

Production experience with JetFlow F

Bernhard Kohl - Frank Opletal

Four years ago the first installation of a new developed free jet coating applicator JetFlow F started up in a North American fine paper mill. Since the first installation extended pilot trials and research work showed that the use of this type of applicator has almost no limitation. Meanwhile (June 1997) 14 JetFlow F in on-line and off-line coating machines are in operation and prove the potential of the JetFlow F with regard to runnability and quality.

Although free jet application is not a new technology, the demand for high quality at continuously increasing speed in combination with easy handling and better runnability than any other coating applicator were the reason for the revival of this type of coating equipment. It suits all kind of paper grades and covers machine speeds from 150m/min up to 2000m/min. Due to the different dewatering process, coating colours could be modified and require less additives like thickener.

The JetFlow F applicator avoids and film splitting between paper and applicator roll and thus also colour splashing towards the blade. Coating colours can be optimized with regard to paper quality and coater runnability is not a problem any more.

Application principle

A free jet of coating colour is generated by a hydrodynamically optimized nozzle which is located in the six-o'clock position underneath the coater backing roll like it is shown in Figure 1. The approach flow of coating colour across the chamber through a row of holes which cause a pressure drop high enough to ensure even distribution in cross direction. The converging nozzle has a slice opening which can be adjusted between 0.6 and 1.2 mm. This gap determines the initial jet thickness and combination with the applied flow rate the jet velocity.

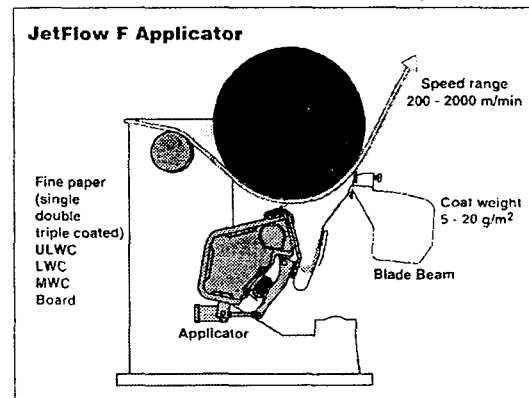
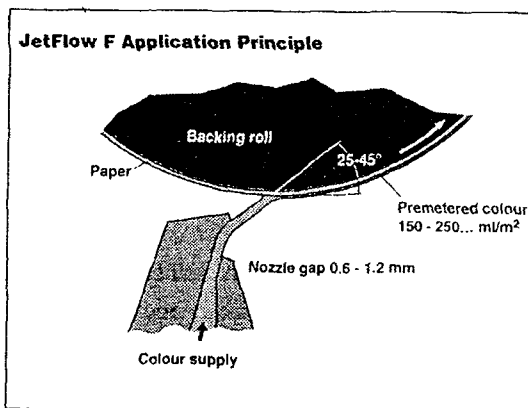


Figure 2 shows a magnification of the nozzle gap and the jet impingement area. The colour jet follows the curved shape of the nozzle body. Centrifugal forces in this region drag small air bubbles away from the side of the

coating layer which touches the paper. All air bubbles larger than 0.25 mm diameter are removed from the colour in a deaerator device between filter station and nozzle applicator.



The length of the free jet is between 6 and 10 mm and is not at all critical for the coating process.

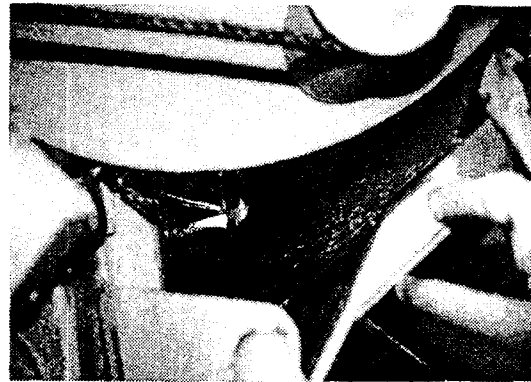
In all applications, the velocity of colour jet is significantly slower than the velocity of the paper. When impinging on the paper surface, the colour jet is stretched by a factor 3 to 5. Thus a film thickness of coating colour between 150-250 ml/m² is premetered on the paper.

An even and uniform film of coating colour can be generated for a wide range of machine speeds, paper grades and coating colour by adjusting the slice width, the flow rate (and thus the jet velocity) and the impingement angle.

The photograph in Figure 3 shows the view from tender side into the application zone of a 8 m wide LWC off-line coater. The JetFlow F-head is located bottom left underneath the

backing roll. The roll is turning anticlockwise towards the blade in the top right edge. The colour return pan is the bottom center of the photograph.

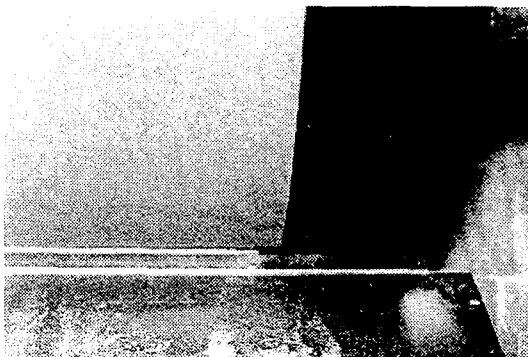
JetFlow F



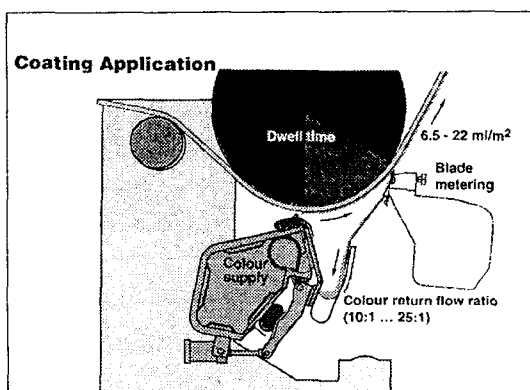
Compared to flooded nip applicator, the colour film the paper is much more even and uniform. Any filmsplitting between paper and applicator roll is eliminated and thus the streaks which occur with flooded nip applicators sometimes at speeds even lower than 1000m/min. Due to the very even film, centrifugal forces during the dwell time cannot cause splashing of fine droplets. The whole area remains clean. In six-o'clock position of the backing roll, and edge of the free jet can be seen. The free distance to the paper is in the range of 6-10 mm. The very precise edge can be positioned by an electric actuator which moves an edge deckle within the nozzle.

Figure 4 shows the edge of the free jet from the paper in-going side. One advantage of the nice edge of the jet is the even coat thickness at the very edge. Therefore in some cases a edge trimming before calendering is no more necessary. The typical flow rates and applied

JetFlow F



colour quantities are shown in Figure 5. The free jet nozzle premeasures a colour film between 150 to 250 ml/m² on the paper. Within the range of solid contents(50-65%) and coat weights(5-20g/m²), the liquid film after the blade is 6.5-22ml/m². As it is a volumetric unit, 1m/m² is equivalent to a film thickness of 1 m. The difference between the applied quantity and the final coat weight returns to the machine tank.



The amount of colour applied to the paper is primarily adjusted by the flow rate. It should be high enough to avoid skip coating. Experience from several start-ups showed that the film thickness for production is lower than it was anticipated and does not exceed 200ml/m². So the return factor is the range of

10-25, depending on the desired coat weight.

Production Experience

Between April 1995 and September 1996, six machines were equipped with JetFlow F applicators. The table in Figure 6 gives a survey of selected installations. Four of them are off-line and two are operated on-line with the paper machine. In mills A to D the JetFlow F replaced either a flooded nip or a short dwell time coater. In mill E a coating section with two stations was added to an existing machine instead of one Bill blade coater. In mill F an existing on-line coater with three heads will be rebuilt this summer. In this case one air knife applicator will be replaced also by a JetFlow F. The new metering element will be a grooved PC-Rollflex.

Production experience with JetFlow F

Mill	Grade	Speed m/min	Coat weight g/m ²	replaced
A, off-line	ULWC + LWC	1250 - 1550	4 - 12	roll applicator
B, off-line	LWC + MWC	1000 - 1400	5 - 16	roll applicator
C, off-line	LWC	1100 - 1400	8 - 16	short dwell applicator
D, off-line	fine paper	1000 - 1250	10 - 14	roll applicator
E, on-line	fine paper	800 - 1000	8 - 14	bill blade
F, on-line	board	300 - 650	6 - 14	roll applic. air knife

In the following there will be mill by mill individually pointed out the reasons for the installation of the JetFlow F and the special technological results in these mills.

■ Mill A: Off-line ULWC and LWC

An existing paper machine was speeded up

continuously. Especially for ULWC. This resulted in a bottle neck for the production in the coater. The existing coating stations (with roll applicators) caused many breaks and quality defects at high speeds. The targets for the rebuild are summarized in Figure 7. Immediately after installation of the JetFlow F the following production experience came up (Fig. 8).

Mill A: Off-line ULWC + LWC

Target:	<ul style="list-style-type: none"> Increase of production by 6 % higher production speed less breaks shorter cleaning time
Measure:	Built-in of 2 JetFlow F - applicators instead of roll applicators

Mill A: Off-line ULWC + LWC

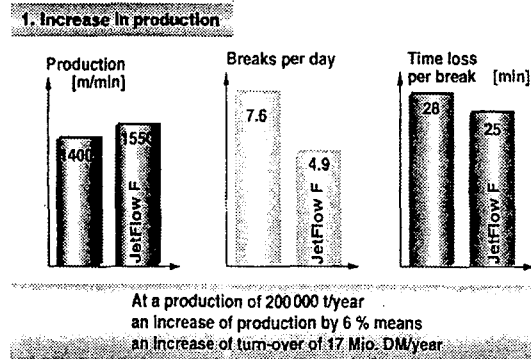
Production experiences with JetFlow F

1. Increase of production by 6 %
2. higher solids of the coating colour possible
3. less colour losses at breaks
4. less drive input at the coater needed
5. less Co-binder in the colour possible

An increase of production by 6% was reached, because the JetFlow F shows best quality even at high speed. The even premetered film provides a homogeneous coat structure. Due to the low mechanical stress of the paper at the coater (there is only the free jet) the amount of breaks per day went down.

The time loss per break could be reduced, because of less cleaning required. The results are shown in Figure 9. Calculating with 7 to 8% profit on turn-over the savings reach approximately 1,3 Mio DM per year.

Mill A: Off-line ULWC + LWC
Economical benefit of the JetFlow F:



The economical benefit are shown in Figure 10. The higher solids of colour is caused by less dewatering in the application process. Therefore the initial solid could be increased by 2% on average.

Mill A: Off-line ULWC + LWC
Economical benefit of the JetFlow F:

Result	Δ	Savings	Add-on profit in DM/year
1. Increase in production	+ 6 % rel.		1300000
2. higher solids of the colour	+ 2% abs.	250000 [gas]	
3. less colour losses at breaks	-100 l breaks	200000 [colour]	
4. less drive input			
- backing roll	- 50 %	80000	
- applicator roll	-100 %	[electrical]	
5. less Co-binder	- 0.1 % abs.	450000	
Total			2280000
Amount of investment			4000000
Redemption time			1.8 years

The old applicator roll with its pan was filled with colour and had to be emptied at a break. The colour volume in the JetFlow F is

Production experience with JetFlow F

much smaller and thus the colour losses are reduced. Of course the JetFlow F requires less drive input. And last but not least the chemical swings are enormous. The JetFlow F applies the colour like a curtain onto the paper. Therefore the binder doesn't penetrate as much. The benefit is a reduced required amount of thickener or Co-binder. A reduction from 0.4 down to 0.3% means 450,000.-DM per year.

Putting all numbers together a redemption time of less than two years is an excellent result.

■ Mill B : Off-line ULWC and MWC

Not only the economical but the product-political and logistical reasons forced this project.

An existing off-line coater has to produce single and double coated LWC and MWC. The targets for the rebuild are shown in Figure 11. Especially the flexibility of the coating application are focused.

Mill B: Off-line LWC + MWC

Target:	Capacity increase - higher production speed
	Quality improvement - better coating coverage
	Wider production range - 5 - 16 g/m ² - 250 - 2500 mPas - LWC and MWC
Measure:	Built-in of 2 JetFlow F - applicators instead of roll applicators

The production experience(Figure 12) are shown by two most demanding grades. The

very low and the very high cost weight. In both cases the JetFlow F proves its high performance. Very interesting are the good profiles at high cost weights. Due to the even premetered film the final CD profiles are excellent through the whole range.

Mill B: Off-line LWC + MWC

Production experiences with JetFlow F:

Feature	before problems with roll applicator	Advantages of the JetFlow F
MWC - top coat 5 - 6 g/m ²	coat weight too high lower solids needed lower viscosity needed limited in quality and speed	low coat weight easy adjustable high solids possible high viscosity possible less migration better colour hold out higher gloss
LWC - single coat high coat weight 14 - 16 g/m ²	"Colour rings" caused by film splitting poor CD profiles limited in quality and speed	even and homogeneous coat structure good profiles at high coat weights better quality at higher speeds

■ Mill C : Off-line LWC

An existing LWC-line had to increase the production speed. The SDTA-applicators were the bottle neck. Especially high cost weight could not be handled at higher speeds than 1200m/min(Fig. 13).

Mill C: Off-line LWC

Target:	Capacity increase - higher production speed (1400 m/min) especially at high coat weights (> 14 g/m ²)
Measure:	Built-in of 2 JetFlow F - applicators instead of SDTA - applicators

The production experiences exceeded the targets by far (Fig. 14). From the very beginning at maximum drive speed excellent

quality could be produced. Of course at high coat weights. The results in gloss and smoothness were significant better than expected.

Production experiences with JetFlow F:

1.	Capacity Increase - by higher production speed - by higher coat weight
2.	Better quality - no SDTA - streaks - higher gloss and smoothness - better CD profiles
3.	More production - less losses at the reel spools due to better CD profiles

The improved CD profiles lead to much better reel build-ups. The paper losses could be reduced. The economical benefit is summarized in Figure 15. A redemption time of less than one year is great.

Mill C: Off-line LWC

Economical benefit of the JetFlow F:

Result	Δ	Add-on profit DM/year
more production	+ 6 %	1300000
higher coat weight (same base paper)	+ 4 g/m ²	1600000
less paper losses	- 4 cm each spool	2000000
Total		4900000
Amount of Investment		4000000
Redemption time		10 month

■ **Mill D : Off-line Fine Paper**

The quality demands for double coated woodfree papers are steady increasing. Additionally for competitive reasons the productivity must also improved. This was the over all reason for rebuilding the four-head

Mill D: Off-line Fine Paper

Target: **Quality Improvement**
 - better coat structure at high speeds
 - avoiding streaks
 - less up-concentrating of coating colour

Capacity increase
 - less breaks
 - shorter cleaning time

Measure: Built-in of 2 Jetflow F - applicators instead of roll applicators in coater station No. 3 and 4 in a four-head off-line coater

Mill D: Off-line Fine Paper

Production experiences with JetFlow F:

Feature	Before problems with roll applicator	Advantages of the JetFlow F
Coat structure	not stable, at high speeds irregular	even premetered film to the paper homogeneous coat structure
Coating defects - streaks	created by film splitting	no streaks
Use of bent blade	the CD and MD coat weight profiles are not controllable at high speed	even premetered film better profiles with bent blade

Mill D: Off-line Fine Paper

Production experiences with JetFlow F:

Feature	Before problems with roll applicator	Advantages of the JetFlow F
Often breaks at coater 3 and 4	the paper is stressed twice: at the applicator roll nip and at the blade the splice is wetted through	no nip → no stress not contacting edge blades during splice the colour is switched off to a bypass 30 % less breaks
cleaning time too long	expensive cleaning of coater pan, applicator roll and backing roll	less parts in contact to the colour shorter cleaning time

off-line coater (Fig. 16). Due to economical evaluations only coating station No. 3 and 4 were equipped with JetFlow F. The production experiences are shown in Figure 17 and 18.

Production experience with JetFlow F

Remarkable in this case is the following. This paper producer decided to install in a new four-head coater 4 JetFlow F.

We are convinced that the JetFlow F - being successful in the moment-will have a promising future.

■ Mill E : On-line Fine Paper

An existing on-line coater with an old fashioned applicator was no more suitable for the economical production of good quality. It had to be exchanged. To get a modern on-line coater the existing after dryer section was splitted and two complete JetFlow F coating stations were installed. From the very beginning the targets were hit (Fig. 19). The quality and efficiency is good.

Mill E: On-line Fine Paper

Target:	Quality Improvement <ul style="list-style-type: none">- no two sidedness of the coat- higher coat weight- high quality at high speed
	Capacity Increase <ul style="list-style-type: none">- higher efficiency of the on-line coater- higher speed
Measure:	Built-in of 2 complete JetFlow F - coaters instead of a Bill blade coater

Gathering the experiences of this customer there come out the three big strength of the JetFlow F (Fig. 20).

Mill E: On-line Fine Paper

Production experiences with JetFlow F

