Computer to Press with Inkjet Imaging

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Abstract

Direct digital in-press plate making (Computer to Press) widens significantly the range of application for conventional Offset presses. It brings the press closer to the pre-press system and closes the actual gap of automation between plate making and printing. It increases especially the short run productivity by shortening the change over time between to print runs. It offers additional features like press calibration or automatic press presetting and control.

The paper deals with an approach to realize digital in-press plate making by inkjet imaging: A polymerising ink accepting liquid is deposited image wise on a hydrophillic substrate to create an Offset print forme. Starting from the well known continuous jet (Hertz) method the modifications are discussed which are necessary to end up in a plate making system. Emphasis is put on the substrate (plate) and transfer materials (inks), that have to meet manyfold demands: the easy operation of the inkjet device and the suitability for the Offset process. The technological potential is discussed in terms of e.g. image quality, imaging speed and run length.

Introduction

MAN Roland is number two among the printing press manufactures around the world and is selling newspaper and commercial web presses as well as sheet-fed presses in a big variety of format sizes. These conventional offset machines are produced mainly for industrial applications and represent the high end of quality, productivity and reliability. The print quality corresponds to a resolution of 2500 dpi or even more of the image setters and is limited by the paper quality more than by the printing process. Typical printing speeds are e.g. 15 m/s web speed in newspaper printing, 50,000 copies/h for commercial web presses and 13,000 copies/h for sheet-fed presses. Most common run lengths of individual print jobs are in the range of more than 100,000 in newspaper printing down to around 5000 for the smaller sheet-fed presses.

In conventional offset printing all copies are printed from a permanent print master. Offset print masters usually are imaged outside the press in a multi step process which comprises color separation and raster image processing, film generation on an image setter with manual or automatic imposition. The full page images are copying it to the printing plates (anodized aluminum coated with photopolymer). The developed plates have then to be mounted on the forme cylinders of the press. The different color separations have to be registered, the ink and fountain systems have to be adapted according to the contents of the image and a number of other presettings have to be done until the first acceptable copy is to be printed. So in contrast to the high printing speed the change over from one print job to another is rather time consuming and expensive, typically more than one hour for newspaper presses down to around 15 minutes for smaller sheet-fed presses, depending strongly on factors like number of colors/printing units, manual or auto plate loading and press presetting, or accuracy of the print master. This down time combined with a lot of operator activities and waste paper output represent a major drawback of conventional presses in terms of cost and overall productivity and is an obstacle to economic short run production.

There are several ways to shorten and automize this press change over. Plate imaging can be accelerated and automized by so called Computer to Plate systems, plate change over can be speeded up by automatic plate loading systems combined with automatic registering and press presetting. The most advanced approach in this direction are Computer to Press systems, which already have been introduced to the market (Heidelbergs GTODI) and certainly are a major R&D topic of press manufacturers.

Computer to Press (CTP)

A Computer to Press (CTP) system is characterized by the following features:

- **Image once, print many:** The print forme generation and the printing process are separate, the printing process works with a permanent print master. The press speed is therefore not limited by the imaging (data rate), but only by the printing process (paper handling, ink transfer, drying). Conventional printing processes like offset printing can be used.
- **Direct, digital imaging:** There is a complete digital image data processing and transfer from the creative prepress system including page lay out and imposition, color management and separation, raster image process-

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ing and screening and at least fast data transfer to the imaging unit.

- **Automatic in-press imaging:** The forme cylinders are imaged within the press without manual operation and with register accuracy. Modified electronic (NIP) printing technologies can be used for imaging.
- **Reusable or renewable print forme substrate:** After each imaging/printing cycle the forme cylinders of the press have to be prepared for the next imaging. This can be achieved either by automatic change over of a suitable imaging substrate or preferably by a complete erasure of the previous image.

So beside the already mentioned goal of accelerating and automizing the press change over the above described CTP features imply a number of further advantages:

- The single step, in-press imaging has the potential of better image quality and makes the overall process reproduceable.
- The direct link between prepress and press allows it on the one hand to use information derived from for press presettings and on the other hand to modify image data according to press characteristics.
- The high degree of automation and the prepress interface makes it easier to operate the press and accelerates the workflow (similar to computer peripheral).
- The in-press imaging replaces a lot of prepress equipment and processes including wet chemistry and has the potential to be environmentally less offensive.
- It will be possible to organize print shops according to the rules of computer integrated manufacturing. Sampling, creation, archiving, preprocessing, printing, postprocessing, storage and distribution of printed products can be done in a complete computer integrated environment comprising even multiple shops at different locations. Much of material logistics can be replaced by data transfer.

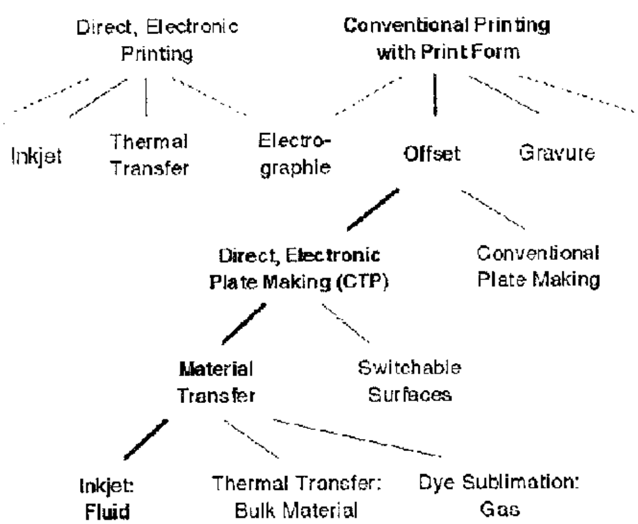

Figure 1.

Inkjet Imaging of Offset Print Formes

Conventional printing is traditionally based on permanent print masters, the different printing processes like e.g. gravure, offset, flexo or screen and their applications are strongly related to the characteristics of the print formes and the effort to generate them. One of the most suitable processes for a CTP system is certainly the offset process, on the one hand because of its proven print quality and on the other hand because offset print forme generation requires no bulk material transfer or ablation, but only the modification of surface properties: The image carrying areas of the offset master are water repellent and ink accepting, whereas the image background has to be hydrophilic. Such print formes can be generated in principal by chemically modifying the surface material or by transferring e.g. ink accepting material to a hydrophilic substrate. Image-wise material transfer can be achieved by different NIP technologies, e.g. by thermal transfer of bulk material, by dye sublimation of gases or by fluid transfer with Inkjet (see Figure 1).

Among the Inkjet applications there exist a number of technologies like Drop-on-Demand systems with thermal or Piezo actuators or Continuous Jet devices in deflection or binary mode. At MAN Roland we focused on the latter method (Hertz technique) in a configuration quite similar to Inkjet proofing devices offered e.g. by Iris Graphics or Stork. The main reasons for this choice were the following assumptions:

- Continuous jets offer smaller droplets (high resolution) at a higher droplet rate than DOD devices.
- There is no thermal stress on the fluid (reactive ink) like in Bubble-Jet print heads.

The main disadvantages of the Continuous Jet method have to be overcome:

- The control of a free jet is difficult (pollution, variations in drop generation).
- The ink must have a low viscosity and a certain conductivity.

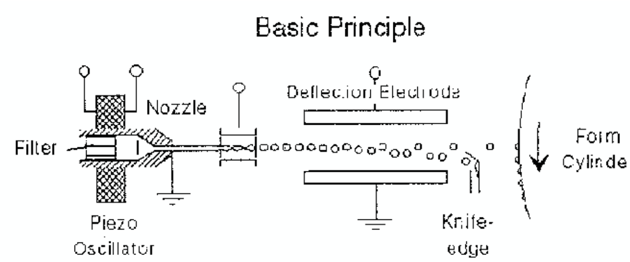

Figure 2.

Imaging Head

According to Figure 2 the well known Continuous Jet process can be described as follows. Liquid is ejected from a small nozzle under high pressure to generate a jet with high velocity. To enforce and synchronize the jet break up into uniform droplets, the nozzle is put into vibration by a piezoelectric oscillator. Using electrical conductive liquid, it is possible to selectively charge the droplets by an electrode located at the break off points. The signals at the electrode are switched between charging and zero potential, according to the desired droplet charge. The droplets then pass a strong electric field, where the charged droplets are deflected and intercepted by a knife edge. The uncharged droplets proceed unaffected to the surface of a rotating drum, in our case the forme cylinder. To enable exact single droplet addressing the switching time of the charging signal has to be synchronized with the drop break off time.

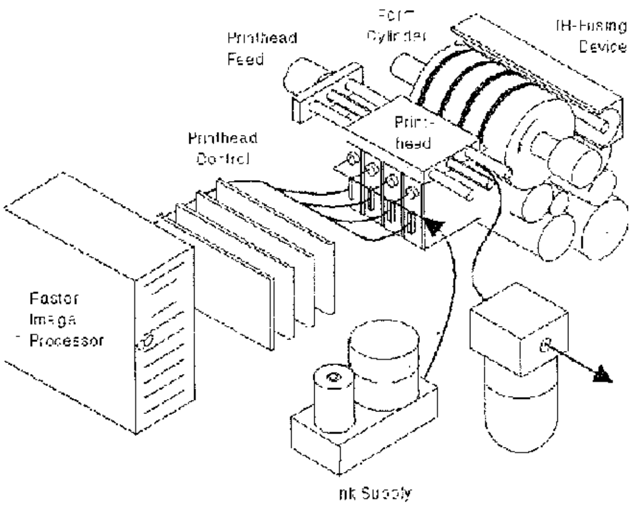

Figure 3.

Based on this principle we developed a R&D model of the imaging device using nozzles from Siemens-Elema. The main components are sketched in Fig. 3, with the following characteristic features:
- four nozzles with a diameter of 10 µm, in a distance of 25 mm;
- jet velocity 50 m/s, droplet rate 1 MHz;
- ink supply driven by pressurized nitrogen at 3.5 MPa;
- automatic phase adjustment for each jet at each revolution of the drum;
- binary, single drop addressing at a resolution of 600 dpi and a data rate of 400 kbit/s;
- scanning by rotating drum (surface speed 4 m/s) with encoder and lead screw drive;
- data processing by a software RIP based on a 486-PC.

Materials

The substrate as well as the imaging materials have to meet all requirements of a high quality offset print master. This means:
- The substrate must be hydrophilic to avoid scumming in the image background;
- The imaging material has to be ink accepting and water repellant to provide a high image density and contrast;
- The adhesion of the imaging material on the substrate has to withstand the mechanical wear of the printing process to achieve a high runlength;
- Substrate and imaging material have to be chemically resistant against all materials involved in the printing process (ink, fountain solution, plate and blanket cleaners);
- The imaging material has to be ready for use in the range of one minute after being transferred to the substrate.

Additionally the imaging material has to be a suitable fluid for the above described continuous jet imaging device:
- The viscosity of the fluid has to be low (typically 2 mPas) and isotropic;
- The fluid must be electrically conductive (typically 5 mS/cm);
- The fluid has to be free of particles and pigments;
- There must be a way of preventing nozzle clogging and printhead crusting.

Substrate

In this first approach we used conventional but uncoated offset printing plates as substrate material. These are thin aluminum sheets with an electro-chemical surface treatment to create a thin porous layer of aluminum oxide. These substrates offer a good print quality due to excellent hydrophilic properties and also a good adhesion of transfer material. On the other hand these plates cannot be erased and reused after imaging and printing and require an automatic change over system.

Uncoated aluminum plates loose their hydrophilic properties by the fusing step after imaging. So it is necessary to apply commercially available plate cleaners before printing.

Imaging Material

The imaging material had to be specially designed for our application. We use a water based alcalic liquid with two polymer groups. The liquid is very stable as long as the pH value remains constant. When transferred to the substrate the cross linking of to polymers starts due to the evaporation of the alcalic solvent. To accelerate the reaction and to get the required adhesion and mechanic stability, it is necessary to thermally fuse the imaging material by IR radiation or hot air convection at temperatures of about 150°C.

To prevent nozzle clogging and crusting of the jet control area, it is necessary to flush the nozzles and the nozzles with purge solution after each imaging cycle.

CTP R&D Model

To investigate the total CTP process (image data processing and transfer, forme cylinder imaging and printing) we built up a R&D model. According to Figure 4 the imaging system is mounted to a laboratory web offset press (cylinder width 140 mm, diameter 220 mm) with simple inking and damping systems (newspaper quality). Fusing is done by an IR lamp. The imaging/printing process is automized to a high degree by a PLC.

The whole imaging/printing process comprises the following steps:

- RIP'ing of image data (maybe in parallel to print run)
- Replacement of the substrate material and blanket wash (~1 min)
- Imaging of the forme cylinder (2 min) and purging of the printhead
- IR-fusing of the image (1 min)
- Start up of the press
- Print run with 600 copies/min and a run length of ~10000.

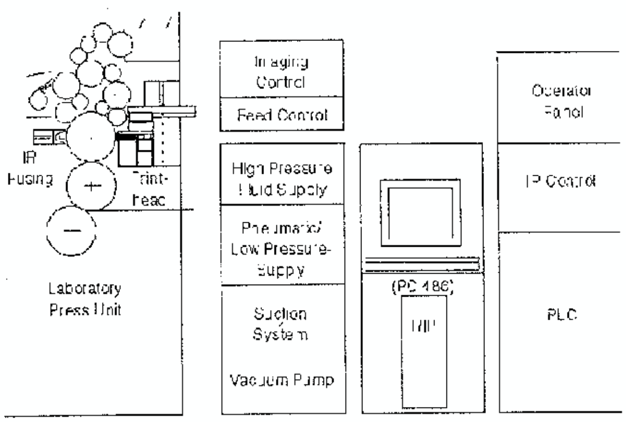

Figure 4.

Conclusion

A complete Computer to Press system based on Inkjet imaging has been demonstrated on the level of a R&D model. A short imaging time requires a number of parallel nozzles depending on the format size. The single nozzle arrangement should be replaced by an integrated nozzle array e.g. based on silicon micro machining. With the 600 dpi printhead newspaper quality can be nearly achieved. To widen the field of application a resolution of more than 1000 dpi combined with advanced screening algorithms would be necessary. The achieved runlength of 10000 is sufficient for short run printing. A major problem is still the reliability of the imaging head.

Nevertheless, the Inkjet technology has the potential to equip a Computer to Press system with a comparatively cheap imaging device at least for medium quality applications.

References

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