State-of-the-Art Deposit Control with Deposit Dispersants

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ABSTRACT

Deposits create serious technological problems in the paper industry, for example unplanned shutdown, paper breaks or paper defects. Papermakers are applying different technologies to cope with deposits, such as using biocides, anionic trash catchers or regular boilouts.

During recent years dispersants have become increasingly popular in the paper industry. In general, dispersants are complex mixtures of substances with emulsifying and dispersing effects for microorganisms, inorganic filler material and fines. For the formulation of an efficient product it is important to understand the mechanism involved in the build-up of the deposits and the interaction with dispersants.

In the development of new generation of deposit dispersants, Kolb made a two-step approach: First, a number of deposits from different paper machines were analyzed and the microorganisms were identified by microbiological methods such as PCR analysis. In a second step the dispersants were developed with laboratory screening tests testing the dispersants specifically in their capacity to delay and reduce the creation of slime. A lot of the studies were conducted with P.putida, an important biofilm forming microorganism.

During the studies the most important parameters influencing the efficiency of a dispersants on a paper machine were identified. Laboratory test methods are an additional tool to identify the most efficient dispersant. Many paper machines are now running with dispersants, which have a number of important advantages regarding paper quality, paper machine runnability, ecology and safe handling along with economic benefits. A case study on a wall-board paper machine shows how the use of dispersants allows the reduction of deposits and the number of paper defects.

Introduction

The paper industry faces major challenges as a result of increasing production costs, tough competition and stricter environmental requirements. In many paper mills deposits create serious technological problems, for example unplanned shutdowns, paper breaks or paper defects. A paper mill in the Netherlands quantified the losses due to deposits at approx. 3% of productivity loss1.

Papermakers are applying different technologies to cope with deposits, such as the use of anionic trash catchers (fixatives) or regular boil-outs. Biocides can be added to the papermaking system to control microbial growth within acceptable limits. Efforts to reduce the toxicity of deposit control have generated an increasing interest in the use of dispersants.

Deposits in the Paper Industry

Deposits are typically complex, containing highly diverse microorganisms along with wood fibers, fines, fill er material, pitch, latexes, clay, or other papermaking additives. When deposits break loose and fall into the paper furnish, they can cause end-product defects such as holes, spots or web breaks.

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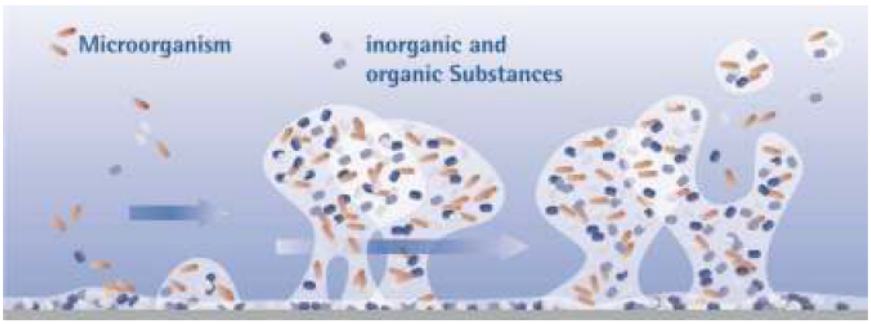
- **Inorganic Substances**
  - √ $CaCO_3$, $CaSO_4$, clay, silica, talcum *„Scaling"*
- **Organic Substances**
  - √ Resin, lignin derivates *"Pitch"* (natural wood components)
  - √ Sticky substances *"Stickies"* (recycled paper)
  - √ Binder, PVAc, latex, styrol - copolymere *"White pitch"* (coated broke) (Recycle fiber)
  - √ Fibres and fines
  - √ Colours, sizing agent, starch (chemical additives)
  - √ Microorganisms (stock, fresh water, chemical additives, air)
  - √ Extracellular polymeric substances *"Biofilm"* (microorganism)

The formation of deposits is often described as a 5-step phenomenon. The five stages are2: 1) Free microorganisms and particles are suspended in the water. A conditioning layer is formed very rapidly on the metal surface, consisting of micro-scale organic and inorganic precipitates. 2) Attachment of particles and microorganisms to the metal surface. 3) Protected a growing layer of deposits and by EPS (= extracellular polymeric substances) the microorganisms are changing their physiological behaviour. The microorganisms are communicating with quorum sensing signals – molecules which are released into the environment, allowing bacteria



Formation of deposits
Efficiency of biocides

Dispersants → lower consumption of biocides

to co-ordinate their behaviour. 4) The deposit is developing a 3-dimensional structure. 5) The mature deposit is releasing large flocs, which are the cause for spots, holes and breaks.

Dispersants

Dispersants are used in the paper industry to delay and reduce the formation of deposits. They are complex mixtures of a variety of non-toxic chemical compounds. They are interacting with particles at each of the five stages mentioned above. By their dispersing effect, they stabilize the free particles thus lowering their tendency for attachment to a surface. They also have the ability to break up the 3-dimensional structure of deposits. Dispersants permit deposit layers to be removed evenly, which minimizes the risk of the detachment of large flocs, leading to spots in the paper or web breaks.

In some cases deposits can be controlled without the use of biocides, as wil be shown in the case study below. However, by the use of dispersants it is **always** possible to reduce the dosage of the biocide. Why?

One disadvantage of biocides is that they are acting mostly against free microorganisms. The activity of biocides against microorganisms in a biofilm is approx. 100 times lower3, because deposits, slime or biofilm protect bacteria from biocides[4] 5.

Dispersants, on the other hand, are developed specifically against deposits6. The dispersant breaks up the deposit and releases the bacteria, which allows an easy access of the biocides to the microorganisms. This is the reason why dispersants give the papermaker the opportunity to run the biocide treatment at a minimum dosage level.

It is important to understand that dispersants do not have a biocidal effect on their own, but they only enhance the efficiency of biocides.

In Europe legal pressure will result in major changes in the area of biocidal products.

New regulations are for example the Directive 98/8/EC (the Biocidal Products Directive), REACH and the Detergents Directive. This will lead to a reduction of the number of permitted active substances for biocides. In addition, biocidal products (formulated mixtures of active substances, as they are used in the paper industry) are subject to a long and expensive registration procedure. For this reason it will be increasingly difficult to bring new biocidal products onto the market.

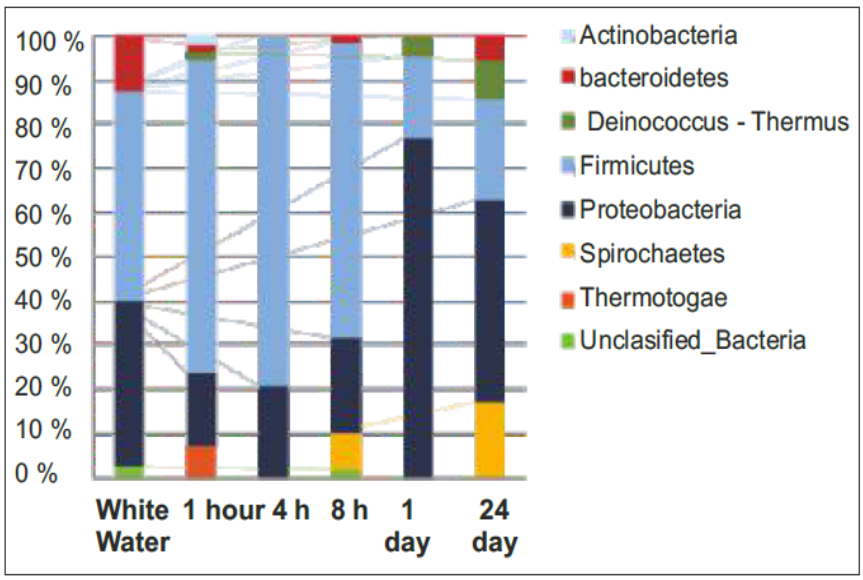
As a result of the legal pressure, the product range for wet end deposit control will shift towards more environmentally friendly products, especially dispersing agents. As dispersants do not have any biocidal effect, they are not covered by the Biocidal Products Directive. Therefore they offer a higher potential for new developments than biocides.

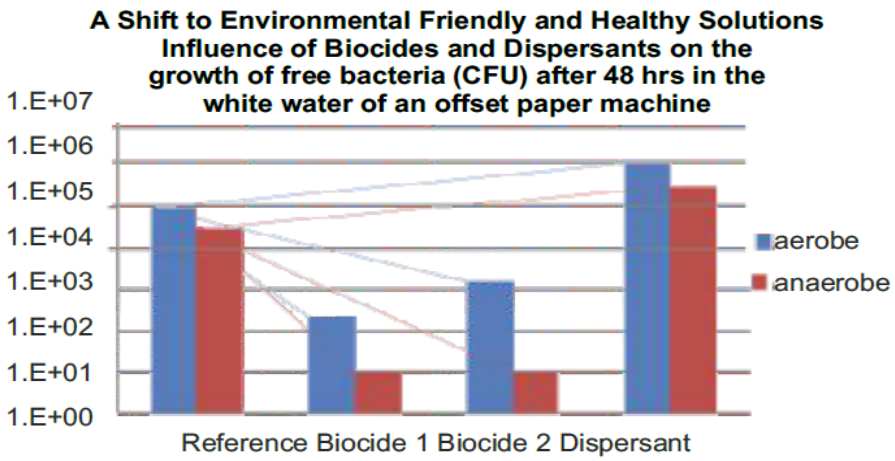
The dispersants developed by Kolb are readily bio-degradable. They fulfill the Detergent Directive EC 648/2004 which specifies a level of biological degradation of over 60%.

All dispersants in the Kolb portfolio are either approved by FDA, BfR or both. They are all non-toxic aqueous solutions and therefore they allow an easy and safe handling.

Development of new Dispersants

In the development of a new generation of deposit dispersants, Kolb made a two-step approach. First, a number of deposits from different paper machines were analyzed, and the microorganisms were identified by microbiological methods such as PCR analysis (16/18S rDNA/rRNA) and FISH (fluorescence in-situ hybridization). During the past few years methods based on molecular biology have gained importance. They are faster and more specific than classical methods such as the cultivation of microorganisms using selective media.





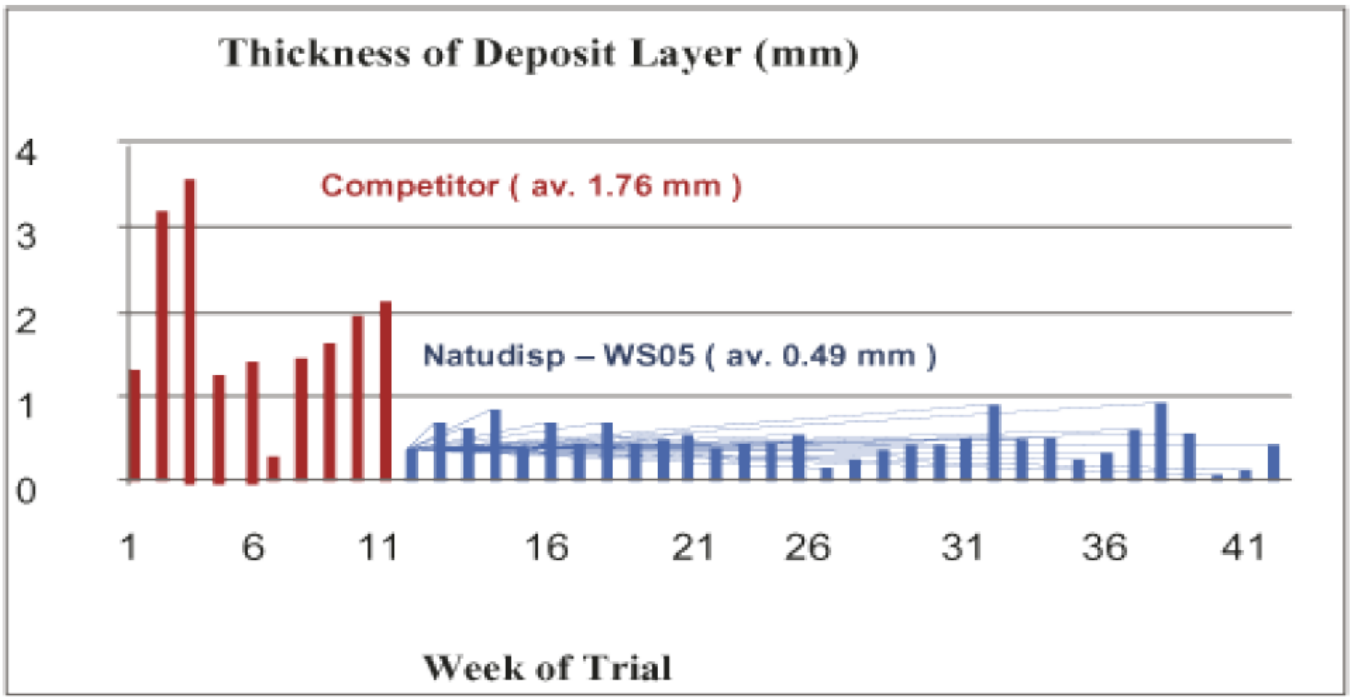
The main goal of those studies was to find out which microorganisms are most critical for the build-up of deposits. In a second step, the dispersants were tested in their capacity to reduce the formation of deposits induced by white water, which was simulated by a mixture of water containing microorganisms, nutrients and salts, sometimes also fillers and fines. *Pseudomonas putida* was chosen as microorganism for most of the lab studies.

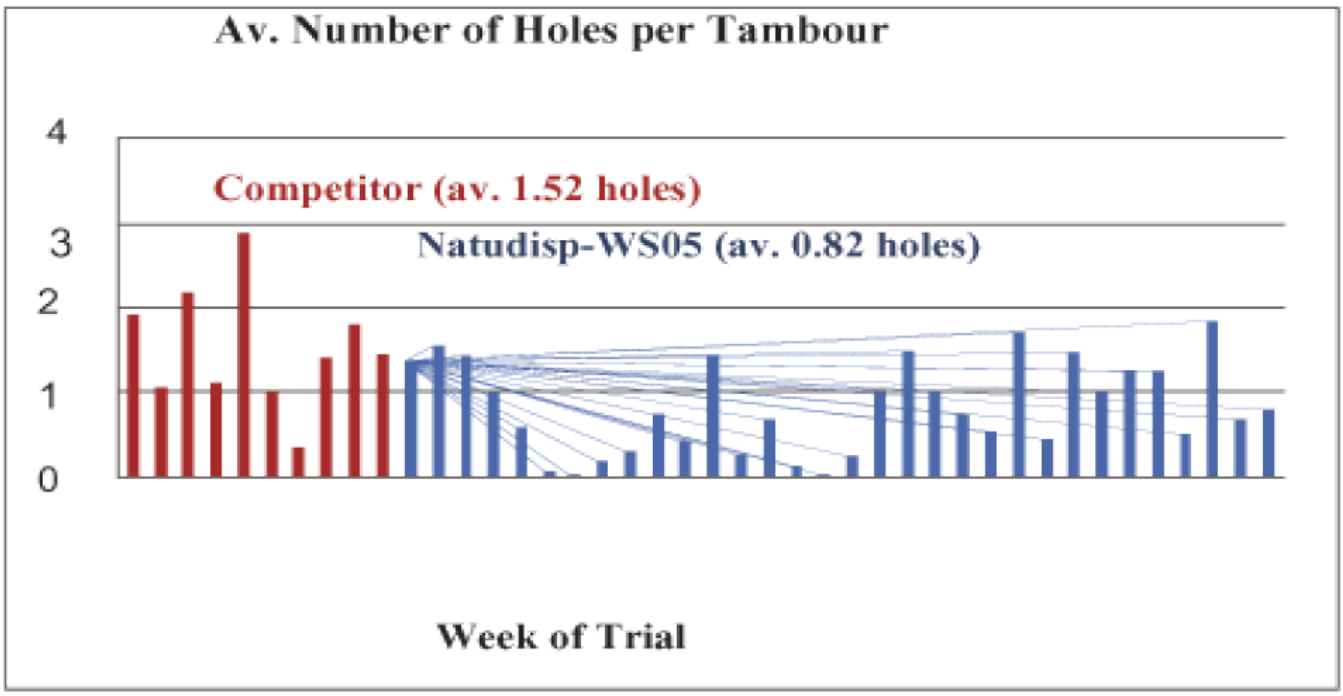
Success Story Natudisp-WS05

Paper Grade	Wall board paper, 65-170 g/m²
Furnish	100% Recycled fiber
PM speed	600 m/min
Production	80.000 t/year
Process	40°C, neutral pH
Fresh Water	15 m³/t paper
Sizing	ASA

The existing conventional dispersant was replaced by Natudisp-WS05, which was dosed at 5.5 ppm into the machine chest. After approximately 30 weeks of use of Natudisp- WS05 the results were the following: The thickness of the deposits improved from initially 1.76 mm to 0.49 mm with Natudisp-WS05 (improvement > 70%). Even more important for the customer, the number of holes in the paper was reduced by 46%, based on the number of holes per tambour. The costs for the treatment remained constant.

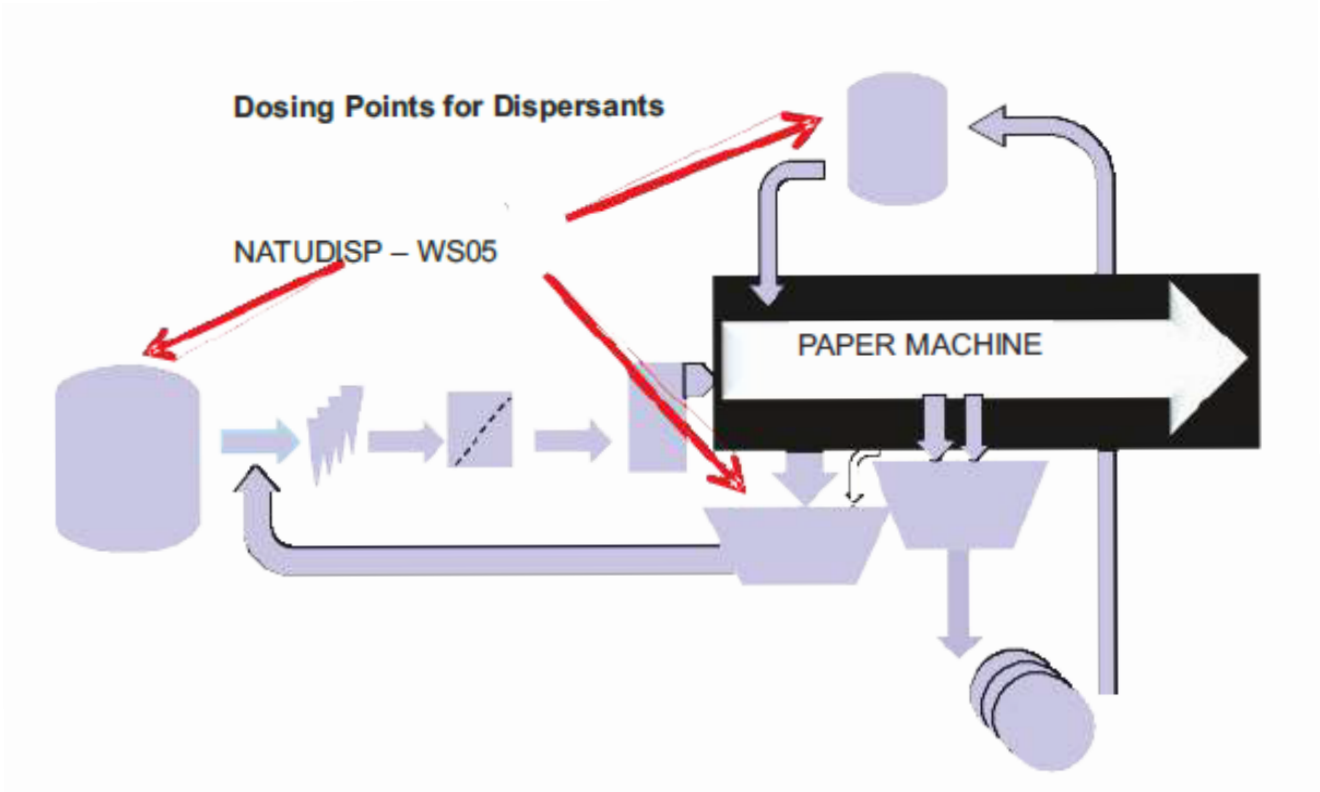
It was possible to control deposit formation in the paper machine circuit in the absence of any biocides with satisfying results for the customer.





Dosing Strategy

The dosing strategy for dispersants is quite simple: The undiluted product is dosed to the machine chest or the white water in order to reduce the deposits in the primary circuit of the machine, the approach flow or the headbox. A typical dosage level is 5 to 10 ppm based on the amount of water and 20 to 100 g/t paper. Deposit dispersants can also be used on the shower water to reduce the amounts of deposits e.g. in the former or in the press section.



Natudisp-WS05

- ► To the shower water for clean PM
- ► To the machine chest or white water for clean approach flow

Conclusion

The advantages of deposit dispersants can be summed up as follows: Extended operating times with fewer breaks, shorter downtime and longer cleaning intervals. Improved quality of the finished paper, less spots and holes. Prevention of machine corrosion by avoiding anaerobic conditions, which may occur under thick deposits layers. Easy and safe handling (FDA and/or BfR approved). Readily biodegradable. Cost-effective solution.

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