

New concepts for coated mechanical papers



Dr. Michael Trefz

*Voith Paper
Heidenheim, Germany*

Low paper prices and competition from improved supercalendered and coated woodfree paper are threatening the market position of coated mechanical grades (lightweight coated paper). Producers are under pressure to reduce their production costs while maintaining or improving the paper quality. This situation is the background for the development of new on-line concepts that provide maximum efficiency with greatly reduced costs for equipment. These concepts and their potential will be discussed in this paper.

Lightweight coated papers are best characterized by their basis weight range and quality figures. In general, they are produced from stone groundwood or TMP and include between 15% and 50% kraft fiber. They are used for offset and roto-gravure printing, and the different print processes require certain differences in paper-making and finishing. The following table gives a survey of the typical product characteristics.

Machine concepts

Traditionally LWC papers are blade coated and supercalendered. Many of today's major production lines were installed in the 1980's and include a paper machine, an off-machine coater, re-reelers and two or three supercalenders.

Later in the 1980's, large machines with on-line coaters were built. It became at-

Fig. 1: Development of coater concepts.**Table 1:** Typical properties of LWC paper.**Table 2:** Comparison of machine concepts.

Property	Unit	Offset	Roto
Basis weight	g/m ²	48-70	48-70
Gloss 75°	%	45-60	45-65
PPS-10S	μm	1.1-1.6	0.8-1.2
Bulk	cm ³ /g	0.8-1.1	0.78-1.0
Brightness	%	66-72	66-72
Opacity	%	88-94	90-96

	Concept A	Concept B	Concept C
Max. Speed (m/min)	1,700-1,800	1,600-1,800	1,600-1,800
Line Efficiency	75-85 %	73-84 %	75-85 %
Investment cost	100 %	70-75 %	60-64 %
Manpower req.	4	2	2
Quality aspects	Offset & Roto No limitations	Offset & Roto with blade Offset only with film	Offset only 10 g/m ² max. coat weight

tractive to save all the investment and space for the re-reelers and the off-machine coater. As a trade-off, the overall efficiency of such a machine with online coaters was slightly reduced.

In the early 1990's, improvements in the application of hot soft calendering made it possible to develop the first LWC machines with both coating and calendering on-line. Another reduction of investment (no supercalenders) and an even more operational challenge came along. Machines like Port Alberni PM 5 and Ortviken PM 4 started in early 1996.

In the late 1990's, another milestone in calendering technique made it possible to consider multinip-calenders with polymer covers on-line. An even better quality can be produced with this new concept.

Fig. 1 and Table 2 show a general comparison of available machine concepts for coated mechanical grades.

Concept A is the conventional off-line blade coater with a re-reeler between paper machine and coater. Concept B is the on-line coating section within the paper machine. Concept C is also an on-line coating section, but with only one coater

station for simultaneous coating of both sides of the paper. The coating section for concept A (off-line) requires roughly double the space as concept B (on-line). Most of the additional space is needed for reel transport from the PM to the re-reeler, the re-reeler itself and the unwind for the off-line coater. The significant difference in price is mainly influenced by the additional equipment such as three reels instead of one, continuous unwind with flying splice, more reel spools, parent reel transportation carts.

The difference between concepts B and C is the number of coating stations. In concept C, the coating is applied simultaneously to both sides of the sheet with a premetered film coater. Having only one coater station instead of two provides another reduction of investment costs. The efficiency is in the same range as with concept B. However, there are certain trade-offs coming with the film coating technique as well as with the simultaneous application that will be discussed in the next chapter. The comparison of the concepts A to C is summarized in **Table 2**.

It is shown in **Table 2**, that the significant differences are the investment costs and the number of operators needed.

Concept C with only one coater station on-line is the most economical production line for coated mechanical grades as long as only offset paper is produced. It is still not possible to produce the smooth surface needed for rotogravure printing with the film coating technique. The advantages and limitations of film coating are discussed in the following chapter.

Potential and limitations of the new concept

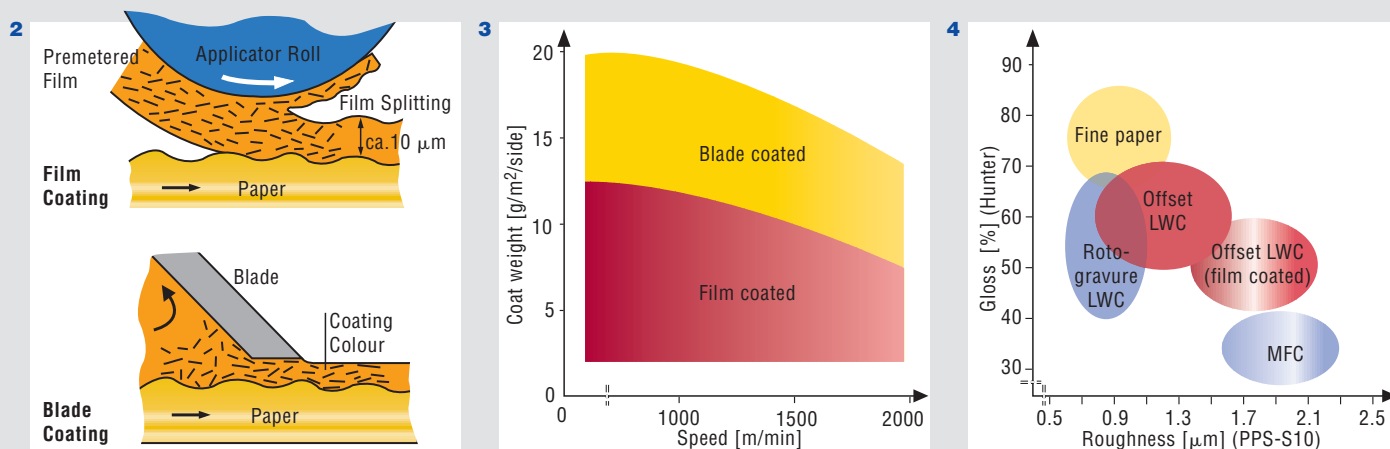
A major breakthrough for coated mechanical paper was the rapid development of the film coating technique in the early 1990's. Advances in equipment and – more important in coating color formulations – made it possible to produce film coated LWC paper for offset printing with a quality according to **Table 1**.

The driving force for this development was the fact that film coating imposes much less stress on the paper during the coating process. While the blade is a perfect digital hole detector – each hole causes a break – film coaters promise a greatly increased efficiency. The reduced paper stress allows also to reduce the

Fig. 2: Principle difference between film and blade coating.

Fig. 3: Max. possible speeds and coat weights for film and blade coating.

Fig. 4: Gloss and roughness values for coated mechanical grades.



amount of kraft fiber from a level between 40% to 50% down to somewhere around 20% and below. This fundamental difference is also a major contribution to any return-on-investment calculation.

The advantage, however, comes at a certain price. With maximum possible paper machine speeds reaching 2,000 m/min, film coating requires careful optimization of both the base paper properties and the coating color formulation. The reason is shown in Fig. 2: While the blade more or less levels the surface topography of the sheet, film coating applies a film of color with a constant thickness of 10 to 15 microns onto the paper. It is obvious that a rough base paper will be rough after coating. Also the two-sidedness is much more difficult to compensate with film coating and should be avoided as much as possible by carefully designing the wetend of the paper machine.

The major challenge for the quality is the film splitting effect. The elongational forces at the nip opening cause a disturbance in the alignment of the mineral

pigments on the sheet surface. This is the reason why it is generally more difficult to reach similar gloss and smoothness levels as with blade coating. This problem is solved by using very glossy clay pigments and also some plastic pigment to enhance the final sheet quality.

Another aspect to be considered is the misting of color droplets created in the outgoing side of the nip at high speeds and high coat weights. These effects limit the film coating technique today to the areas shown in Fig. 3. There should not be a problem for coat weights of 8 g/m² and speeds up to 1,800 m/min. But beyond that, careful optimization and adaptation of the coating color to the base paper is mandatory.

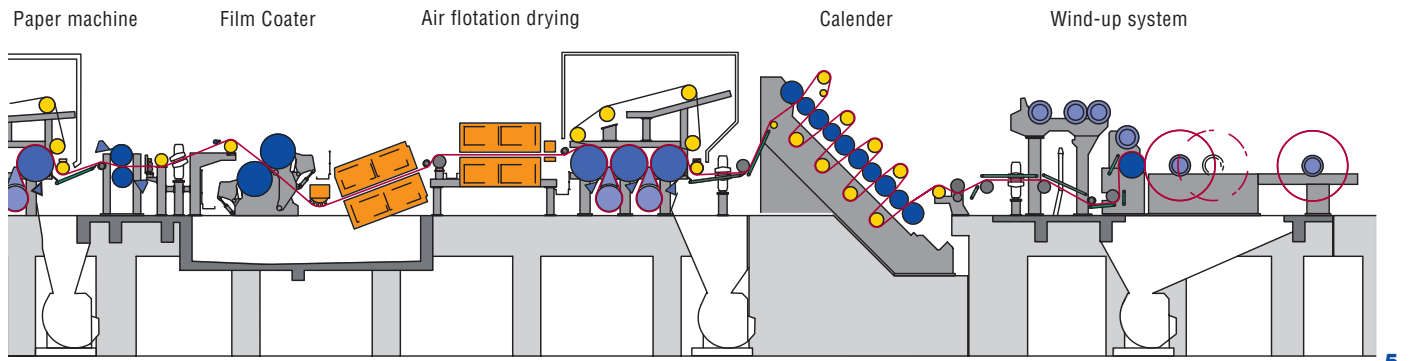
Finally, the use of film coating for light-weight coated paper was made possible by new calendering techniques. While conventional blade coated paper produced with machines from the 1980's is finished with supercalenders, newer machines are equipped with hot soft calenders or multinip calenders with polymer

covers that allow high surface temperatures. The changes in the calendering technique, which is primarily an increase in steel roll temperature, new polymer covers, and the development of heat sensitive coating color components such as plastic pigment made it much easier to reach satisfactory gloss levels.

A more detailed analysis of the quality potential is shown in Fig. 4.

Film coated LWC can be produced with surface roughness between 1.3 µm and 2.0 µm PPS, depending on the base paper roughness and the calender configuration. As it is shown in Fig. 4, blade coated and film coated LWC qualities overlap in the area around 1.3 to 1.6 µm PPS. Gloss levels are almost equal.

A medium quality blade coated paper is as good as a premium film coated one. This requires a coat weight of 10 g/m² per side. Although film coating has some of the above discussed limitations with regard to speed, coat weights around 8 g/m² are possible at 1,800 m/min.



Practical aspects

Film coated LWC with on-line calendering is produced since 1996. The first two machines are using two separate film coating stations and hot soft calenders.

Main reasons to go for this concept was the advantage of independent control of coat weight, coat weight profile and sheet release with single-sided application.

The investment costs for the coating section, however, is about 30% higher compared with only one film coater for simultaneous application. This was one motivation to further develop the most economic machine layout as it is shown in **Fig. 5**.

In this layout, the coating color is applied simultaneously with a film coating station. As the sheet is coated with 8 to 10 g/m² per side, a contactless sheet run into a drying section is required. The first contact of the sheet with a roll surface should be at a point where the color is dried beyond the immobilization point.

Otherwise color build-up on guide rolls would damage the sheet surface. The standard element for a contactless drying section is an air turn to guide the sheet into the required direction. The air turn is typically followed by an air flotation dryer

to evaporate the water. Since there is only little danger of print mottle with lightweight coated grades (and coat weights below 10 g/m²), the evaporation rates can be chosen higher than in fine paper coating.

Other than in earlier installations, there are no more hot soft calenders used. They are being replaced by new developed multinip calenders with polymer covers and steel roll temperatures between 120° and 140 °C.

The lower temperature is a major operational advantage over the hot soft calender, and technologically it is compensated by the number of nips that produce the critical surface roughness. Spacewise there is no significant difference between both calender concepts.

By middle of 2000, the first machines with this concept started up in Germany and Switzerland. Compared to the conventional concept with the off-machine coater and the supercalenders, the investment costs are dramatically reduced (about 36% to 40% less, according to **Table 2**).

On the other hand, a very high degree in automation is required to keep the line efficiency around the 80% value.

Fig. 5: Modern machine layout for light-weight coated grades with simultaneous film coating and online calender, design speed 1,800 m/min.

The quality will fit into the typical range for light weight coated offset papers. A good example how development of new techniques such as film coating and multinip calendering dramatically decreases the investment costs while the quality is maintained. The new concept is a suitable upgrade for older newsprint or uncoated mechanical machines.

The new PM 4 at Perlen Papier in Switzerland to a similar concept as shown in **Fig. 5** is a perfect example for that. The completely new machine that replaces an old newsprint machine started up in the summer of 2000.