

THEORETICAL STUDY ABOUT FORMING FABRIC DESIGNS

DANIELA FLORESCU IULIAN FLORESCU

University of Bacău

Abstract:

Forming fabric designs influence dewatering and formation along the total dewatering area. The development of high speed twin - wire machines makes the experience and expertise of the fabric manufacturer of paramount importance.

Keywords: forming process, twin-wire machine,

The task of the forming fabric manufacturer is to further increase dewatering and improves formation by constantly adapting fabric designs to their ever-changing environment. This implies that the correct interpretation of available fabric characteristics and the limits of their meaning fullness are understood. At the same time the understanding of how a fabric works within the dynamic sheet - forming process is gaining importance.

In principle, the formation of a sheet is a filtration process that has to be influenced in such a way that the emerging filters cake takes on "sheet characteristics". This means that the several processes happen simultaneously, namely the separation of water and fibres, and the intended or unintended creation of shear flows, figure 1.

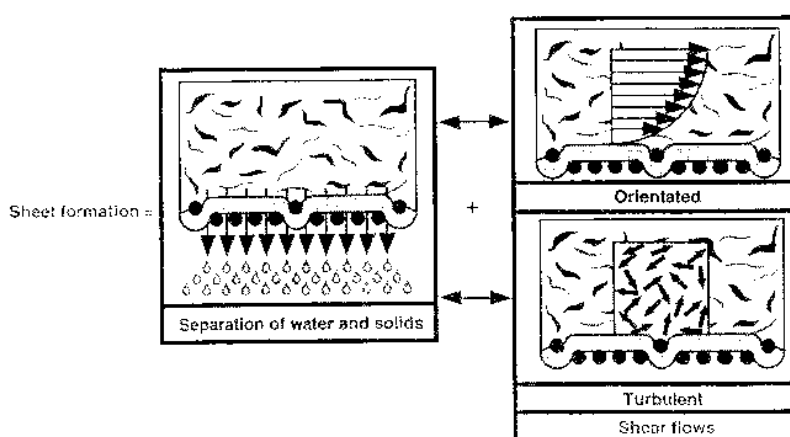


Figure 1. Schematic of sheet forming processes.

Filtration is a process whereby water is extracted from the fibre suspension. Fibres are laid on the fabric, and they are then interlocked with each other to form a compact fibre web. Depending on the stock characteristics and the fabric, a more or less high stock concentration is built up near the fabric.

During the filtration process a clearly distinguished surface is created between the already formed fibre web on the fabric and the liquid suspension on top of it, whereby the consistency of the un-dewatering suspension remains basically constant. The driving force behind a filtration process is the pressure differential between the run-in and run-out surface. The differential is created by:

- the liquid column;
- overpressure caused for example by the stock jet impact;
- mechanical pressure, which occurs with gap formers in the sandwich between the two fabrics;
- vacuum on the filtrate surface;
- a centrifugal field as with roll former.

Filtration will be a purely mechanical process, even if chemical additives are used, as these influence only the behavior of the filtered particles and not the filtration process as such. By means of an air permeability tester, measurements were carried out on different fabric types and graphical paper samples to determine the liquid volume of the air drawn off and the corresponding flow resistances.

The intention was to infer from the flow resistance of the paper sample, the flow resistance of the fibre web on the fabric. It was therefore assumed that the flow resistance of the fibre web at the beginning of the wet and is approximately 10 times less than the actual measured flow resistance. It was also assumed that the flow resistance of the fabric is negligible compared to that of the fibre web (as soon as the latter exceeds the first by at least 100 times).

The comparison of respective mean flow resistance straight lines showed that the flow resistance of the fabric on average loses all effect upwards of a surface-related fibre web mass of approximately 8 g/m^2 . Drainage measurements on Fourdrinier machines and on hybrid formers show that a surface-related fibre web mass of more than 8 g/m^2 is reached in most cases already after the forming board, figure 2.

The direct effect of the fabric on the dewatering of graphical papers is thus very small. Already, after a few hundredths of a second the fibre web forming on the fabric largely controls the dewatering. By the impact on formation, the fabric also has an indirect influence on dewatering. Fibers have a natural tendency towards forming groups. The uniformity of the distribution of these flocks is called formation. The time fibre needs to flocculate is extremely short. With average stock consistencies it is normally between 0,01 and 0,1 seconds. This corresponds to a distance of 15 - 150 cm for a wire speed of 900 m/min.

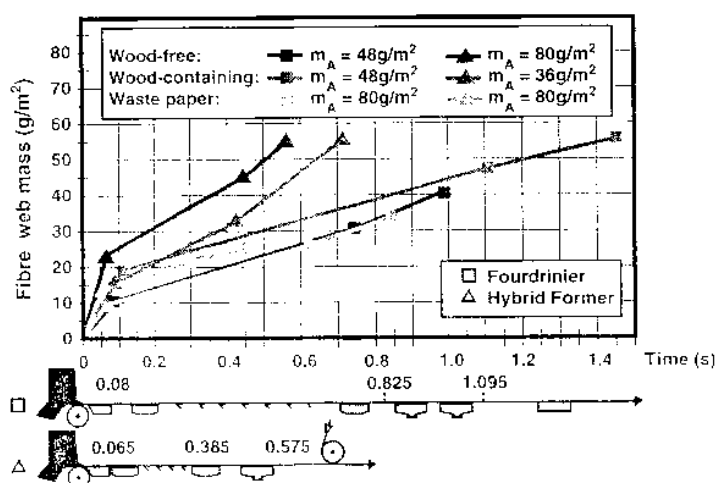


Figure 2. Fibre web mass in relation to the dewatering distance on Fourdrinier machines and hybrid formers

The process of flocculation is very complex because of its combination of physical and chemical characteristics. It is influenced by the type and quality of the furnish (fibred length, filler content), the head box consistency, the head box design and the chemicals used (drainage and retention aids).

The phenomenon of the fast flocculation of fibres is one of the main reasons why considerable efforts have to be made in the wet end in order to form an acceptable sheet. Fibre flocks do tend to spread themselves evenly over the forming surface, as the dewatering flows always follow the line of least resistance.

In order to improve the even distribution of the fibres in the sheet, that is formation, the web structure must be destroyed again and against to give the fibres renewed freedom of movement. This is done by using what is called random response controlled filtration, which causes, in addition to the dewatering flow, both oriented and turbulent shear within the suspension.

The dewatering flow, caused by the filtration process, whereby water is drawn off from the fibre suspension, is almost totally perpendicular to the fabric surface.

The decisive factors with regard to fibre retention are the pattern and intervals of the curved yarns on the fabric surface, which serve as so-called piers for the arising fibre bridges. Shear flows are required to obtain mobility of the fibres in the suspension. These flows and the resulting dispersion should occur during the dewatering process because of the fibres' tendency to flocculate.

Sheet forces can be created by the speed differential between stock and fabric shake. With twin - wire machines a relative movement between the not yet dewatered suspension and the fabrics can also create a laminated flow in the suspension.

Turbulence is another shear flow. These are localized flow disturbances within the not yet dewatering suspension. Their task is also dissolving flocks in the suspension, and also to move the fibres in the suspension. The main difference to laminated flows is the degree of orientation. The turbulence pulses are created by the dewatering elements and by the fabric. These pulses develop at the lead-in edges of the dewatering elements by the shaving off the water film under the fabric, and by the accelerating forces caused by the curvature of the fabric. These accelerating forces develop for instance at the lead-off edge of foils, at vacuum supported suction boxes and forming shoes, but also at deflectors. These pulses thus develop in the fabric, pass through the forming fibre web, and then enter the suspension. During this process there is always the danger that the turbulence damages the fibre web, reducing turbulence energy and its positive effect on formation.

An analysis of a hybrid formed making wood free paper showed that a minute change in the microstructure of the fabric can have effects on formation and dewatering: under almost identical operating conditions the tension of the bottom fabric was first increased from 50-75 N/cm, and then to 90 N/cm. The resulting effects in dewatering and formation are shown in figure 3.

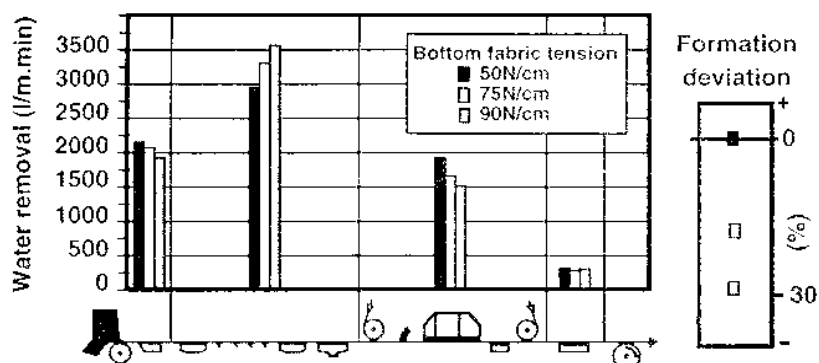


Figure 3. Influence of fabrics on dewatering and formation - field test

The various fabric parameters can and should be of assistance; however, their correct understanding is essential. This is where the experience and expertise of the fabric manufacturer plays a vital role.

Last but not least, the constant high level in the production of the fabrics is a decisive factor. This is the condition to guarantee uniform dewatering and formation over the total machine width and length, as well as repeatable paper production and quality.

REFERENCES

- [1] Ahn, J., Kufferath, A. - *Forming*, GmbH & Co KG, Germany, 1999.
- [2] * * * World Pulp and Paper Technology, 1995/ 96.
- [3] Florescu, I. - *Fluid Mechanics and hidropneumatical machines*, Editors Alma Mater, Bacău, 1998.
- [4] Florescu, D., Florescu I – *Mechanics. Static's*, Vol. I, Editors Tehnica – Info, Chişinău, 2004.