Novel total dewatering concept improves water removal and paper machine runnability

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Novel total dewatering concept improves water removal and paper machine runnability

Simulation of overall water removal in heavy weight paper and board

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1. INTRODUCTION

The efficiency of overall water removal during papermaking is critical for good runnability, quality and cost-effective paper production.

Water removal occurs in three areas on the paper machine: the forming, press and drying sections. It has long been accepted that the most cost-effective dewatering takes place in the forming section. As a result, it is advantageous to remove as much water as possible during web formation. The cost and effort of removing water increases considerably throughout the production process, so it is imperative, though often difficult, to find the right balance.

2. BACKGROUND

2.1. Optimal dewatering is dependent on the size of the flocs created at various stages of the process.

Large flocs in general have the potential to drain well in the wire section but tend to hold a substantial amount of water when entering the press section. This water can be very difficult and crucially expensive to remove in the pressing and drying sections of the paper machine.

A well-designed laboratory test can provide useful information about the dewatering process without incurring the high cost and risks associated with full-scale evaluations

Therefore one has to consider a certain balance between floc size and water removal in the wire section and press/dryer sections. In particular, small (micro) flocs or flocs with a more open structure tend to favour water removal in the press and dryer sections.

Controlling floc size, with the aim of optimising dewatering, becomes even more difficult when producing high basis weight paper and board (>250 gsm).

A well-designed laboratory test can provide useful information about the dewatering process without incurring the high cost and risks associated with full-scale evaluations of many different retention and drainage programs.

2.2. Test Methodologies

Traditional laboratory retention and drainage testing can be done with tools such as Drainage Freeness Retention (DFR), Dynamic Drainage Analyser (DDA, **see Figure 1)** and Vacuum Drainage Tester (VDT). In general, VDT differentiates itself from gravity drainage testing (Schopper Riegler, Britt Jar, DFR) by providing information related to the sheet moisture content as it enters the press section of the paper machine. For cases where one is most interested in obtaining highly reproducible dewatering rate data following treatment with different chemical programs, DDA is the recommended tool.

Unfortunately, none of the described methodologies provides accurate predictive values regarding the potential of efficient water removal in the press and dryer sections during full-scale machine trials. Nor do they fully capture or predict the behavior of polymer programs. Hence, there is a need for a predictive laboratory or field method that can simulate wet-end drainage, press dewatering, and water removal in the drying section.

3. TOTAL DEWATERING CONCEPT

3.1. The Challenge

Polyethyleneimine (PEI) has been the benchmark for retention and drainage for higher basis weight recycled packaging grades. In an effort to reduce total operating costs, heavy weight paper and board producers have been searching for new technologies that allow them to

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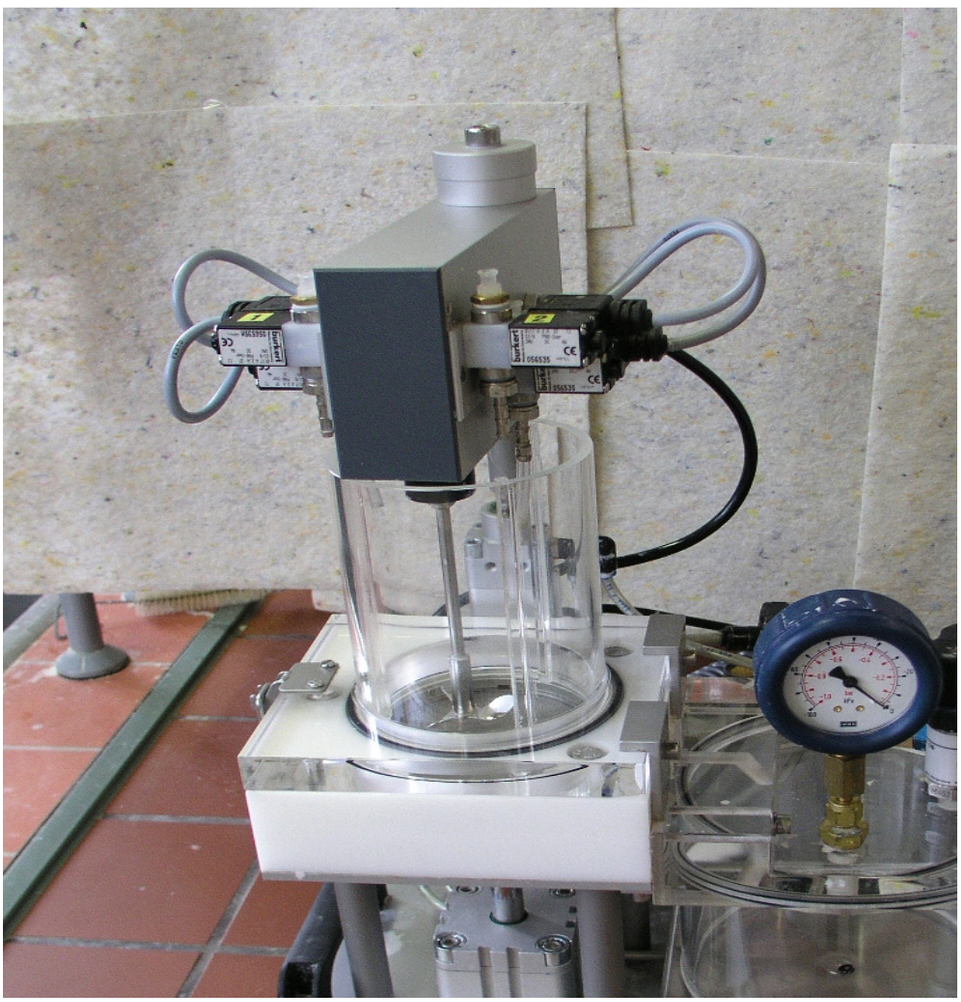

Figure 1. Dynamic Drainage Analyser (*DDA)*

optimise water removal whilst increasing productivity and maintaining product quality.

3.2. New Method Simulates Overall Water Removal

Acknowledging the market requirements for a breakthrough in dewatering, Solenis committed resources to the development of a new laboratory methodology referred to as the Total Dewatering Concept. The approach uses many of the traditionally available laboratory tools, such as the DDA, laboratory sheet presses, and the laboratory sheet dryers.

To better emulate the customers' processes, the new laboratory method incorporates improvements in press and dryer dewatering simulation (Fig. 2). Starting with a sheet formed in the DDA, the goal is to measure the performance of a range of dewatering programs during the different stages of papermaking. The method measures the sheet weight and sheet dry solids at each individual process step (drainage, pressing, and several drying steps) and can even be used with a range of target process parameters, such as final sheet moisture, energy required, or drying time. Developed at Solenis' Krefeld Technical Centre, this new method evaluates and ranks the dewatering performance of existing products, but it can also be used as a tool to develop new, more effective products.

4. A CASE-ORIENTED APPROACH

4.1. Introduction

The value of the Total Dewatering Concept has been demonstrated first at the Mayr Melnhof production

facility in Neuss, Germany. A number of drainage technologies had been thoroughly evaluated by the experienced technical team at the mill. Trials on the paper machine revealed that the incumbent PEI program gave the best performance despite data from traditional lab testing that showed otherwise. The Total Dewatering Concept developed by Solenis was then applied to studying the dewatering characteristics of the furnish. Simulating each step in the dewatering process gave an insight into the optimum floc structure required to effectively manage water removal at each stage (Fig. 3). Once this was established, it was then possible to develop novel polymers that enhanced each dewatering step.

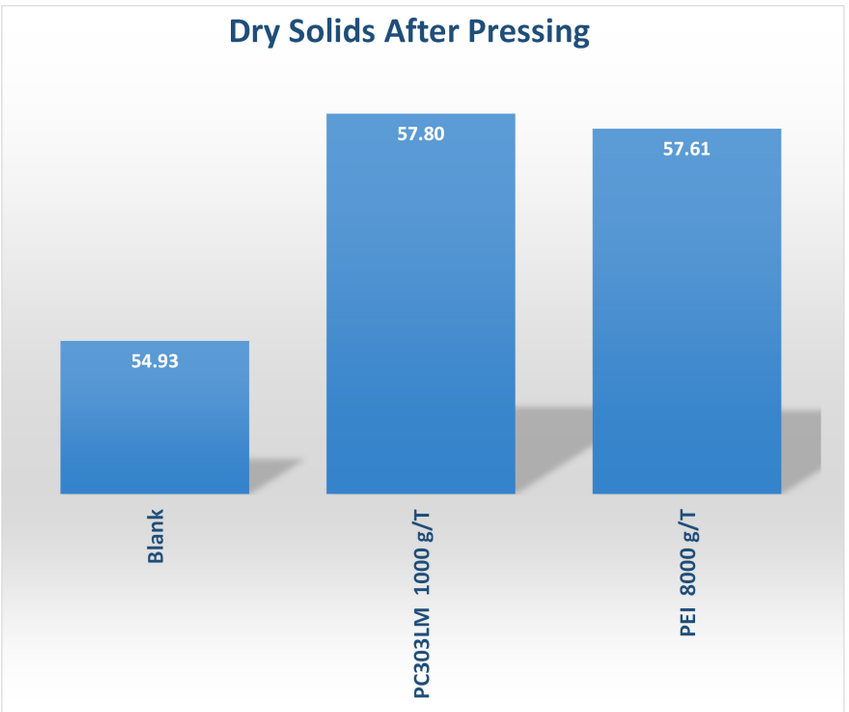

Figure 2. *Pressing Results*

4.1. Collaboration with Mayr Melnhof

Mayr Melnhof Neuss Mill was established in 1911. Today, it has the largest and most modern recycled fibre folding carton board machine in Europe. The grades produced at the Neuss mill are characterised by consistently high quality and application safety, making them perfect for use in the food and non-food packaging sector. It achieves these results with the following machine characteristics:

- 4-ply Fourdrinier machine producing folding carton board
- Different furnishes in each ply
- Production: 55 tonnes per hour
- Grammage range: 180 to 375 gsm
- Machine speed: 425 to 850 metres per minute
- Mid Ply: 100% Recycled Packaging

As the basis weight of the mid ply increases, control of dewatering in the press and dryer sections becomes critical. The initial trials at Neuss focused on replacing PEI in the mid ply. The application of the Total Dewatering Concept was used to select the most effective polymer for managing dewatering during forming, pressing, and drying. PerForm PC303LM was found to give the best results, especially after pressing.

Based on these findings, the mill at Neuss implemented a program in which overall water removal in the mid ply is controlled by a post-screen injection of up to 3.5 kg/T polyethyleneimine (~70% reduction) and up to 850 g/T PerForm PC303LM dosed via Solenis' PerForm VMax 1000 injection system. The actual dosages vary according to the grade being produced.

The application of the Total Dewatering Concept was used to select the most effective polymer for managing dewatering during forming, pressing, and drying

4.3. Program Results

Following the successful application in the mid ply, the program has now also been extended to the outer plies (PerForm PC303LM up to 400g/T dosed via PerForm VMax1000). Such has been the success of the program that it will soon be adopted by other similar machines.

Total Dewatering Concept Result	Retention [%]	Wire Section Water Removal [%]	Press Section Water Removal [%]	Dryer Section Water Removal [%]
Target	>75	97 - 98	1.2 - 2.0	0.8 - 1.0
Solenis	81.10	97.87	1.73	0.75
Competition	79.13	97.55	1.66	0.72

Figure 3. *Total Dewatering Concept Results*

It is anticipated that the Total Dewatering Concept will support the development of novel polymers to improve dewatering at each stage of the papermaking process.

5. Conclusion

The development of the Total Dewatering Concept and subsequent application to real papermaking processes has yielded significant benefits for the Mayr Melnhof mill in Neuss. The implementation of the PerForm PC303LM program has resulted in more stable running conditions on the paper machine, and total operating costs have been greatly reduced through the reduction in polymer consumption.

The Total Dewatering Concept can be applied in all cases where paper producers are seeking to optimise water removal in their processes whilst maintaining or improving the paper properties, quality, and overall machine efficiency.

Benefits of Improved Dewatering;

- Improved paper machine runnability
- Improved ply bond results on specific grades
- Lower total operating costs
- Reduced retention treatment costs by up to 75%

The authors wish to extend a special thanks to the Mayr Melnhof Neuss mill, which collaborated extensively with Solenis to demonstrate the success of this new methodology and polymer-based program.

The implementation of the PerForm PC303LM program has resulted in more stable running conditions on the paper machine

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