

Prevention of Microbiological Proliferation in Starch-Based Glues for Corrugated Board

Hygiene for microbiological control

Glue preparation plants are commonly referred to as "glue kitchens," and just like restaurant kitchens, hygiene is particularly important in order to prevent various types of contamination and ensure a high quality finished product.

Glue fermentation is principally caused by mono- or multicellular microorganisms, bacteria and fungi combined with mold (Penicillium, Bread Red Mold, Aspergillus, etc.), which find ideal conditions for development in polysaccharides such as starch glue.

The first step in minimizing fermentation is to examine the layout of the plant, checking for possible areas for improvement. It should be easy to ensure that adequate hygiene levels can be maintained (shape and positioning of pipes), that there are no contaminant receptacles such as acute angles in the circuit, filters should be installed and maintained to remove foreign bodies coming from the glue pan, storage containers must be covered, and doors must be used to prevent fauna (insects, rodents and birds) from contaminating the facility.



Example of the bottom of a stainless-steel storage tank, with rounded corners and a pipe that allows it to be completely emptied during washing/maintenance operations.

The high-speed agitator, placed close to the bottom of the storage tank, prevents sedimentation of potential foreign contaminant materials (glue lumps, paper residues, etc.).

(image: courtesy of OLAR srl)

Risks of microbiological growth

In addition to the obvious hygienic considerations for the board, glue sanitization avoids a number of other issues that may cause production difficulties, damage equipment and risk the safety of operators in the plant.

One such issue is glue acidification. Caused by a reaction between metabolites in bacterial colonies (mainly CO₂) and caustic soda in the glue, this reaction causes a partial neutralization of the chemicals that increases the temperature of gelatinization of secondary starch, which negatively affects the bonding behavior of the glue, ($2\text{NaOH} + \text{CO}_2 \Rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$). Another negative effect of this reaction is that limestone deposits form more readily on the glue rolls and reduce machine productivity.

Further, microbiological growth in glues often causes unpleasant odors that can be transmitted to corrugated board. This issue is particularly problematic during production of food packaging. The main cause of odors is the presence of anaerobic bacteria (sulphite-reducers or methanophores). Bacteria, such as *Desulfuvibrio Vulgaris*, may cause hydrogen sulfide, a hazardous gas with a smell like rotting eggs, to develop due to its sulfur-based metabolism. It can also cause pipes to corrode as iron ions catalyze during fermentation. Additionally, in the presence of methanophores, bacteria, flammable vapors and gases can be generated, which can cause a dangerous working environment and damage equipment

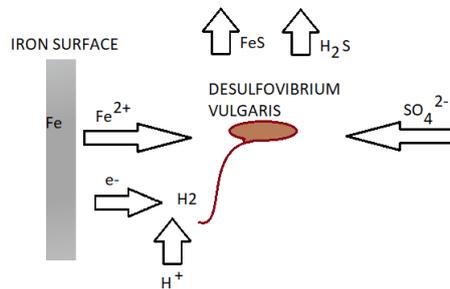
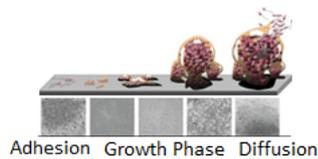
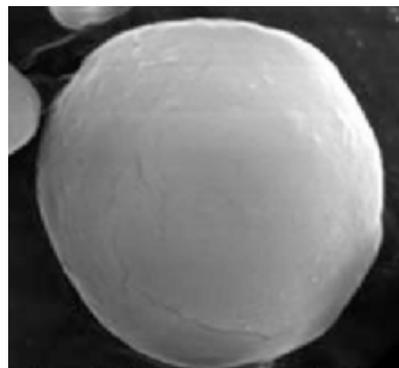
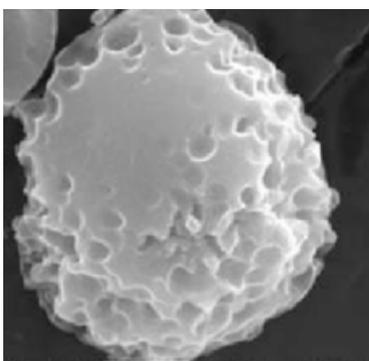


Diagram of metabolism of *Desulfovibrio vulgaris*



Propagation mechanism of bacteria colonies in the glue circuits: the mucilaginous casing developed by the colony is quickly dissolved by caustic soda in the glue, exponentially accelerating the contamination of the system.

A third issue that can cause problems with dosage and consumption of glues, production speed, and quality limits is the fluidification of starch. Primary starch (immediately available in the colloidal solution) and, to an extent, secondary raw starch, can be affected by enzymes produced by microorganisms, such as alpha-amylase, that break the bonds between glucose monomers and allow assimilation. The result is a reduction in glue viscosity and proper bonding.

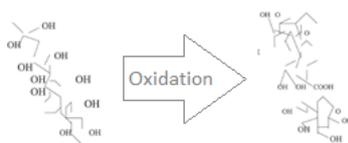


On left: raw starch grain partially degraded due to the reaction with enzyme Alpha amylase.

On right: still intact starch grain. (Image www.creativecommons.com)

Effective use of biocides for glues

In the past, formaldehyde was used for its strong biocide power. However, because it is carcinogenic, its use is restricted by EC regulation 1272/2008. Other biocides are not recommended for use because they fluidize starches. For example, oxidising agents such as sodium hypochlorite and hydrogen peroxide as shown in the reaction below:



What are the biocide characteristics necessary for starch-based glues?

- Effective on a wide spectrum of contaminants, both aerobic and anaerobic
- Effective against bacteria in strongly alkaline environments (pH higher than 12)
- Compatible with glue and common additives, insuring no changes in characteristics
- Maintains its effect for an extended time (at least two days) to prevent fermentation during machine stops
- No generation of potentially hazardous vapors
- Fully compatible with food packaging

Benefits of effective biocide programs

Use of specific antibacterial products has several positive effects on the glue characteristics:

Elimination of enzymatic fluidization allows optimal viscosity to be maintained, which reduces glue consumption, allows better management of boarding and reduces wash-boarding problems.

Lower development of CO₂ keeps the gel temperature at optimal values, allowing higher machine speeds to be achieved and reducing loose bonding phenomena near the scores and knives at the slitter scorer.

Reduction of the bacterial charge eliminates the onset of unpleasant odors and reduces the formation of gaseous metabolites, which are among the main causes of foam formation.

Elimination of bio-corrosion in the glue circuit, reducing plant maintenance costs and prolonging equipment life.

Kemind program solutions

The first step in our approach is to complete a process survey of the production environment. We examine the physical and mechanical parameters of your facility and incorporate recommendations for improving the hygienic conditions for production.

Next, we perform an analysis of the process including potential areas where microbiological growth can be problematic and take samples for laboratory analysis so that we can design a chemical program treatment for the environment and for controlling the microorganisms found there.

Kemind has developed biocide solutions that are safe and effective for use in starch-based glues, that provide a number of advantages for the production of board and paper products. The biocide solutions developed by Kemind during our 35 years of experience in the field of additives for starch-based glues, allow:

- Full compatibility with food packaging
- Easy use
- Prolonged bacterial effect
- Production stability
- Minimum dosage
- High effectiveness on the entire microbiological spectrum (both aerobic and anaerobic)
- No interaction with other components and additives
- Null effect on the texture and other characteristics of the glue
- Delivery suitable for every need (drums, 1 cubic meter containers, tankers) including complete dosage systems integrated with the mills' DCS environment

Want to find out more?

Please visit our website, www.kemind.it or contact us directly info@kemind.it

Kemind's 35 years' experience makes us uniquely qualified to deliver complete industrial solutions and concepts to our customers in the pulp, paper and board industry.

Kemind's entire product range is fully CERTIFIED ISO 9001:2015; analysis certificates, data sheets and security sheets are available to our customers on request.

Kemind has agencies in Europe, Africa and the Middle East to ensure that our customers can communicate quickly and easily with our commercial network.

Kemind guarantees development of our applications during industrial testing on site, and our staff of technicians provide users with the appropriate assistance for varying needs and technical problems of any kind. In addition, our labs provide supplementary technical support to customers thanks to our qualified staff and wide range of analytical equipment.

Kemind's logistics network ensures fast, secure delivery in Europe and the Mediterranean basin, on the African continent and throughout the Middle East, even in the case of emergencies due to stock rupture.