New One-Two Punch Gives Mills the Upper Hand Against Stickies

A new technology combines patented enzyme chemistry for stickies treatment with the leading detackifier to generate a breakthrough in stickies control, reducing the size and quantity of stickies while stabilizing any remaining stickies to reduce agglomeration downstream.

By Dexter B. Monroe

Optimyze Plus technology combines patented enzyme chemistry for stickies treatment with the leading detackifier to generate a breakthrough in stickies control. This patented enzyme technology reduces the size and quantity of stickies while the detackifier stabilizes any remaining stickies to reduce agglomeration downstream. Several studies demonstrate that this new technology provides a new standard in stickies control. Field applications confirm that the synergistic combination of the enzyme chemistry with the detackifier provides greater stickies reduction than enzyme chemistry and better stickies stabilization than detackifiers.

INTRODUCTION

Over the last 40 years the paper industry has experienced several market forces that have influenced the direction of recycled fiber utilization. Buckman conducted a survey of industry experts which indicated that stickies-related sheet quality and machine runnability problems have increased mainly due to marketplace demands for higher sheet quality performance. In order to be competitive in today's market, papermakers must continue to respond to these ever increasing sheet quality expectations. The papermakers rely on procedural, mechanical, and chemical methods to control stickies-related problems within their operation. The scope of this article is limited to chemical treatments. Additionally, environmental improvement efforts have limited the use of prevailing chemical technologies for stickies treatment. [1] These main drivers that have influenced recycled fiber utilization can be categorized as technology advancements, the competitive marketplace, and environmental requirements.

Technology Advancements. Papermaking technology improvements as well as the consumer technology evolution have taken sheet quality expectations to higher levels. The main dilemma is centered on the notion that the paper industry's quest to meet the market demands for higher sheet quality standards is one of the main contributing factors to the problems associated with stickies. The cycle starts with a consumer need to enhance the look and feel of a paper product. A marketing company may request that their paper have improved brightness, softness, strength, or printability in order to create a more distinctive and vibrant advertisement. In order to meet this demand, the competitive marketplace drives chemical innovation. It is this very innovation that leads to the creation of improved ink binders with longer water penetration hold out. As these improved ink binders become a part of the recycled fiber market, the same innovation that led to their development results in a sheet with a more tenacious stickies deposit. Several paper industry and consumer technology advancements are highlighted in Diagram 1.

Competitive Marketplace. The paper industry has experienced company consolidations, paper demand reductions, and global capacity realignments that have affected the distribution and usage of recycled fiber. Diagram 1 depicts the emerging technologies and marketplace drivers that continue to reshape the recycled fiber market. Many of these factors represent challenges for papermakers. Global recycled fiber demands have influenced the price and quality of recycled fiber. Papermakers no longer demand clean, consistent recycled fiber from their

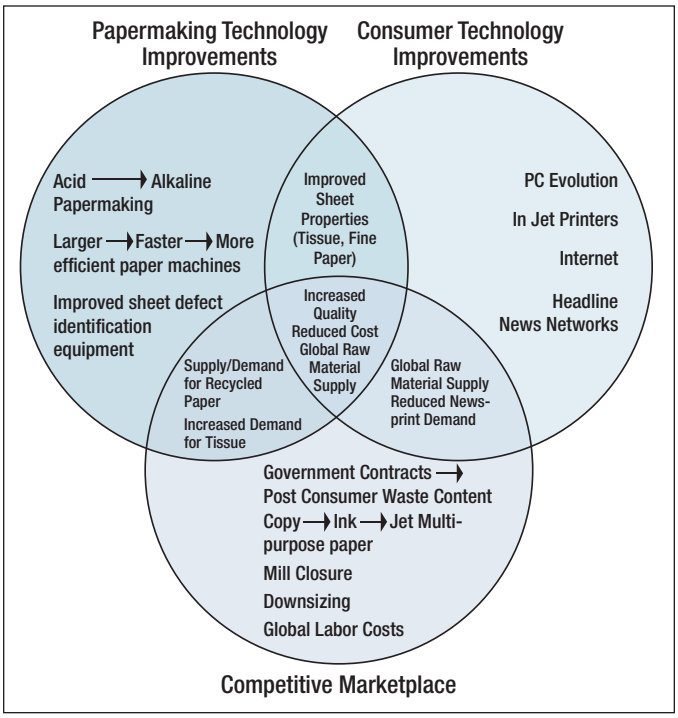


Diagram 1

suppliers. Instead, papermakers accept lower quality contaminated recycled fiber because it is affordable and available. At the same time, chemical innovation has increased the tackiness of stickies, and the global recycled fiber demand has increased the potential for increased contamination in recycled furnish. Many of these issues are shown in Diagram 1.

Environmental Requirements. Throughout the 1970's, 1980's, and 1990's, the Environmental Protection Agency's enforcement efforts have caused papermakers to scrutinize the chemical additives used in the papermaking process. Some of the strong cleaning agents used in the 1970's and 1980's have been phased out due to water quality discharge regulations established by the Clean Water Act. [1] Even some of the less aggressive detergents used in the 1990's have been banned due to Clean Water and Clean Air regulations. [2] Currently, several paper companies have implemented a lower risk approach to chemical additives by eliminating the use of products that contain even the slightest level of hazardous pollutants. As much as the improved quality demands and the competitive global marketplace have adjusted the stickies control arena, the environmental regulations have changed the pool of potential chemical actives available for use as stickies control agents. Today, the demand for "green" products have led to the creative use of natural alternatives such as enzymes and agriculturally derived products. Figure 1, Environmental Drivers, highlights some of these areas of concern. [3]

COMPETITIVE MARKETPLACE DRIVES SHEET QUALTY IMPROVEMENTS

Market forces have shifted the perspective of consumers into a new competitive marketplace full of increased sheet quality possibilities. Buckman's survey of papermaking experts identified the main drivers for stickies-related issues within the paper industry over the past 40 years. Figure 2 provides a graphic representation of these factors. The top challenge within the industry centered on the increased level of sheet quality expectations. Careful consideration into the key motivations that contributed to the sheet quality improvements are in line with the theory of economic alchemy described by Paul Pilzer in his book entitled *Unlimited Wealth*. [4] Pilzer suggests that economic success comes from creating consumer demand by offering superior products. This type of improvement did not occur in one step within the paper industry. In fact, the changes occurred through a series of small steps as a result of the papermaking technology improvements, consumer technology developments and competitive marketplace factors listed in Diagram 1. Although the list in Diagram 1 may not be all inclusive, many of those factors were key drivers of the paper quality improvements over the past 40 years. The paper industry experienced economic alchemy as one innovation drove another within the competitive nature of the marketplace. Improved sheet properties led to the formation

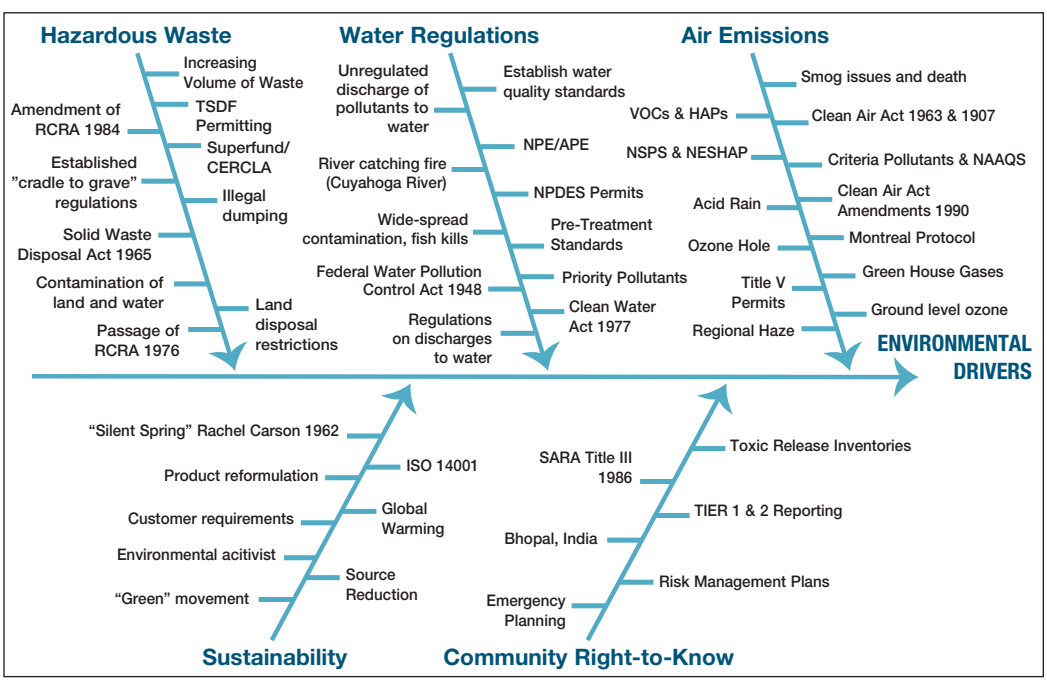


Figure 1. Environmental Drivers

of new paper grades with improved brightness for fine paper, increased softness for tissue, and better printability for packaging grades. These new grades also generated new challenges within the recycled fiber market.

The additives used to help improve the sheet properties also generated new challenges in the repulping process. As our survey revealed, the new challenges were really influenced by the demand for improved sheet quality. The traditional recycling procedural, mechanical, and chemical methods were being utilized comfortably by the papermakers. As sheet quality improvements gained momentum within the industry, these traditional methods started to fall behind the expectations of the papermakers. There had always been a small gap between the desired level of chemical performance and the actual level of stickies control. However, that gap increased due to the need for improved sheet quality performance outpacing the performance improvements delivered by the available chemical technology.

CHEMICAL CONTROL STRATEGIES

Although chemical control strategies have improved over the years, the demand for increased sheet quality has outrun the capacity of chemical treatments to control stickies-related problems. Once a mechanical contaminant removal process has been optimized, papermakers rely on chemical treatments to control the remaining stickies-related issues. It seems that chemical stickies control technologies were simply falling further behind the rapid increase in stickies-related machine runnability and sheet quality complications caused by these increased sheet quality demands. Papermakers were frustrated with chemical treatments that seemed to transfer the stickies from one area of the machine to another surface or end up in the sheet as a large agglomerated stickie, causing converting issues.

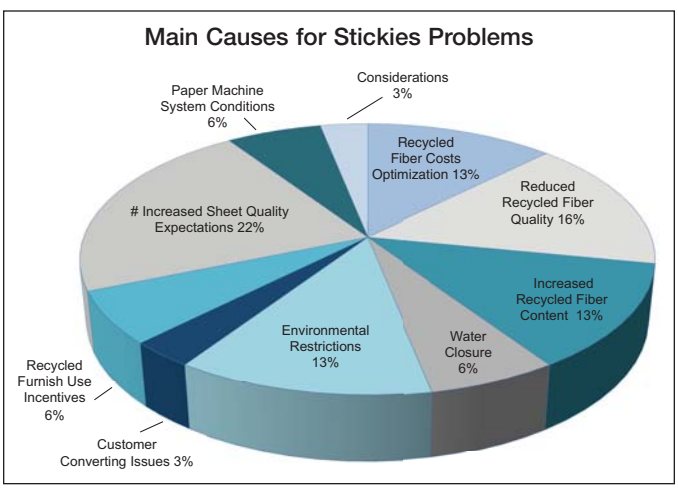


Figure 2 – Stickies Control Survey

One reason for this gap between sheet quality and chemical technology performance is that the majority of the chemical treatment strategies do not address the root cause of stickies-related problems. In order to effectively manage stickies, they must be purged from the process. Table I summarizes the major classification of stickies in order to provide a more comprehensive appreciation for the complexity surrounding the chemical nature of stickies. [5]

In order to help close this gap between increased sheet quality demands and chemical technology performance, a new product was formulated using a blend of enzymes and a detackifier. The new product formed by blending these enzymes with the leading detackifier formed a product with the capability to address a broader range of stickie contaminants. Most stickie deposits are agglomerates formed by various mixtures of the stickie classifications listed in Table I. The enzyme detackifier blend chemically alters the nature of the stickie agglomerates by reducing the size and tackiness of acetates and acrylates while detackifying any remaining components. This product reduces the gap between the sheet quality improvement demands and the available chemical stickies control technologies. Although this product does not completely remove stickies from the process, the enzyme detackifier blend combines the two leading stickies control modes of action in one formulation.

Enzymes. Enzymes are naturally occurring proteins that are used by living organisms to enhance the efficiency of specific chemical reactions. Enzymes are not consumed in a single reaction. In fact, enzymes can participate in millions of reactions per minute. However, system conditions such as pH, temperature, or interfering chemical residuals will break down enzymes over time. The enzymes in this product act together as a catalyst to facilitate the hydrolysis of the ester linkage of stickie materials containing acetate and acrylate components. [6] This

CLASSIFICATION	CHEMICAL NAME	ALIAS NAME	SOURCES
Acetate	Polyvinyl acetate Ethylene-vinyl acetate	PVAc EVA	OCC, MOW, OMG
Acrylate	Vinyl Acrylates	Ink	MOW, OMG
Rubber	Styrene Butadiene Rubber Polyisoprene Polybutadiene Polychloropene	SBR Natural Rubber Synthetic Rubber Neoprene	MOW MOW MOW MOW
Plastic	Polyvinyl chloride Polypropylene Polyethylene	PVC PE	OCC OCC OCC

Table 1

hydrolysis reaction alters the chemical structure of the stickie resulting in a less stable, less tacky material. The chemically altered stickie complex breaks apart into smaller particles. [7]

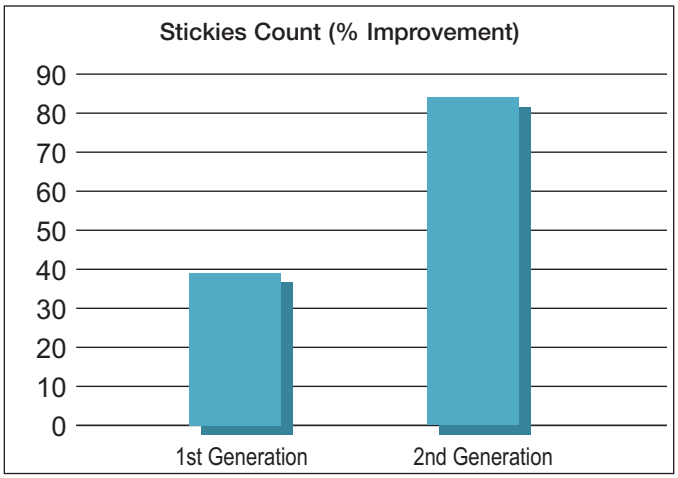
Detackifiers. Detackifiers have been used to control stickies in the paper industry for over 20 years. Detackifiers work at the surface of stickie contaminants. The hydrophobic portion of the detackifier attaches to the hydrophobic stickie surface. Once attached, the detackifier's hydrophilic end remains in the water phase encapsulating the stickie with a water loving coating. Detackifiers vary in chemical structure, available bonding sites, and molecular weight. Each of these factors contributes to the detackification ability of the product. The leading detackifier products offer an improved capacity to stabilize stickies and prevent agglomeration. The detackifier in this enzyme detackifier blended product is a natural polymer exhibiting a strong stickie stabilization capacity. This detackifier, like the enzyme, is a naturally occurring compound. Therefore, the enzyme detackifier blend can be categorized as an environmentally friendly or "green" product.

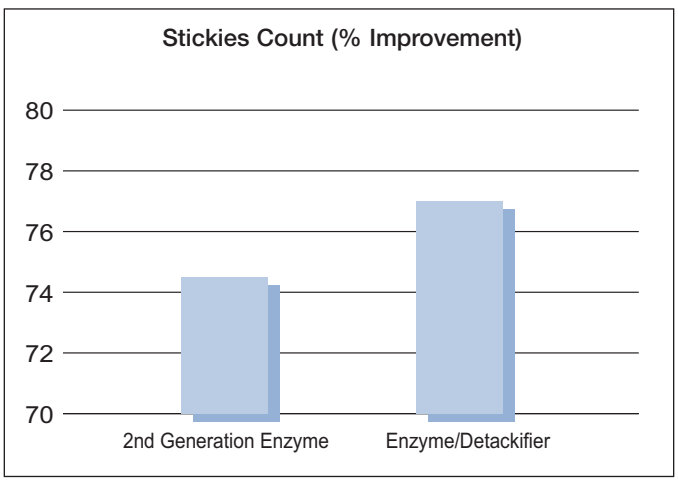
RESULTS

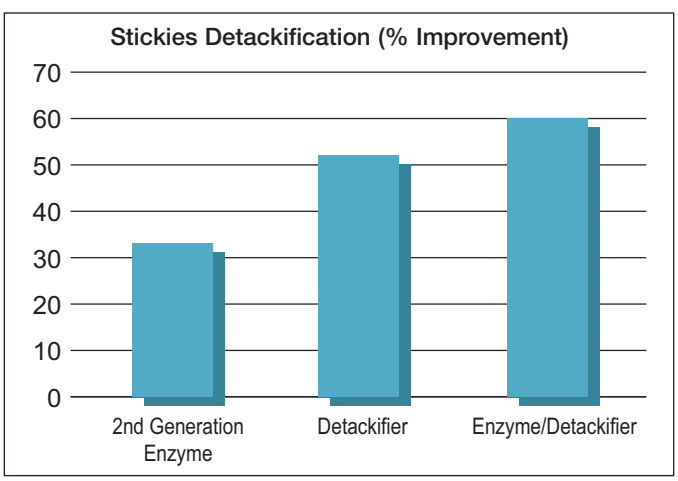
Enzyme based products have successfully reduced the size and quantity of stickies in many mills by breaking the chemical bonds associated with the tacky nature of Poly Vinyl Acetate (PVAc) type stickies. While PVAc stickies make up a large percentage of problematic stickies, most agglomerated stickies contain components of several classifications of stickies.

The opportunity to combine the leading detackifier with the most effective stickies control enzyme appeared to offer the potential for improved performance. The combination of these different modes of action could provide a much needed synergy. The enzymes could help reduce the particle size of the stickie contaminants to allow the detackifier access to smaller stickies. At the same time, the detackifier could boost the performance of the enzymes by helping to stabilize contaminants once they were treated with the enzyme. Lab studies were conducted to evaluate the compatibility of the enzymes and the detackifier. Both actives have proven effective individually, but testing was needed to confirm that the actives could work together with synergistic performance.

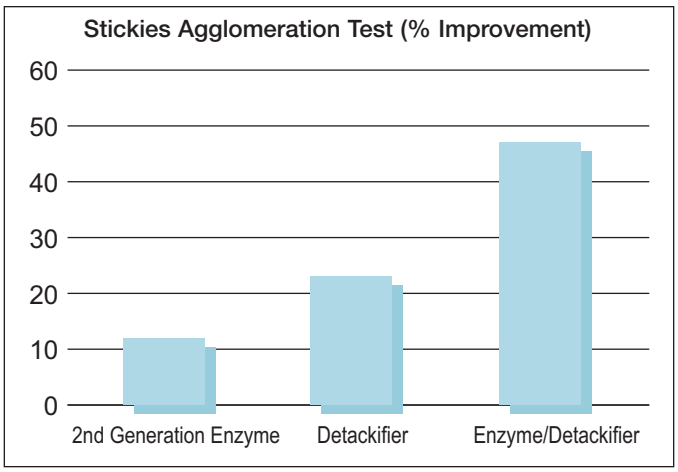
The 1st generation of enzyme products utilized a family of esterase based actives that attack the ester linkages in sticky materials like PVAc. Further research and development efforts led to the 2nd generation of enzyme products. The 2nd generation of enzymes provided an increased tendency to react with the functional groups associated with the tackiest chemical bonds within the structure of the stickie molecule. The following test compared the stickie particle size distribution reduction potential of various enzyme products with and without a detackifier component in an Old Corrugated Container furnish. The combination product, which contains the detackifier in addition to the enzymes, gave better performance than the 2nd generation enzyme product. These results proved to be extremely important because they confirmed that the enzymes could work effectively in the presence of the detackifier.







The next study investigated stickie detackification improvement. The following test compared the detackification capacity of the detackifier, enzymes alone, and the enzyme detackifier blend.



Note that the enzyme detackifier blend provided improved performance over the 2nd generation enzyme product as well as the detackifier product. This is also important because it confirmed that the detackifier could work effectively in the presence of the enzymes. In fact, the enzyme detackifier blend offered a slight improvement over the detackifier.

The next study compared the potential of the detackifier, enzymes alone, and the enzyme detackifier blend to prevent agglomeration.

This study proved to be the most significant because it confirmed the synergy between the two modes of action. The enzymes clearly act on the acetate and acrylate portion of the stickie deposit while the detackifier passivates the surface of the remaining hydrophobic particles to prevent further agglomeration in the process. In fact, the enzyme detackifier blend offered an increased level of performance. Therefore, the bench testing was sufficient to warrant field confirmation of the results. Our field confirmation trials were designed to confirm that the enzyme detackifier blend performed better than the detackifier component alone and better than the most effective enzyme product. Several trial sites were selected and the following two field evaluations clearly confirmed the bench testing.

Field Evaluation Site #1 - A paper machine running a bleached grade using 50% mixed office waste.
Situation: The machine was using the industry leading detackifier at 1#/ton to control stickies loading in the sheet.
Evaluation Result: The machine replaced the industry leading detackifier with the enzyme detackifier blend at 1#/ton with outstanding results. The machine experienced a 57% reduction in sheet stickies.

Field Evaluation Site #2 - A paper machine running a bleached grade using 75% sorted office waste.
Situation: The machine was using an enzyme product to reduce the solvent batch wash frequency in order to lower their chemical cost and increase their production.
Evaluation Result: The machine replaced the enzyme with the enzyme detackifier blend at equal treatment costs. The machine experienced a 54% reduction in solvent chemical usage. They also took advantage of a 40% reduction in batch wash frequency.

CONCLUSION

The introduction of enzyme stickies control marked the first chemical technology that actually addressed the root cause of stickies-related deposition: the tacky nature of the stickie. Buckman's patented enzyme treatment products include actives that work together to reduce the size of stickies by breaking the key bonds that are present in the chemical structure of most acetate and acrylate containing stickies deposits.[8]

Due to the variability of recycled furnish, papermakers rarely have stickies-related deposits from only one type of contaminant. Most stickies deposits found on paper machines or in sheet spots contain a blend of two or more combinations of the classifications listed in Table I. Lab testing and field evaluations clearly confirmed that the enzymes and detackifier modes of action were compatible. The enzymes performed well in the presence of the detackifier as measured by the stickies count reduction test. The detackifier worked well in the presence of the enzymes as measured by the stickies detackification test. Most importantly, synergistic performance of the enzyme detackifier blended product was highlighted in the stickies agglomeration test. Therefore, the use of the patented enzyme chemistry to break the chemical bonds that hold most agglomerated stickies together, combined with the leading detackifier to stabilize any remaining stickies and reduce agglomeration downstream, is clearly a breakthrough in stickies control technology. This technology represents Buckman's 3rd Generation of enzyme products and offers a significant advancement towards closing the gap between customer demands for sheet quality improvements and stickies chemical control technology performance. ■

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