 360 Head and a standard hot-melt ink formulation was used. As printing surface an Aluminium was chosen. Aluminium is the most commonly used plate substrate, because it is easily made water receptive, and surface roughness may increase the adhesive bond strength by increasing the surface area, promoting wetting or providing mechanical anchoring sites. The bond strength tends to increase with adherend roughness. The offset printing was done in a Heidelberg GTO print unit under standard offset conditions.

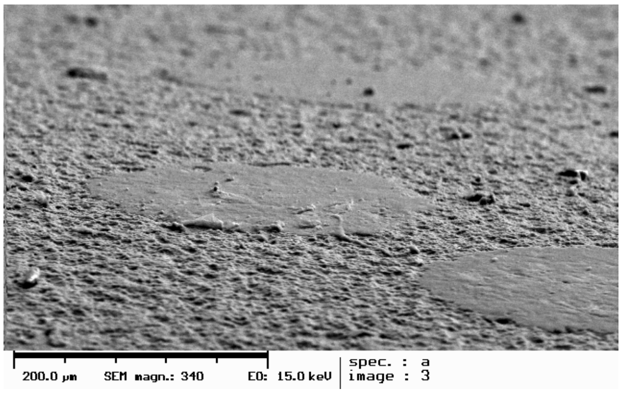

Figure 2. Hot-melt dot on an Aluminium surface

In Fig. 2 a imaged dot on the aluminum surface is shown. A sharp dot with a good contact to the Aluminum surface is seen. Test prints are done with this master coating. Fig. 3 shows that the offset printing process is running very well. The printed dots show a good sharpness and a full tone coverage.

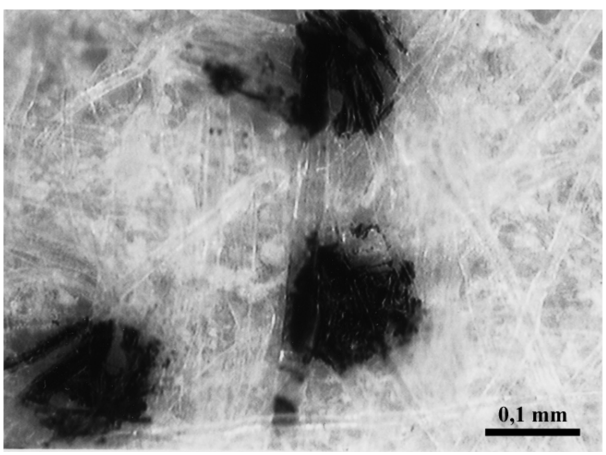

Figure 3. Printed dot by an offset process with and hot-melt ink jet master

The resistance of the ink layer was very poor for standard hot-melt inks. After 50 to 100 revolutions a significant reduction of the print quality was noticed, independently to the temperature of the surface during the imaging process.

Conclusions

Our approach for a hot-melt CtC process which is introduced in this paper leads to some advantages. First, the imaging unit could be realized by standard ink jet heads which are used also in office printers. Therefore we expect benefits for the pricing and the build-in conditions of such an imaging unit in a production offset press. Also the chemical conditions of the hot-melt ink gives the chance to design a system which prints und conventional offset conditions, especially using standard offset inks.

The resolution of todays print heads is not high enough to reach high quality printing. But for applications with lower quality requirements like news paper print 600 to 900 dpi are adequate.

The further work which has to be done by our group is to optimize the ink formulations and the surface conditions of the master cylinder to obtain a stable performance at higher run length an a sufficied erasing procedure.

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