Speciality chemical technologies for high-quality, sustainable and cost-effective chemical pulp production

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INTRODUCTION:

Pulp production plays a key role in the bioeconomy, the transition and transformation to a fossil-free society and circular economy, producing not only the original bio-based product, but also products replacing fossil-based products. In this respect, pulp production is an enabler of a sustainable future, but can they do it on their own?

Changing global market conditions require pulp producers to manufacture pulp of a higher quality while lowering overall operating costs. Together with variable fibre supplies, sources and qualities, the need to meet regulatory goals and quality improvements at lower capital cost, can create a challenging situation. The pulp and paper industry has improved its environmental record by reducing its pollution of rivers and high water consumption by closing water circuits in pulp and paper mills. Fresh water consumption has been drastically reduced in the last decades especially in Europe, and continues to be reduced as more and more water circuits are closed. This development requires an adaptation of technology, as well as the chemicals used. With these environmental, quality and economical requirements in pulp production constantly increasing, mill and supplier business partnerships are essential.

Specialty chemicals for sustainable and cost-effective pulp production

High quality finished paper and board require high quality fibre. However, the fibre line is only as strong as its weakest link and any problem in the fibre line will impact the final paper. To eliminate weak links and reduce costly bottlenecks in pulp mills many inter-related, and sometimes competing, reactions need to be managed in an efficient way. By understanding the complex chemistry and having access to chemical expertise that can help in analysing and optimising the chemical processes, mills can get big gains and savings - all the way from wood preparation to pulping, while maintaining a sustainable profile.

Figure 1: Optimising chemical processes from wood to pulp.

Specialty chemicals and smart technologies can support in reducing bottlenecks in pulp production, to improve brightness and reduce bleach usage and to keep the mill running efficiently. Cost benefits, removing bottlenecks and production increases can be achieved through very small changes in the system to a complete process change.

You just need to know what to look for and how to do it – the pulp specialists at BIM can provide that expertise. Through their profound knowledge combined with our chemical solutions and analysis tools, they can add real value to the pulp process and help produce pulp according to required needs.

Improving drainage for an efficient pulp washing

The pulp mill's performance is only as good as its washing performance. Inefficient pulp washing can lead to production bottlenecks, reduced quality and increase chemical and production costs. Poor drainage and washing occur when there is much entrained air in the stock. Foaming and high entrained air content are big problems for many pulp and paper manufacturers due to the negative effects they have on the process and the quality of pulp and paper. Air or foam caught in the mat interferes with liquid passing through thus slowing drainage and giving a poorer washing efficiency. The maintenance of vat consistency and vat levels is directly attributed to both the air attached to the fibre and the air in the liquor.

The most successful mills realise that to be viable in this challenging market, you need to break the foam/air cycle. That means finding out what's really impacting washing performance, with the expertise to solve problems at their source and introduce long-term improvements across the entire process.

But what is actually air/foam?

Air is a component which is always present during pulp production and appears as bubbles or foam in the process. Bubble is a small gas particle entrained and dispersed in the fluid. The amount of dissolved air in water increases with pressure and decreases with temperature increase.

Figure 2: Foaming and high entrained air content have negative effects on the process and the quality of pulp and paper.

Foam is formed by many gas pockets surrounded by a thin film of liquid. Foam is created when fluid is mixed with free surface air or when bubbles gets bigger and rise to the fluid surface. Surface-active materials can create foam when they get stabilised.

Foam control and drainage improvement are integral parts of ensuring downstream productivity and cost efficiency. When the process is closed, the level of undesirable substances increases, which leads in turn to foaming and deposit problems.

There is much to be gained by using effective chemical products that deaerate the system and reduce foam formation, such as:

- Reduced air content
- Improved drainage, which gives cleaner pulp, which gives lower COD and chemical savings
- Reduced surface foam
- Elimination of process bottlenecks
- Improved process stability and in some cases increased soap separation
- Increases washing yield, pulp quality and chemical recovery
- decreases bleaching chemical usage, water usage, and energy need.

Advantages of a talc free pulp production

Talc has been widely used for many years in chemical pulp mills with sulphate and sulphite process in order to change physically the surface of aggregated wood pitch particles. This surface change makes the wood pitch particles less likely to attach themselves to metals surfaces in the process which, in turn, lessens the tendency for build-up in the form of deposits. However, one major disadvantage for using talc is its relatively poor retention to the wood pitch particles and fibres as well as its hydrophobicity. To cover for the poor retention talc is dosed at high rates. This overdosage causes in many cases deposit problems, a counter act towards its purpose. In addition, talc is often found with a lot of impurities, such as iron - calcium - and aluminium containing minerals. All of them, not desirable in the pulp process. In recent years, there has also been growing concerns regarding the health risks posed by talc which has led to some paper producers not buying pulp which has been produced using talc.

Talc free pitch control – organic and inorganic

One of the most common challenges pulp producers face is pitch control. As long as people have been making paper from trees, pulp manufacturers have struggled to eliminate pitch. Pitch deposits in open and closed systems often lead to quality problems in both pulp and paper mills. Many times we talk of pitch, but several times it is a blend of organic and inorganic materials.

Pitch is a complex organic colloidal contamination released during the pulp production process and can contain resin acids, fatty acids, triglyceride fats, stearyl esters, sitosterols and other unsaponifiable materials. Pitch can vary in amount, tackiness, and composition, and poses a major challenge for pulp manufacturers, as it can agglomerate and its sticky nature causes production and quality issues. One of the requirements for high product quality is properly functioning pitch control.

Wood types used in pulp and paper production have species-specific compositions of wood extractives, which often cause a variety of process technical and quality related problems. Although the pitch is a minor component of the wood, its effects on the pulp and papermaking process can be quite intense.

In paper making, pitch can cause:

- lowered tensile strength,
- spots and holes in the paper,
- deposits on paper machine parts, wires and felts,
- unwanted foaming and problems with odour and taste.

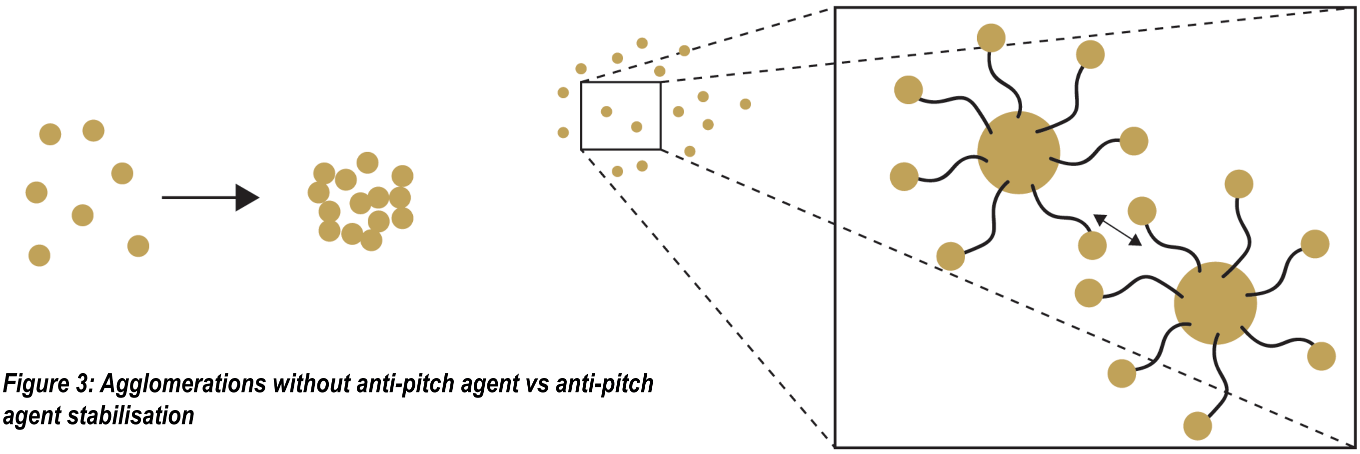


Figure 3: Agglomerations without anti-pitch agent vs anti-pitch agent stabilisation

Closure of the water loops and the neutral papermaking processes have caused severe pitch issues in recent years. Optimal pitch control without talc can be achieved by continuous use of anti-pitch agents suited for both alkaline and acid conditions.

The benefits of a pitch control are:

Primary:

- Lower extractive content in pulp
- Cleaner process and pulp
- Improved runability

Secondary:

- Talc free pulp production
- Reduced holes and spots in paper
- Increased tensile strength
- Improved smell and taste of paper and board

To achieve optimal results, a thorough working knowledge of the process is essential. This knowledge is then applied to mapping the system in great detail, localising the critical points for pitch deposits. Test samples are then taken and analysed to provide indications for product choice as well as dosage amounts and points.

Different analytical measuring tools, such as BIMPICS, POF-analysis, etc. can help analysing the pitch and choosing the correct dosing position and correct product.

Protecting the fibre for a uniform cooking

In a chemical pulp process all chips are not treated evenly, leading to an uneven cooking with following consequences:

- process variations and uneven quality
- higher alkali concentration needed to reach the target kappa
- increased bleaching chemical consumption due to a wider kappa variation
- higher reject amount due to undercooked chip centres
- decreased yield and pulp mechanical properties

The growing shortage and higher cost of raw materials for pulp production have increased the need to maximise yield during the pulping process. Several modifications to the pulping process have been attempted, such as extended modified continuous cooking and super batch cooking of all which require major capital investments and increase boiler recovery load. Chemical additives are less costly alternatives for a uniform cooking and as replacement of anthraquinone (AQ), since there is a growing concern over the impact of AQ on downstream operations such as evaporator fouling and tall oil production.

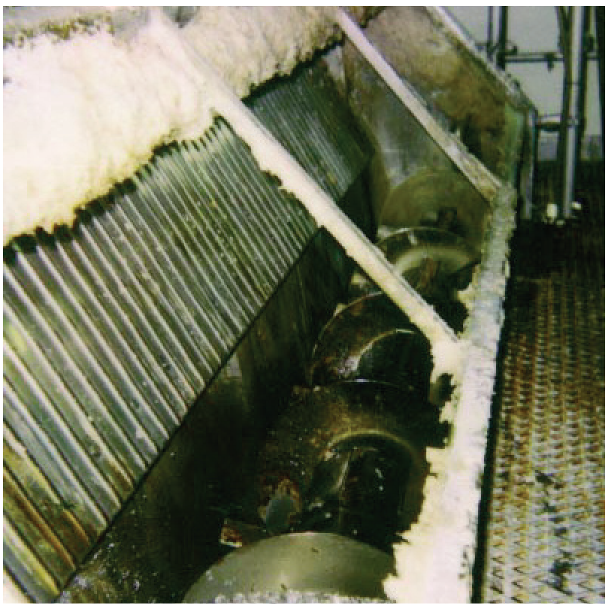


Figure 4: Conveyor screw covered with pitch- and talcum deposits.

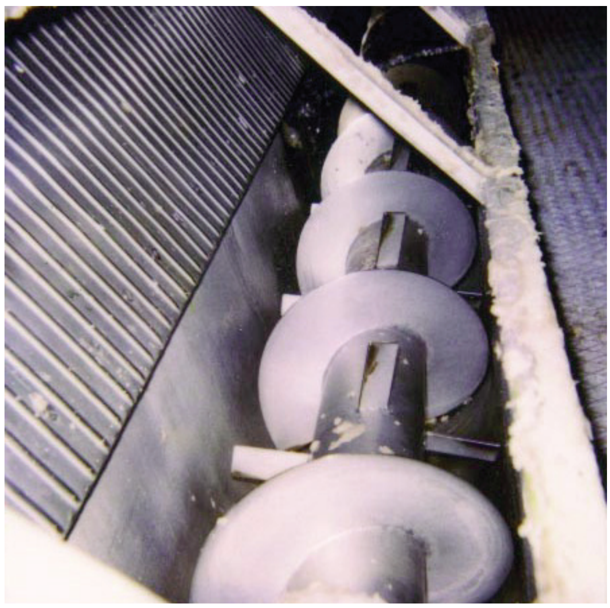


Figure 5: The same conveyor screw treated with pitch control agent.

Chemical additives reduces variations giving several benefits:

- Improved cooking liquor penetration into wood chips for more uniform cooking
- H-factor reduction (alkali / steam / time)
- Extractives load reduction and stabilisation
- Reject amount reduction, gives possibility to increase Kappa target
- Improved pulp physical properties
- Reduced evaporation load
- Yield increase
- Reduced bleaching chemicals consumption
- Improved BSW

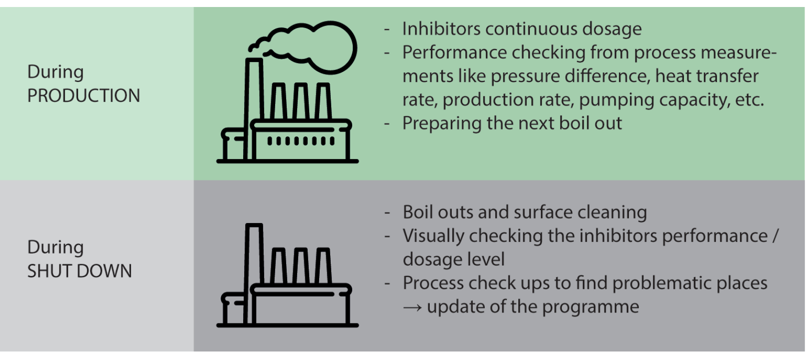
To get real benefits and chemical cost payback from chemical additives, a thorough evaluation must be done by a chemical supplier. The dosage can take place in different positions depending on mill conditions and process parameters, amongst others impregnation/digester and the oxygen stage. The fibre protection and cooking aids applications can be combined with other pulp concepts for synergy effects, for example anti pitch agents and fixative to achieve talc-free production.

Inorganic scaling is a growing problem in the pulp industry

Scaling is a growing problem in the pulp and paper industry. There are many reasons for this; increased productivity, demands on higher yields, problems with raw material supply and not least closure of process water loops. Closure of the process water loops will result in an increasing concentration of non-process elements and lead to enhanced risks for precipitation and scaling of compounds with low solubility. This is a pervasive problem where the build-up of scale costs the industry in terms of equipment downtime, quality problems, reduced volume capacity and heat-transfer efficiency, lost production, de-scaling operations costs, and occupational health and safety.

Pulp production uses a high amount of water; roughly 20 – 40 m^3/produced ton. The tendency to reduce fresh water usage leads to higher concentration of salts and scaling problems. When liquor dries solids increase, the concentration of metals as iron, manganese, calcium, copper etc gets higher and higher, until their solubility is exceeded.

Scale, or more accurately inorganic scale, consists of precipitated metal salts. The most common scale in pulp mills is calcium carbonate, typical in heat exchanges, digester and evaporation plants. In acid stages calcium oxalate and barium sulphate are a common scale. The traditional tools for fighting scale are acid cleaning and high pressure water cleaning, two methods which have benefits but there are drawbacks as well. Today, there are much more effective and cost-efficient methods available to control the scale problem. When it comes to elimination of scaling, the most economical way usually is to use highly efficient cleaning methods combined with an effective scale inhibition strategy.



When a scale control programme is implemented, the whole system has to be included. Otherwise, in the modern pulp mills, there is a risk that the scale problem could me moved from one position to another. A comprehensive view of the system combined with knowledge about how the process works is necessary for an effective scale control programme.

Effective cleaning

"It's much easier to keep a clean surface clean than to prevent a dirty surface from getting dirtier". The main problem with mechanical or high pressure water cleaning, is that these methods don't really clean the metal surface, they only appear to. Scaling is a surface-controlled chemical reaction and the precipitating ions attached to crystals already on the metal surface. It is essential to clean the whole surface, even the microscopic crystal growth sites to prevent the new starting points for scaling. Efficient cleaning with a scale cleaning agent dissolves all the scale, even the crystals within the metal pores, and is the best possible start for a scale treatment programme.

Continuous scale inhibition

Two of the methods available which prevent the return of the scale problems are stoichiometric and sub-stoichiometric additives. Stoichiometric additives are basically chelating agents, e.g. EDTA or DTPA. They work very well, but the problem is that at least one chelating molecule per metal ion is needed. Large quantities are required.

Sub-stoichiometric additives work by a combination of different mechanisms, such as crystal distortion, threshold inhibition and dispersing. The scale inhibitor blocks the growth sites of the crystals, increasing the chemical reaction's activation energy. By understanding the scale forming mechanisms, it is possible for chemical supplier to produce and choose the best continuous scale inhibitor in each different situation.

An efficient scale control programme provides:

- Increased production capacity: deposits are avoided in the digesters, in the brown stock wash, in the bleach plant and in the evaporation plant.
- Reduced production loss and decrease energy cost
- Improved process control
- Quality benefits due to more even process control: more stable conditions in the digesters and in the bleach plant give pulp with more stable and better quality.
- Maintained heat exchange: deposits are avoided in heat exchangers and in evaporators.
- Increased runtime between stops.

Avoiding harmful metal reactions to spare fibre properties and reduce chemical consumption

Keeping control of metals and other cations, for example Mn, Fe, Cu and Ca will save a lot of problems and, in the end, money. These substances will cause scaling with decreased production and/or quality issues as a consequence. Especially iron manganese and copper will react with bleaching chemicals, such as hydrogen peroxide, and can destroy the bleaching sequence. By using sustainable solutions for metal chelating and sequestering, the amount of dosed EDTA and DTPA can be reduced or completely removed in cleaning and bleaching applications. This chemistry can also replace MgSO4 in oxygen delignification and peroxide bleaching.

Figure 6: Head box with barium sulphate scale before cleaning.

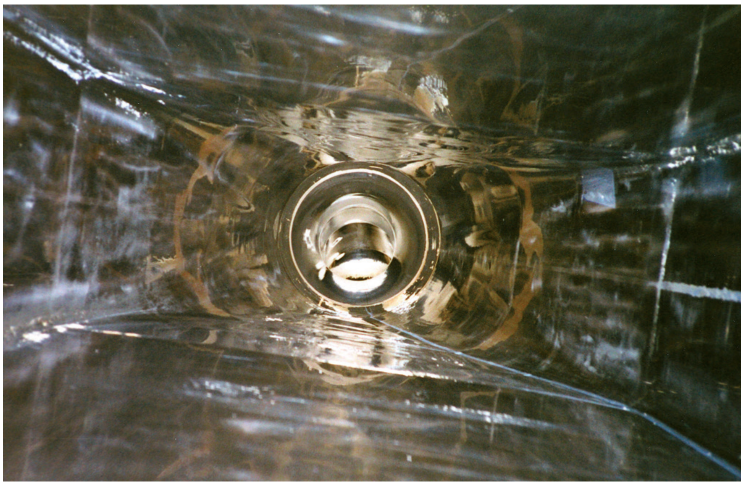


Figure 7: Same headbox after successful cleaning, barium sulphate scale removed.

Tall oil and soap separation improvement

Resin- and fatty acid blend create problems in brown stock washing area and will increase defoamer and bleaching chemicals consumption. Therefore, it is important to separate soap in the right position and most optimal way. Critical factors for good soap separation are, amongst others

- Temperature
- Dry content
- Separation time and process construction
- Residual alkali
- Salt content

Even if all process parameters are optimised, some of the soap will still be dissolved in the black liquor. This will cause fouling in the evaporation area. By adding chemistry to the mixing liquor going into the separation tanks, the equilibrium will be changed and more soap will be subjected to separation. This will lower the risk for fouling and decrease the load on the recovery boiler. If there are no other bottle necks white liquor production can be increased significantly.

Working together for a more sustainable future

We all have a responsibility to commit to a positive and greener future and the pulp and paper industry has an opportunity to make a real impact. Together, pulp producers and chemical suppliers can contribute to make life on earth more sustainable, healthy and inspiring by focusing on creating more value from fewer resources and use the world's limited resources more efficiently.

In switching to a more sustainable pulp production, you should be able to expect close support and consultancy from application specialists at your chemical partner. This support should range from identifying the specialty chemical applications needed to process setup and optimisation.

At BIM, we are aware of the chemical industry's role in the history of modern eco-movement. We also have insight in the huge potential we as a supplier of chemicals within the pulp and paper industry have of being an enabler of a sustainable future, e.g. to enhance our customers' energy, water and fibre efficiency. We believe that our knowledge and experience should be used as a driving force in the continuous development within the pulp and paper industry. Our expertise is founded on a number of core competences and technologies, which lead to the development of green specialty chemical-based concepts, technology and service for the pulp and paper industry's products and processes.

By working in close cooperation, we believe that producers and chemical suppliers can play a central part in making every day-life more comfortable, healthy and inspiring. But it's not enough to merely talk about this aim; we must actively work to achieve it. And we must do it now.

CONCLUSION

BIM is a family-owned, entrepreneurial chemical company supplying the pulp- and paper industry since 1973. With a customer-focused research and product development, we develop innovative specialty chemical concepts designed to improve products and processes in a cost-effective and sustainable way. We focus on creating more value from fewer resources to use the world's limited resources more efficiently.

BIM provide services and concepts all over the world through a global network of experts, production units and R&D facilities. Our local operations include Sweden, Norway, Finland, England, Germany, Poland, Belgium, Czech Republic, Portugal, Spain, France, South Africa and dedicated agents and distributors in most other pulp and papermaking countries.

BIM in brief

Pulp and paper focus

Founded in 1973 by Peter Wållberg with approx. 220 employees worldwide

Certified according to ISO 9001 and ISO 14001

Member of the UN Global Compact

Gold rated by Ecovadis

Associated with the Responsible Care Program