Cost reduction by mathematical furnish modeling and potential analysis

PerfectFit for furnish recipes

Voith's furnish modeling and furnish potential analysis is a tool for cost optimization for graphical paper grades. The main focus of these studies are furnish recipes, refining of the components, filler content, basis weight and machine speed. The critical weak points concerning furnish strength can be identified and proposals for their amendment can be discussed.

In today's economic situation, overcapacities and predatory competition force every papermaker to reduce costs to stay competitive. There are two main ways to reach this goal: optimizing the furnish recipes or increasing the machine speed. Which way promises more leverage is mainly determined by the machine concept.

Up to now, it was not possible to determine the optimum future operating point concerning furnish composition and the resulting furnish strength. Neither was it possible to calculate the possible maximum machine speeds. Voith's furnish modeling and furnish potential analysis closes this gap.

Fig. 1: PM requirements and furnish properties in balance.

Balance out requirements and possibilities

The basis for such a study is, of course, the paper machine itself. This may be an existing machine which is to be optimized or a planned new machine. The machine requirements concerning the sheet and therefore the furnish strength properties can vary hugely; The main influence parameters defining the machine requirements are the paper grade, basis weight, machine speed and, of course, the machine concept. The furnish compositions have to fulfill the requirements in every case under all circumstances (Fig. 1).

In order to evaluate the balance of the furnish strength potential and the PM requirements, the single fiber and filler components are analyzed in detail. The available fiber and filler components are evaluated together with the customer with the aim of optimum cost efficiency. At the same time, more advantageous alternatives are looked for and discussed.
As a next step, the selected single components are evaluated and optimized individually. Subsequently, the suitability of the optimized single component for mixtures is tested. For the assessment of existing machines,

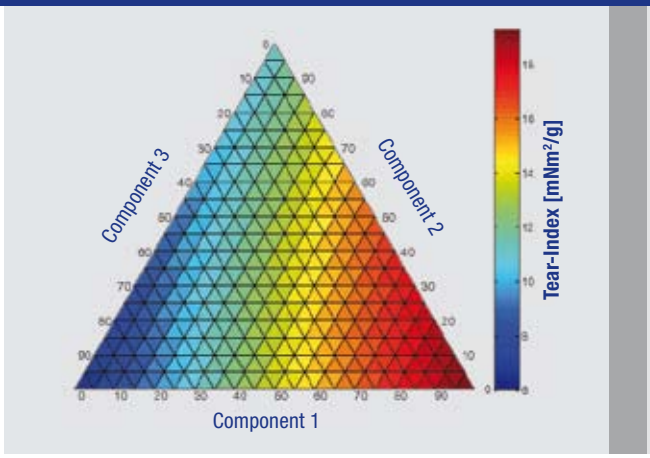

Fig. 2: Tear-Index diagram for a furnish model with three fiber components.

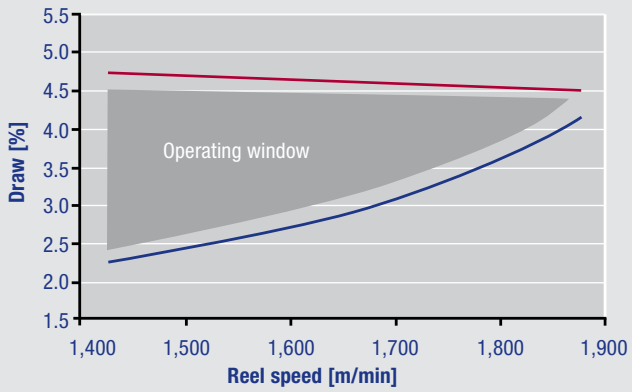

Fig. 3: PTC draw trials allow furnish limitation predictions.

the furnish samples are mostly taken directly from the stock preparation lines. If this is not possible, e.g. for planned new machines, the chosen fiber components can be refined in lab scale or full scale in the Voith research facilities.

Continuous prediction of the mixtures' strength properties

The properties of the single components are now known. But how is it possible to predict the sheet strength that can be achieved with a certain furnish composition?

For this goal, a series of mixtures of the base components is made in the lab and hand sheets are produced from every mixture. The necessary minimum number of different mixtures depends exponentially on the number of base components. From these hand sheets, all important paper properties are measured. The center of attention focuses on the strength properties, the initial wet web strength at different dryness levels as well as the commonly used static and dynamic strength of the dry sheets. This procedure is mandatory because the mixtures typically do not follow linear mixing rules but show complex non-linear dependencies.

The strength parameters measured for the different furnish mixtures are then described by fitting mathematical equations. As a result, predictions of the strength properties are also possible for furnish compositions that have not been measured on hand sheets.

The results of the mathematical modeling can then be displayed in interactive software tools and in diagrams (Fig. 2).

Wide knowledge base from the PTC

Depending on the selected machine concept, especially the press configuration, different requirements for the sheet strength are resulting. In order to determine the strength requirements, comprehensive trial series have been carried out at the Voith Paper Technology Center (PTC) in Heidenheim on the pilot paper machine XPM 6.

With different raw materials, basis weights and machine concepts, trials have been run to determine the minimum necessary and maximum possible draw for different speed levels. At the same time, hand sheets were produced from the trial furnishes and the strength properties of the wet and dry sheets were measured.

With the operating windows defined during these trials (Fig. 3), predictions can be made concerning:

- the maximum speed that can be reached with a certain furnish strength and a defined machine concept
- the minimum draws and therefore the minimum necessary strength properties at a certain speed and a defined machine concept

Nevertheless, the results from the pilot paper machine have to be examined critically in every case to verify their validity for full scale paper machines.

Comparative evaluations with actual production machines show the transferability of the pilot scale strength

requirements and complete the knowledge base. The data base is continuously expanded and improved by using all available information from PTC trials, customer projects and optimization work.

Leveling out the balance

The mathematical modeling of the strength properties on the one hand and the machine requirements on the other hand allow it to divide the model space into possible and impossible furnish mixtures (Fig. 4).

This division is made for each examined basis weight and machine speed. Proposed rebuilds changing the machine requirements are also accounted for. These conclusions allow the customer to estimate the answers to the following questions:

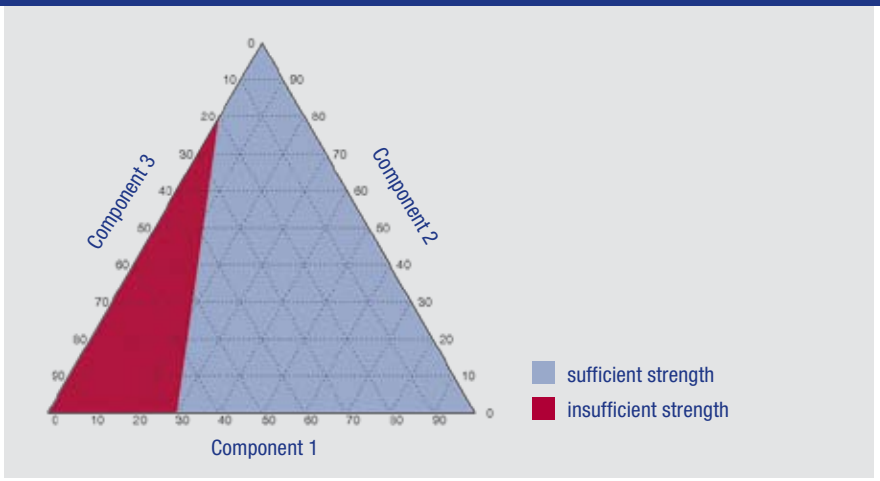

Fig. 4: results of the furnish potential analysis for 3 fiber components: Furnish mixtures with sufficient (blue area) and insufficient strength (red area).

- How much can be saved by optimized furnish usage and/or refining?
- What possibilities are there to increase the machine speed?
- How fast will investments pay fo themselves through possible furnish cost reduction?

Thus, furnish modeling and potential analysis can contribute decisively to cost reduction and increased competitiveness.

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"Alberta Newsprint Company (ANC) is extremely pleased with the front end research work performed by Voith to aid in the design of our shoe press."

Gary Smith, Technical Director, ANC Whitecourt

"Alberta Newsprint Company (ANC) is extremely pleased with the front end research work performed by Voith to aid in the design of our shoe press. ANC will be faced with the challenge of utilizing inferior Mountain Pine Beetle killed fiber from saw mill residual chips. The chip moisture content will range down to 25%. We also expect higher pitch extractives from the freshly attacked trees. Voith lab work illustrated the potential benefits we would derive from installing a shoe press. This will allow ANC to increase the use of inferior fiber while maintaining paper quality for the printers ensuring ANC's long-term viability."