Establishment of Water-based Coating Technology in Perfecting Printing for Short Time Delivery

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The mainstream in the sheet-fed perfecting press industry is for short time delivery, and sales of sheet-fed perfecting presses that enable printing on both-side surfaces simultaneously are increasing rapidly. However, a problem for short time delivery is ink drying. Both-side water-based coating is a technology that may solve this problem. The establishment of this technology has enabled us to propose a printing method for short time delivery to our customers who are considering establishing their technical superiority in an effort to survive in their industry and pave the way for further expansion of sales of sheet-fed perfecting presses.

1. Introduction

The mainstream in the sheet-fed perfecting press industry is for short time delivery that enables prompt delivery of printed matters, and sales of sheet-fed perfecting presses that permit simultaneous both-side surface printing of books, magazines, catalogs, leaflets, etc., are expanding rapidly. Mitsubishi Heavy Industries, Ltd. (MHI) mobilized its techniques to meet the market needs, and in 2003 a sheet-fed perfecting press "Tandem Perfector" consisting of the world's first such unique machines was introduced to the market, realizing high-quality both-side surface printing and receiving consistently high evaluation from customers since its introduction.

However, the greatest difficulty for short time delivery is ink drying. The both-side water-based coating is a technology that may solve this problem. The establishment of this technology has enabled MHI to propose a printing method for short time delivery to its customers who are considering establishing their technical superiority for the survival of their industry using sheet-fed perfecting presses, thus paving the way for further expansion of sales of sheet-fed perfecting presses.

This paper introduces MHI's leading edge both-side water-based coating technology.

2. Present printing process and related problems

Until now, one side surface printing at printing companies has needed for front face printing, drying, back face printing and drying. Oil-based ink used in both-side surface printing requires 8 to 12 hours to dry so that a minimum of two days is necessary before starting post press process (cutting, folding, etc.).

The introduction of the perfecting press has shortened the time for both-side printing and ink drying, enabling the post press process to be done on the following day. However, the conventional printing method was unable to reduce further time, and the need could not be answered for short time delivery that would enable the printed products to be shipped on the same day the order was issued.

Meanwhile, there is the ultraviolet (UV) printing method that may be able to realize short time delivery. The greatest advantage of UV printing, which uses ink that is totally different in composition from oil-based ink, is that the ink used dries (cures) instantly as ultraviolet radiation is irradiated on the printed surface. This makes the drying process after both-side printing unnecessary. In addition, the printed ink film is hard and excels in abrasion resistance, contributing to surface protection.

However, the introduction ratio of UV printing is still around 10% among companies using sheet-fed perfecting presses. The reasons why oil-based ink users in general cannot decide to introduce the UV printing are as follows:

(1) UV dryer is expensive.
(2) UV ink is twice as expensive as oil-based ink.
(3) The materials necessary just for UV printing are all expensive.
(4) Printing techniques for UV ink differ from those for oil-based ink and are difficult.
(5) Gloss of the print is inferior (approximately 30% less than that of oil-based ink printing).

3. Technologies for achieving short time delivery

Attention has been given to water-based coating as an alternative method to UV printing. According to this method, a water-based coating is applied over undried oil-based ink so that the ink drying process can be eliminated as the water-based ink dries fast. Water-based coating is used throughout the world as a means to enhance gloss and protect print surface. This method could be more acceptable to general users than UV printing. The advantages of this method as compared with the UV printing are as follows:

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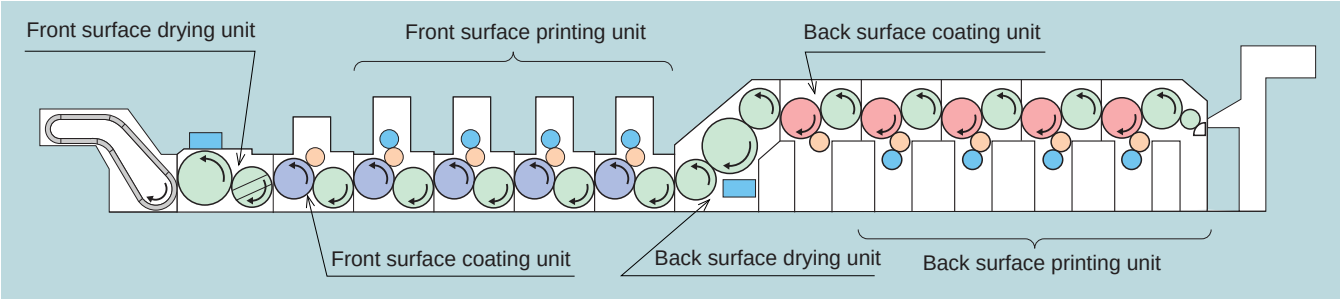

Fig. 1 Both-sides water-based coating facility configuration

(1) The cost of facilities for this method is about the same as for UV printing.
(2) Running costs are lower.
(3) No special printing techniques are required.
(4) Gloss of the print can be improved (approximately 40% improvement compared with oil-based print).

For the above reason, the techniques of water-based coating for the perfecting press have been developed.

Facility-wise, a water-based coating unit and a drying unit (including drying device) are to be added to the perfecting press (**Fig. 1**).

4. Technical problems and solutions

4.1 Optimization of paper feeding in back surface drying unit

The printed paper passing the first transfer cylinder in the back surface drying unit has the previously applied water-based coating that is about to arrive at the drying unit, so that undried coated surface is in contact with the cylinder surface. Therefore, in order to prevent the printed surface from contamination and abrasion damage, air is blown up from inside the cylinder while the printed paper is locally supported by means of a spring. In this way, stable high-speed paper transfer of up to 11 000 sheets per hour is achieved (**Fig. 2**).

4.2 Optimization of the drying system

With the perfecting press, the printed back-side surface is pressed against the impression cylinder. To prevent the back-side surface print image from being transferred to the impression cylinder at this time, the impression cylinder is provided with a ceramic jacket that has roughened surface and is treated with non-adhesive coating (**Fig. 3**).

However, if the water-based coating over the back-side print surface is not completely dried, the water-based coating surface may be exfoliated when the pressure of the ceramic jacket is applied at time of front surface printing, as shown by the enlarged sample photo (**Fig. 4**). In the present development, the following measures were taken for machine and materials in order to improve the on-machinery drying efficiency of the water-based coating:

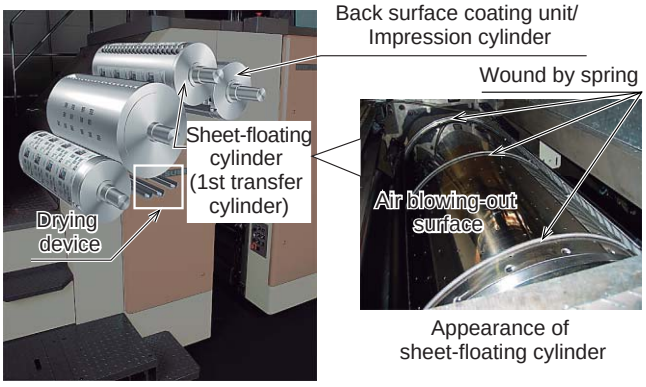

Fig. 2 Back surface drying unit

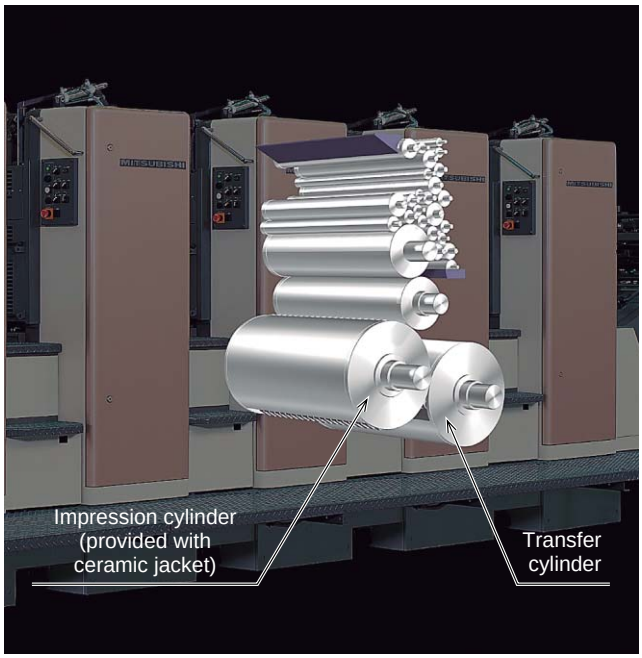

Fig. 3 Front surface printing unit

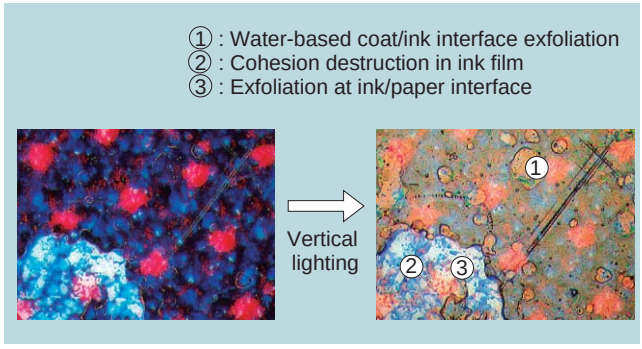

Fig. 4 Enlarged photo of sample print surface

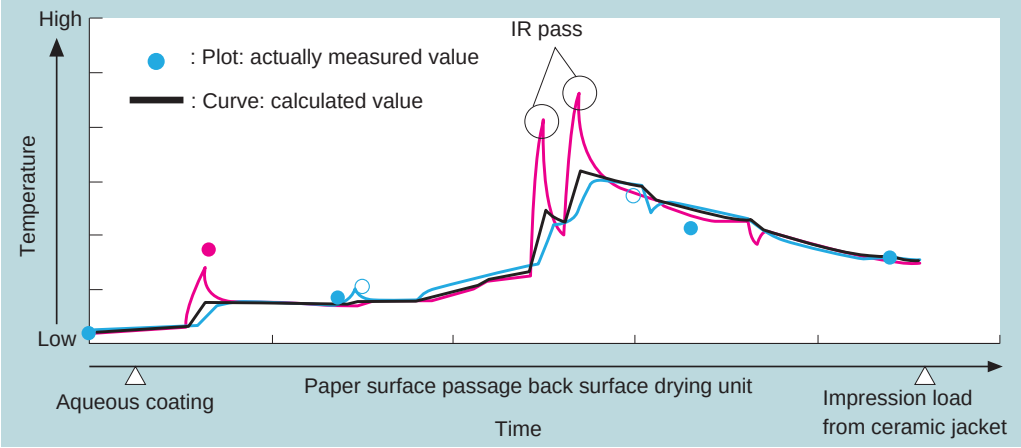

Fig. 5 Temperature distribution of paper surface on machine

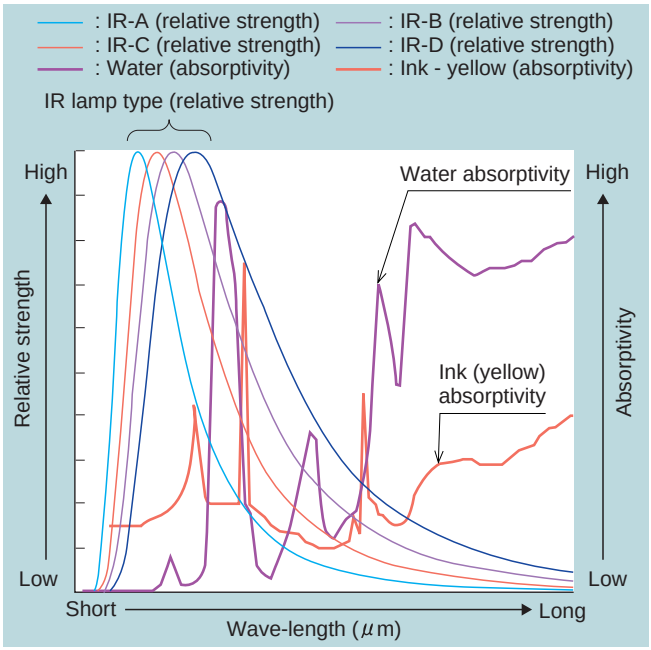

Fig. 6 Relative strength of IR and ink/water absorptivities

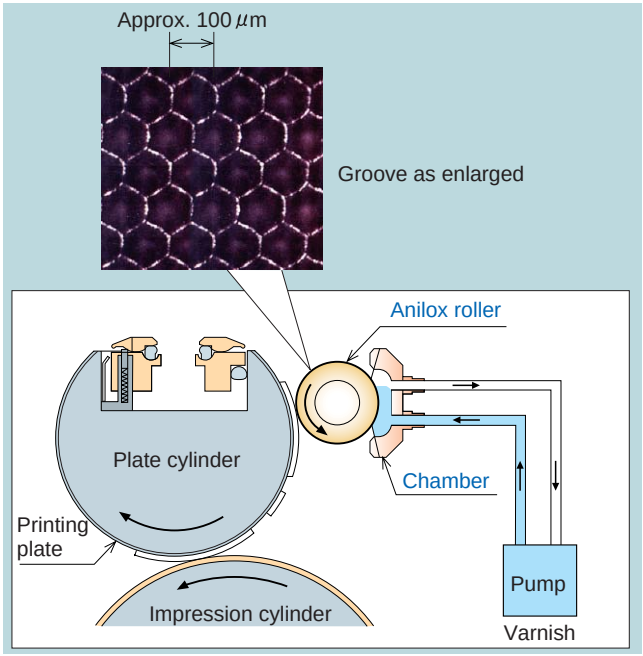

Fig. 7 Chamber coater supply system

(1) Approach from the standpoint of machinery

The principle of drying of the water-based coating is evaporation of moisture in the varnish, and it is therefore necessary to raise the temperature of the varnish on the paper efficiently in order to accelerate moisture evaporation. In the present development, the optimal layout of the infrared ray (IR) lamp and hot air units was determined following calculations and measurements of the temperature of the paper surface while it was passing the back surface drying unit (**Fig. 5**).

The temperature of the paper surface rises as the water-based coating and ink absorb IR. For this reason, an IR lamp that suits the IR absorption wave-length domains of moisture and ink was selected so as to improve the energy efficiency (**Fig. 6**).

(2) Approach from the standpoint of materials

Printing materials to suit both-side coating require that the water-based coating should have an appropriate balance between quick-drying performance and gloss (surface smoothness) and that the ink should be of quick-setting performance by high-concentration pigment type. Concerning these printing materials, materials for exclusive use in both-side printing that satisfy the above-mentioned performances were developed in cooperation with Toyo Ink Mfg. Co., Ltd.

Regarding the ceramic jacket, surface roughness configuration that would have effective non-adhesiveness on water-based coating was studied, and a ceramic jacket that would be most suitable for both-side water-based coating was selected accordingly.

4.3 Optimization of water-based coating supply system

The chamber coater system was adopted for the water-based coating supply section. This method, which transfers the aqueous varnish filled in the grooves on the anilox roller onto the printing cylinder, ensures stable supply of water-based coating whose characteristics are easily changed by the external environment (**Fig. 7**).

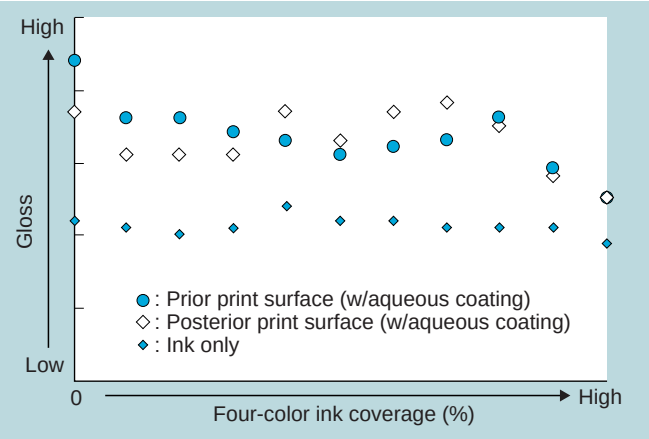

Fig. 8 Equalization of front and back surface print quality (gloss)

Water-based coating thickness can be controlled by the number of grooves on the anilox roller. Normally, the back-side printing surface receives impression pressure from the ceramic jacket, so its gloss is seriously degraded compared with the front-side surface. However, equalization of front surface gloss and back surface gloss was accomplished by changing the number of grooves on the anilox roller -- in other words, by changing the varnish supply film thickness (**Fig. 8**).

5. Conclusion

This development work has established the both-sides water-based coating technology to the specifications shown below (**Table 1**).

Table 1 Specifications

Max. printing speed (sheet/h)	11 000
Applied ink coverage (%)	0 – 280
Gloss	40 – 60 Front/back same level
Ink/aqueous varnish	Exclusive use materials development Joint development with Toyo Ink Mfg. Co., Ltd.
Ceramic jacket	Special-purpose jacket used
Varnish supply method	Chamber coater system

The introduction of both-sides water-based coating enables printing companies to meet needs for short time delivery, making it easier to procure job orders and improving business chances. It also reduces loss resulting from failure of products by limiting in-machine print damage through improvement of surface protection.

Especially in the United States and Europe, where water-based coating is widely used, demands for this technology are already high. It is therefore intended to increase the overseas market share of MHI's printing machines by introducing this newly developed type in the shortest possible time.

In the future, it is intended to globalize usable materials and improve their performances. MHI is determined to continue to introduce to the market more products that will meet its customers' needs.


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