State of the Art Machine Concepts for Specialty Papers

Almut Kriebel[1], Peter Mirsberger[1] and Martin Tietz[2]

1. Process Technology Speciality Papers Voith Paper, GmbH & Co. KG, Ravensburg, Germany
2. Technology and Development Coating, Voith Paper GmbH & Co. KG, Heidenheim, Germany

ABSTRACT

"Specialty papers' define a very wide range of different paper grads, with a variety of specialized end uses. Due to small tonnages, many grade changes and a dynamic grade development, flexibility is a key word in the production of these papers, Many paper machines have been partly rebuilt and high-tech components have often been installed in order to fulfill the quality requirements. This paper covers some typical high-tech components of a paper machine for specialty papers, including offline coating quality requirements and flexibility are discussed.

INTRODUCTION

Requirements of Specialty Papers and Paper Machine

Demands on specialty papers are various, some of them are very common and simillar to commodity papers, but more distinct or with a closer tolerance. Such characteristics include profile quality, formation, smoothness, strength, thickness, porosity and absorption. Others are very particular characteristics, such as wet strength, chemical reactivity or inserts, or heat resistance. Not only the requirements are various. also the production of specialty papers covers a wide range of speed and basis weights as shown in Fig. 1.

The basis weights reach from 25 g/m² for cigarette paper up to 280 g/m² for some photo base papers The speed range extends from less than 200 m/min up to more than 1400 m/min (Gebroder Koachier company, Thermal base paper).

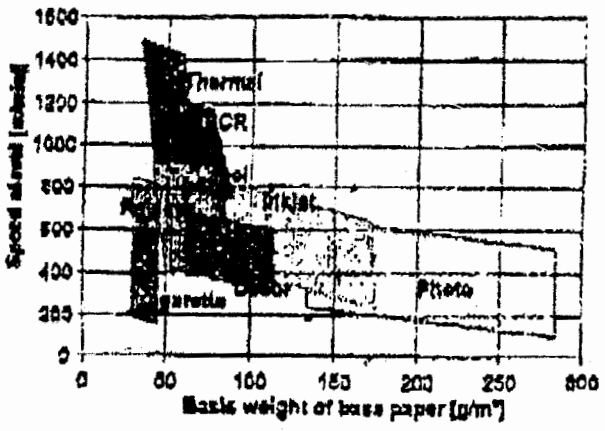

Fig. 1 Speed range and basis weight range of some speciality papers

Sheet forming concepts

Headbox

Due to the fact that most of the specialty paper grades like photo, inkjet, cigarette or label papers are cut into small formats, the basis weight profile as well as the fibre orientation must be as uniform as possible across the width. Dilution water technology for cross profile control, therefore, is a must on all these grades. With the use of dilution water, the fibre orientation profile is independent of the basis weight profile. This gives the papermaker more flexibility in optimising paper quality.

Wire section

The base sheet forming concept for specialty papers is the fourdrinler (Fig. 2). It can be used for the whole basis weight range and up to a machine speed of 1200 m/min. However, new machines may exceed this speed limit and a gapformer is used in this case. Two important quality characteristics of specialty papers are formation and MD/CD tensile ratio. The fields for the individual grades in

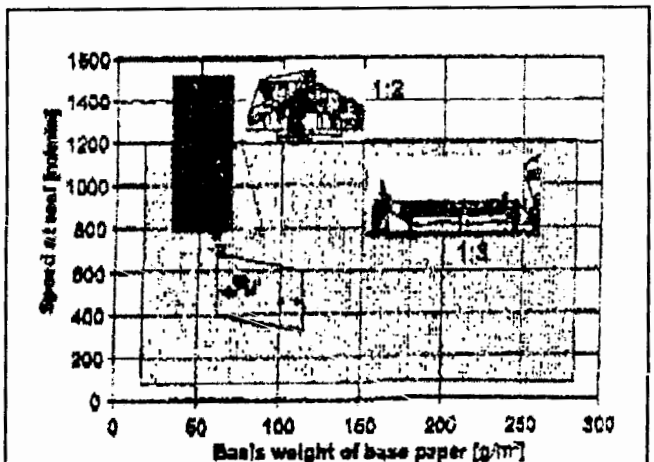

Fig. 2 Application range of the fourdrinier

Fig. 3 reflect today's quality requirement. Thee are grades like docor, inkjet and label, where not only the formation is excellent but also the tensile ratio MD/CD has to be low at the same time.

This has to do with a very important demand on these grades - the dimensional stability. All these grades have one thing in common. They absorb a huge amount of water during laminating printing or gluing. Fibres, however, swell in width more than in length when wet. For good dimensional stability of the sheet the fibre should be randomly oriented.

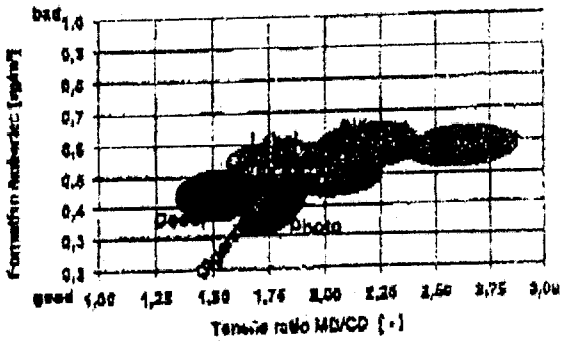

Fig. 3 Formation and tensile ratio MD/CD of diffarent grades

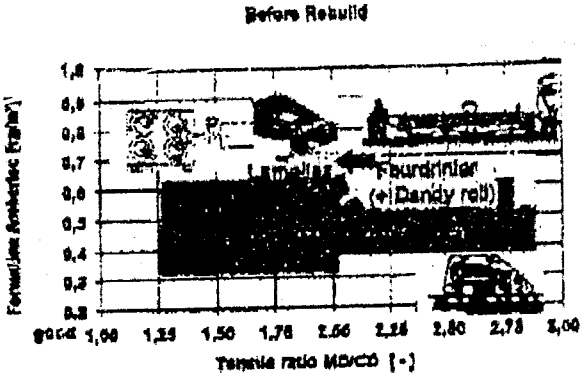

Fig. 4 Formation and tensile ratio-toole to add to the fourdrinier and their effects

In other words a square sheet' gives best results concerning dimenational stability, which means that the MD/CD ratio is 1,0:1. With the fourdrinler as the base sheet forming concept, the tensile ratio is typically between 2,0 and 3,0:1. The available tools to reduce this ratio and their effect on formation are shown in Fig. 4. With woodfree furnish, lamellas inside the headbox nozzle can reduce the tensile ratio by 0.2. The affect on formation however is small. Usually lamellas are introduced because the reduce tigee stripes. By installing a dandy roll the formation can be improved by up to 10%, but without reducing the MD/CD tensile ratio (Fig. 5).

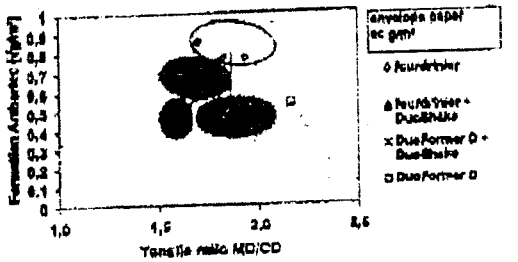

Fig. 5 Formation and tensile ratio results with different wire section, rebuilde of the same machine.

An even bigger improvement of the formation-up to 30% - can be achieved with the installation of top wire with blade dewatering, like the Duoformer D. The MD/CD tensile ratio, however, is not effected (Fig. 5). Both quality parameters can be improved by shaking the wire. The higher the frequency and the stroke, the lower the MD/CD ratio and the better the formation .The best results in formation are achieved in combination with a DuoFormer D (Fig. 5). There is, however, a significant disadvantage with conventional excenter shaking units: Vibrations are transferred via the foundation to the headbox and to the wire causing basis weight deviation in machine direction. In order to be able to play on the full scale of frequencies up to 500 /min and strokee up to 20 mm, according to the grades produced, the effect of reacting forces has to be eliminated in vertical direction, as is done with the Duoshake.

The sheet forming concept for speciality papers can be summarised as follows:

The fourarinter is the base. Depending on requirements, different options are available ad can even be combined:

- Lamallas in the headbox nozzle reduce the MD/CD ratio.
- Shaking of the breast roll reduces the MD/CD ratio and improves formation.
- With a DuoFormer D an optimum formation quality can be achived.

Press Concepts

Two aspects have to be taken into account for press concepts of specialty paper machines:

- Specialty paper machines are often upgraded in order to increasse production. In these cases space requirements are of vital importance.
- Many specialty papers have one smooth side only.

Therefore compact two nip or three nip presses are usually chosan. Both press concepts make a two sided paper, with the wire side being the smooth side. For grades like inkjet or bible paper, where low roughness figures on both sides are required, a bottom-felted straingt through press is added to reduce the roughness on the top side

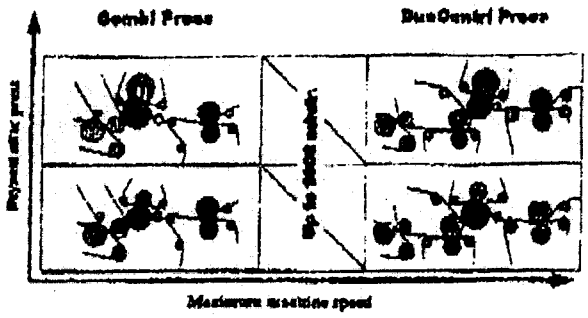

Fig. 6 Compact press concepts for pine smooth side and high runnability. Straight through press for low two sidedness

end to control the roughnes two -sidedness (Fig. 6). This press concept offers very high flexibility concerning roughness two -sideness. It is possible to reduce two -sidedness, to eliminate it and even to switch sides, depending on the line force of the straight through press.

The photo of a label paper machine shows, how compact a press with a combined pick-up and press roll can be (Fig. 8). With a total length of 4m, it even allowed to add two drying cylinders to the drying section. Before, the press section consisted of two straight through presses. A shoe press in the last nip gives best runnability because of the higher dry content in the first open draw, but conventional nips are also possible. To increase dryness even further and to achieve best CD moisture profile, a steam box can be installed between the first and second nip.

Coating

Online versus Offline

There is a trend with coatedgrades to apply the top cost online. Reasons for online are lower capital and operating costs, and higher production efficiencies. Higher flexibility and time efficiency are on the other hand reasons for offline coating. For some functional costs, like thermal paper, there is no alternative to offline coating. The solid content of the thermal coating colour is rather low and due to this heat sensilivity, the temperature must not exceed 60°C. Long drying actions are required and

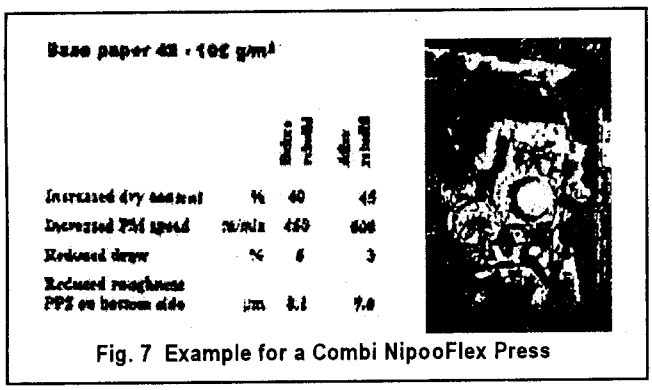

Fig. 7 Example for a Combi NipooFlex Press

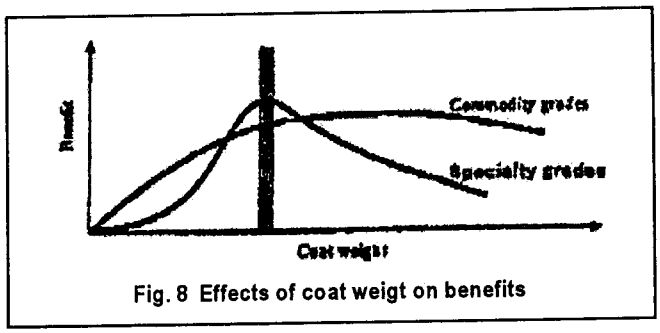

Fig. 8 Effects of coat weigt on benefits

threading would be time consuming. Coating of thermal paper will be discussed later.

Coating Concepts

State-of-the-art coating concepts are blade coating and firm coating. Blade coating is the best concept if a very smooth surface is required. It is very flexible, allowing a wide range of coat weights without changing the blade. Film coating, on the other hand, has the best runnability and is therefore preferred for online application if the levelling effect of the blade coating is not required. It is the standard application for sizing and precoating of specialty papers and is most flexible when the base papers have to be sized, pigmented or not treated at all on changing sides.

The quality of coated commodity grades generally increases with increasing coat weight. On some speciality papers, however, the quality of the print image does not improve further, once a certan coat weight is reached. Taking the high costs of the coating colour into account, the benefit drops rapidly if the coat weight exceecd the required amount. The optimum range is much smaller than it is for commodity grades, and should be hit precisely (Fig. 8). Thermal paper is a very interesting specialty paper grade in terms of coatings is NCR paper. For a correct print image a minimum coating colour thickness must be maintained, but coating colour is very expensive. The optimum coat layer should follow the roughness of the base paper with equal weight. Blade coating is not suitable for thermal paper because of its levelling effect on the coated surface, Some areas do not receive sufficient coating, other areas get more than necessary.

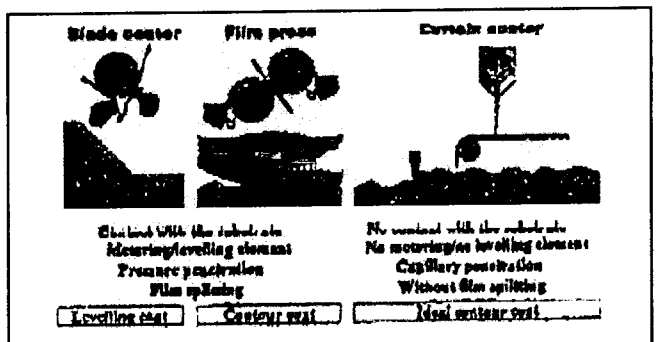

Fig. 9 Basic Principles of application techniques

Fig. 10 Curtain coater in operation

A film press would give a much better contour character of the coat. However, some of the coating medium is wasted due to pressure penetration and to insufficient contour coat or orange peel (Fig. 9).

Curtain coating

For these reassons, curtain coating has recently gained much attention for the coating of some speciality papers, like thermal paper or NCR. The application principle is shown in Figs. 9 and 10. A thin film of the coating colour is formed, which then falls down. The paper or board passes this free falling curtain at a very high speed, thus being coated with the application medium. In contrast to blade and film coating, the curtain coating operation is contact-free. This prevents film splltting , eliminates external penetration pressure and drastiscally reduces the risk of web breaks. The surface tension of the fluid as well as viscous forcess are of great importance. The coating colour formulation has to be adapted in order to form such a thin and homogenous film, which is totally stable in cross direction as well as over time and which does not break when being acclerated by the paper.

Example for a Machine Producing Different Grades

To sum up to the previous reflections, one machine shall be presented here as an example for a flexible concept. It is designed to produce different inkjet paper grades, label paper and cost coating base paper (Fig. 11). Main

Fig. 11 Example for a flexible machine concept

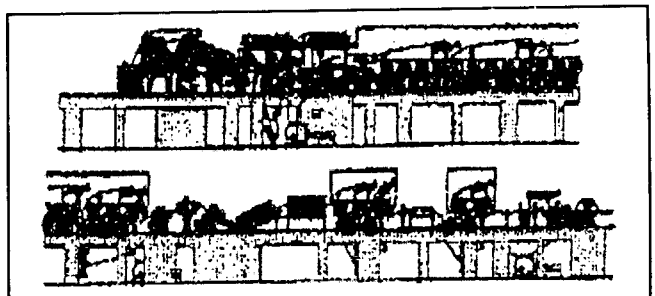

Fig. 12 Example for a high tech specialied machine concept (thermal paper, 1600 m/min).

requirements of these papers are low tenile ratio MD/CD and ome degree of coating. All but one need one smooth side, but at different levels. Ordinary inkjet paper has to be produced with two equal sides, The basis weight range is 55-115 g/m max, operating speed is 700 m/min.

The low tensile ratio MD/CD is created by shaking the breast roll. The Duo Former D is added for the formation and equal each content on top and bottom side. The two nip Combi Press is combined with a straight through press in order to achieve higher dryness and be flexible about the two sideness at the same time. Pigmented starch (both sides), the coating colour for label paper (smooth side) and the precoating colour for cast coated paper (smooth side) are applied online in the SpeedSizer. Two reverse soft nip calenders give a high flexibility in finishig.

Example for a specialised machine producing only one grade

In December 2001 a machine was started up which is speciallised on thermal paper with a basis weight range of 40-80 g/m, Design speed was 1500 m/min, so a Gapformer had to be taken. Thermal Base paper only needs one smooth side, therefore the choice was a DuoCenti Nipco Flex press (three nip compact press with shoe press in the last nip) for highest dryness, small space requirements and reduced. There is an Ecosoft calender before the SpeedSizer because it achieves a more uniform densification than a hard nip calender. Finally the off-line coating of the functional coat is done by a DF Coater (curtain coater).

CONCLUSION

It was shown that specialty papers are very challenging. Often they are produced in small quantitles. Therefore the choice of machine components depends on both special quality requirements, like two sidesness or coating surface, and the flexibility they offer to produce different grades. On the other hand fast-running, highly specialised machines are built for grades with a growing market.