

The DF coater – Coating technology of the new generation



Hirofumi Morita

*Voith IHI Paper Technology
Co., Ltd., Tokyo, Japan*

This article introduces the DF (Direct Fountain) curtain coater developed by Voith IHI Paper Technology. The DF coater is a relatively uncomplicated coating system with many advantages such as user friendliness, high quality of coated surface and high production efficiency. Twenty DF coaters are already in service worldwide, with widths up to 5 m and operating speeds up to 1,200 m/min, which corresponds to a maximum design speed of 1,500 m/min. The maximum design and production width currently possible is 10 m. A maximum speed of 1,800 m/min was successfully attained with the pilot coater. Voith IHI is convinced that the DF coater will be used much more for producing various coated paper grades in the near future.

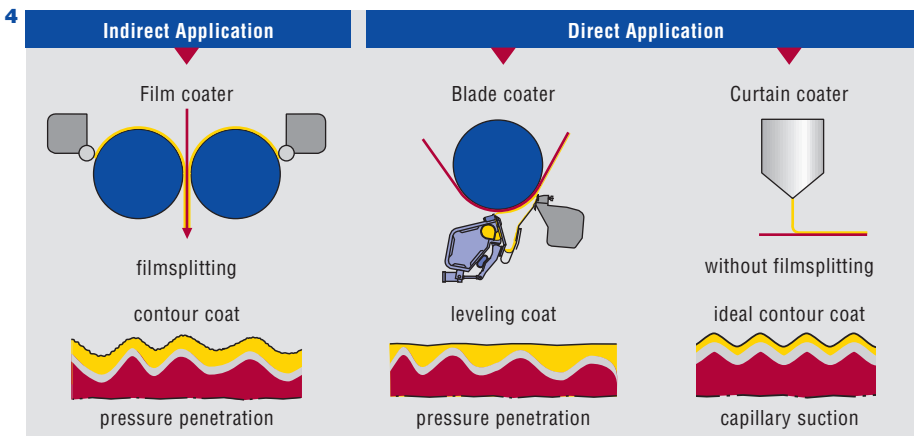
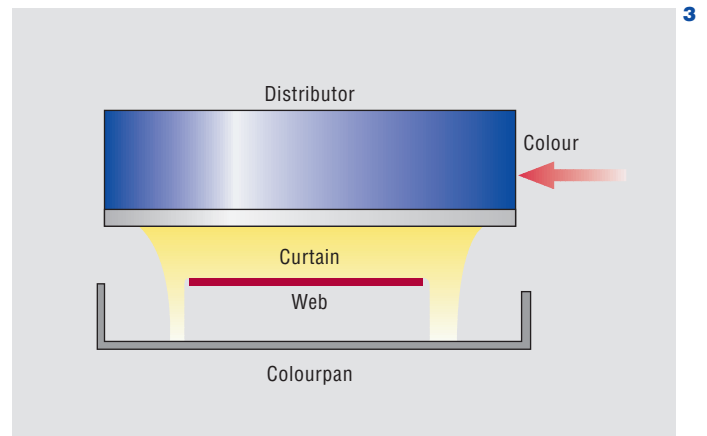
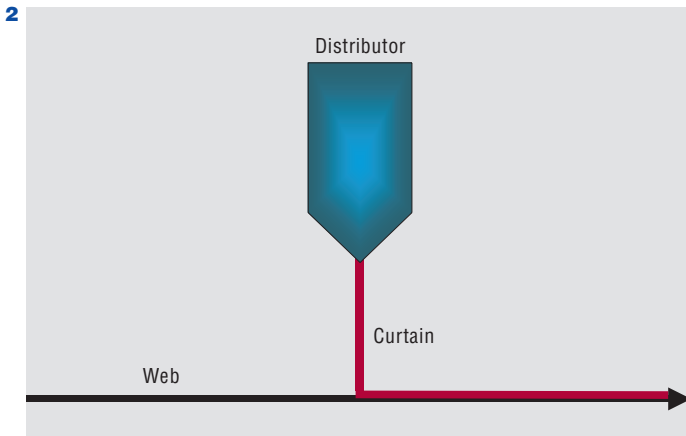


Fig. 1: Curtain coater.

Fig. 2: DF coating system.

Fig. 3: Cross-sectional view of the DF coating process.

Fig. 4: Basic coating technology.

Curtain coating (Figs. 1 and 2) is a relatively new process with very high efficiency, good coating quality, easy operation, cleanliness, etc. So far, this type of coater was hardly used in paper production, because of difficulties in controlling the air boundary layer on the web, coating color deaeration and curtain stability.

Voith IHI has solved these issues and made curtain coating market-ready. This is reflected by the excellent operation and

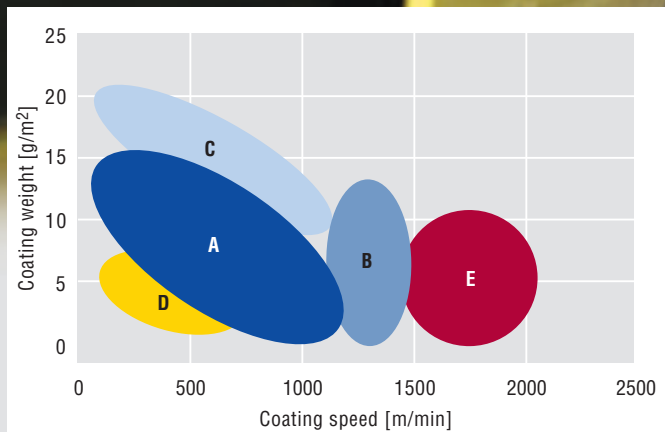
dependability of the 20 DF coaters now in operation around the world.

The DF coating process (Fig. 3)

The deaerated coating color, supplied to the distributor (curtain head), flows smoothly downward to the nozzle, where it is evenly applied to the moving web. The velocity of the curtain film flowing

out of the nozzle slot is accelerated due to gravity. When it impinges on the web, the curtain film is further accelerated and stretched. As a result, ideal coating quality is attained.

With this coating method no metering element is required after application, thus enabling a very even coating profile and uniform coat weight and very stable coat weight adjustment.



Coating method comparison

Fig. 4 shows a comparison with the main coating methods currently used, i.e. blade coating and film coating.

Curtain coating and film coating are pre-metering processes, where coating color dosage is defined prior to application.

With the blade coating method, the coating color is not metered until after application.

Since curtain coating is a pre-metering method, a very even coated surface can be achieved irrespective of web surface condition.

In the case of blade coating, penetration of coating color into the web is caused by blade load and the large amount of color during dwell time.

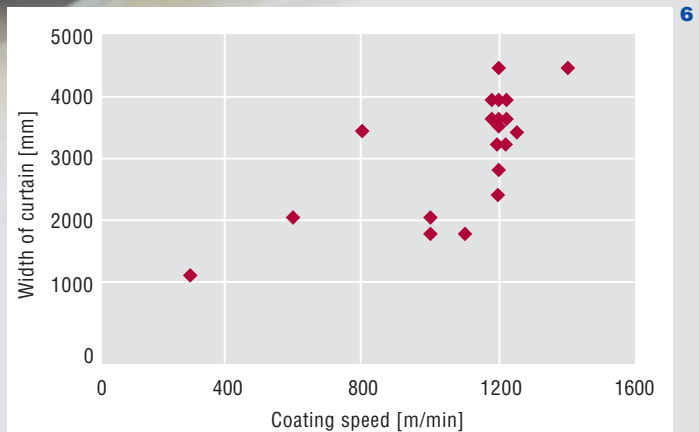
With film coating, penetration is also high due to the nip pressure applied by the rolls. In a comparison with other coating methods, curtain coating results in a more even thickness of coating film, and much less color penetration since only capillary action is involved. This is why the curtain method results in ideal contour coating.

Operating requirements and limits for the Direct Fountain Coater

For stable operation of the DF coater, the following conditions are required.

- Stable curtain film from the distributor
- Suitable coating color which spreads out evenly after impinging on the web.

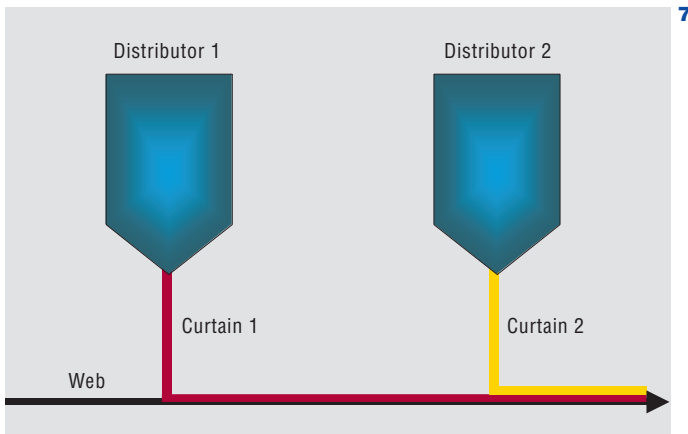
These requirements are met by appropriate mechanical performance and rheological characteristics of the coating color.



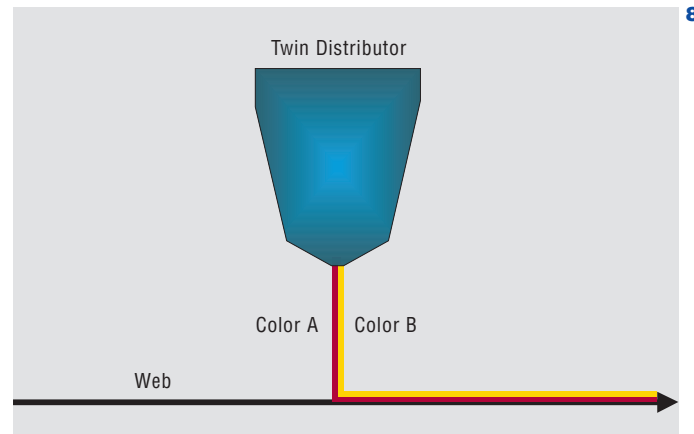
- Mechanical condition: optimal shape of distributor, stable color supply system, efficient boundary air layer removal device
- Coating color: spreadable coating color, no air bubbles, appropriate viscosity range.

The operating windows (Fig. 5) of the DF coater are significantly influenced by the rheological characteristics of the coating color, however, the general limits are as shown below:

- Window A: most suitable range
- Window B: potential range depending on rheological characteristics
- Window C: potential range with changing coating parameters
- Window D: potential range in case of relatively low solid content of coating color.
- Window E: potential range requiring mechanical improvement and coating color enhancement.



7



8

Fig. 5: Operating limits of the DF coater.

Fig. 6: DF coater references at the present time. Maximum width currently: 5,000 mm. Total units in service: 20.

Fig. 7: Double coating by single DF in tandem.

Fig. 8: Double coating by twin DF.

In the pilot trials, the possibility of coating with the DF coater in window E was confirmed.

Advantages of the DF coater

The many advantages of DF coaters compared with conventional coaters are set out below. These are mainly due to the very simple coating mechanism and ideal contour coating.

High coating quality

- Improved CD and MD profiles
- No scratches, no streaks, no film splitting
- Good opacity and coverage (ideal contour coating).

Easy operation

- No splashing, no misting
- No metering element, no blade or rod change

- No applicator roll change
- Easy adjustment of coat weight.

Low operation costs and high productivity

- Coating color savings
- Compact coating color supply and recirculation system
- No wear parts
- No down time needed for changing blades, rods, or rolls
- Less down time due to web breaks.

DF coater references at the present time

Twenty DF coaters are now in service worldwide (Fig. 6), including Japan, Asia, Europe and the USA. The working width of these curtain coaters is mostly 3 to 4 m, with coating speeds from 1,000 to 1,200 m/min. The maximum design speed is currently 1,500 m/min. The maximum

design and production width currently possible is 10 m. A maximum coating speed of 1,800 m/min was successfully attained with the pilot coater.

Future development of DF coaters

The ongoing improvement of coating colors for curtain coating will also enable pigment coatings with high solid content for graphic papers in the future. Particularly in the case of woodcontaining LWC paper with very low wet strength, the DF coater may be very effective.

Due to contamination and noise, it will become increasingly necessary in the future to replace existing air knife coaters with DF coaters for board production. In the near future double coating – wet on wet – will be possible using two DF coaters in tandem, or a twin distributor (Figs. 7 and 8).



**Masahiro
Murakami**

**Director/Mill manager,
Nippon Paper Industries Co.,
Ltd., Nakoso Mill**

We are pleasantly surprised by the excellent performance of Voith IHI's DF Coater Head installed on the No.4 Coater in our Nakoso mill since 2001.

We trust that the DF Coater Head will enhance our reputation and competitiveness to fully comply with our operation and quality requirement for customer satisfaction.



**Shinichi
Suzuki**

**General Manager, Production
Dept., Mitsubishi Paper Mills
Ltd., Takasago Mill**

Takasago 12 CM (Mitsubishi Paper Mills) was designed as a high-speed coating machine for carbonless copying paper. It

started operation with coating color on October 16, 1998 and soon after started commercial operation without any problems.

We already had experience with DF coating operations in the medium speed range (700 m/min), but it was a first challenge for us to handle a higher-speed (1,200 m/min) and wider machine (1.7 m - 2.6 m). We therefore carefully investigated the technical issues using the pilot coater in Voith IHI several times and established the most suitable air deflecting system and color preparation, which we succeeded in, starting up without any problems.

We soon reached a normal commercial operating speed of 1,200 m/min at an early stage after start-up and, furthermore, we achieved a DF coating design speed of 1,500 m/min. Now we are able to produce carbonless capsule paper with one of the highest efficiencies in the world.

The DF Coater gives us higher performance than other coaters both in terms of quality and productivity when producing information papers in our mill. And especially from the operational point of view, we are sure that this method of DF coating is much superior to other coating methods because there is less noise, less mist and the machine is therefore easier to operate.



**Michael
Boschert**

**Head of Division, Production
SD and Production Manager for
Thermal and Carbonless Copying
Papers at August Koehler AG**

August Koehler AG, headquartered in Oberkirch/Germany, was founded in 1807. The family-owned company is today one of the world's leading manufacturers of specialty graphic papers. The Koehler Group manufactures not only decor papers but mainly also coated papers like carbonless copying and thermal paper. Our company has long been associated, in a spirit of partnership, with Voith AG as the process supplier for our systems.

In the field of coating we have again implemented pioneering innovations together with Voith. Since the highest demands are made on the functional coat in terms of functionality and uniformity in machine and cross directions in the thermal paper market segment, we decided to place our full trust in the new development "Curtain Coating". As a first step, our CM1 was re-equipped for this method and simultaneously the new CM 2 designed with a DF Coater (Direct Fountain) and ordered from Voith.

Following preliminary trials at Voith IHI in Japan, it soon became clear to us that only the DF Coater can meet our high demands on thermal paper coating. What looked so simple on the pilot coating

machine then had to be implemented in the production systems.

DF Coaters are today in use on our two coating machines and a new era has begun for us here at Koehler. In our opinion, the constancy of quality reached up to now is not achievable with other coating technologies.

On all our coating units we have, in the past, had to battle to obtain a constant coating color. With the DF Coater, on the other hand, we have now achieved something that had previously been inconceivable to us. We start off with one coating color formulation and no longer need to make any corrections to this up to the end of production. Thanks to this constancy, we now have to ask ourselves: "Do we still need a quality test on the finished paper?"

As the DF Coater operates without contact, there are no longer any sheet breaks at the applicator. And because no wear parts, such as blades or rods, are used for Curtain Coating, these no longer have to be replaced.

After over six months of use, we are highly satisfied with this new and innovative coating technology and have decisively improved the quality of our papers. I am sure that Curtain Coating has a great future lying ahead of it. We at Koehler have only made the decisive beginning with specialty papers. I can well imagine that this technology could also be used for mass-produced papers such as LWC.

