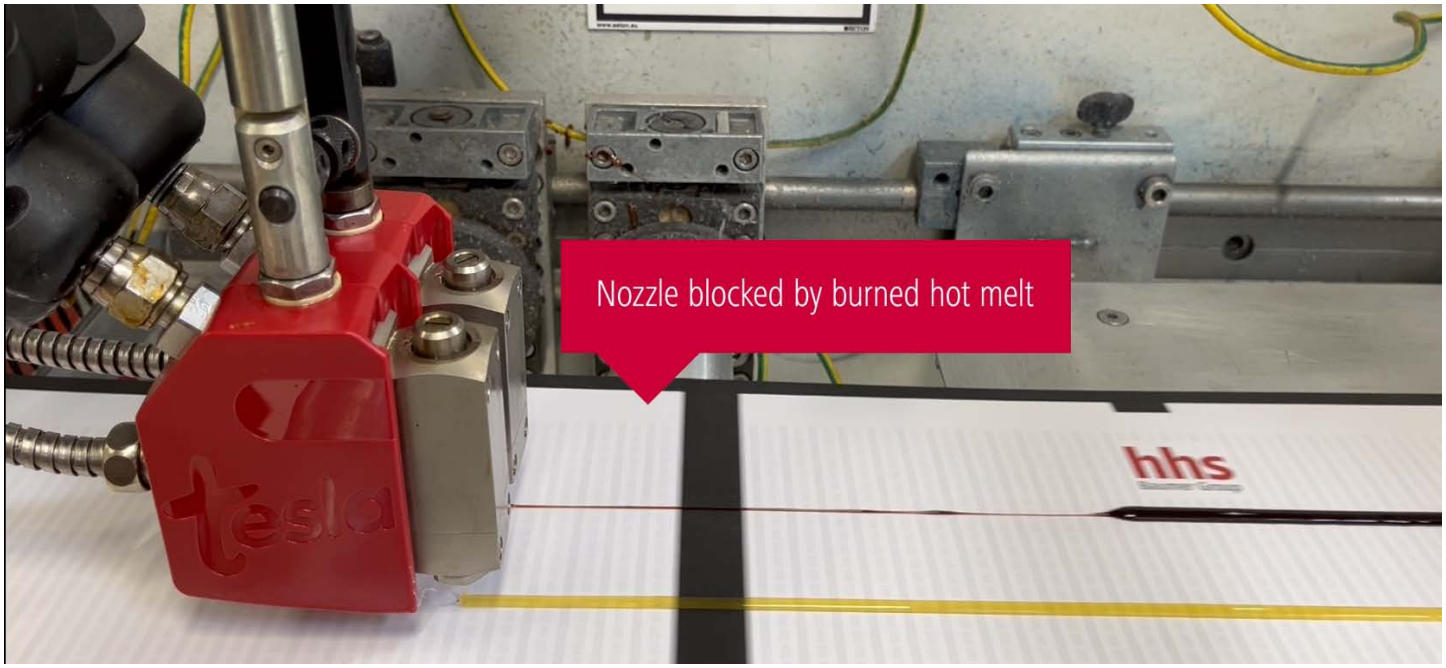

Whitepaper

Maximizing Profitability:

Preventing Downtime and Disruptions in Hot Melt Application

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Unpeeling the Impact of Banana-Like Behavior of Hot Melts on Packaging Profitability

Hot melt adhesives are essential for various packaging processes. They offer immediate advantages such as rapid solidification and resilient bonding. Baumer hhs is renowned for its innovative hot melt application systems, which reduce adhesive consumption by half while maintaining or enhancing adhesive strength. This reduction not only cuts adhesive costs but also minimizes the CO2 footprint and improves packaging recyclability.

Occasional production faults and blockages in the hot melt system have had a impact on its availability and profitability. Consequently, the Baumer hhs development team has dedicated years of research to an phenomenon internal known as the "banana phenomenon." This transformation occurs when bananas are exposed to heat and acid, causing them to develop dark spots and gradually change color from yellow to brown. This ripening process involves a significant alteration in the banana's chemical composition.

Hot melts can exhibit a banana-like behavior when exposed to heat and oxygen, leading to charring, coking, or burning. This degradation process cannot be prevented even with constant flow in hot melt systems. The smallest residues can accumulate and burn, forming dark, hard lumps that

can block nozzles and filters. Hot melt can also build up in hot melt hoses, leading to costly replacements due to deposits and heat-induced degradation. This charring process not only reduces adhesive strength and bond quality but also poses a significant challenge in maintaining the efficiency of hot melt systems.

I. Unforeseen Disruptions in the Bonding Process: Impact on Profitability and Upstream Production Stages

The packaging process is significantly threatened by the unpredictable disruption caused by the spontaneous detachment of burnt particles. These unexpected disruptions lead to blockages in nozzles and filters, significantly impacting the quality and quantity of the applied adhesive. These interruptions not only impair the packaging process, but also disrupt previous production steps. Products that cannot be packed must be stored or possibly disposed of. The unpredictability of these disruptions has detrimental consequences for the profitability of the entire production process.

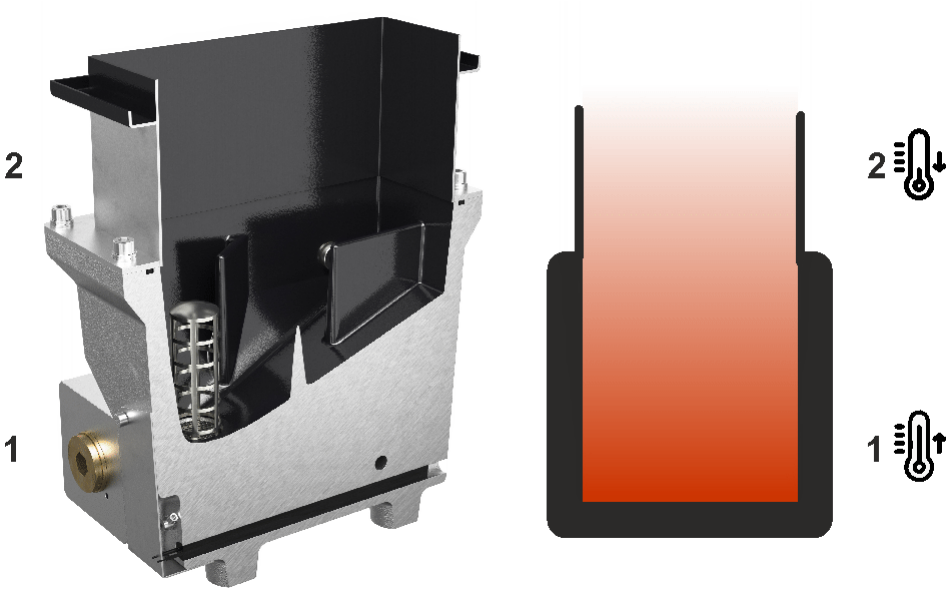
II. High temperatures and oxygen contact: A dynamic duo

Charring in hot melt systems is a result of the combined presence of heat and oxygen . As heat and oxygen work hand in hand, higher temperatures and increased exposure to oxygen accelerate the charring process. To prevent charring, it is crucial to either reduce the temperature or minimize

oxygen contact. These strategies are essential for maintaining the integrity of hot melt systems.

III. Is the melting tank the main cause of charring in the hot melt?

The conventional melting tank in hot melt systems has been identified as a major cause of charring. To address this issue, tankless systems were developed to heat a small amount of adhesive directly in the flow. However, this approach has often resulted in failure, leading to severe burns due to the need for intense heat to melt the adhesive quickly. Consequently, many melt-on-demand systems now require certified, more expensive hot melts. The lack of success of these systems can be attributed to their increased susceptibility to faults.

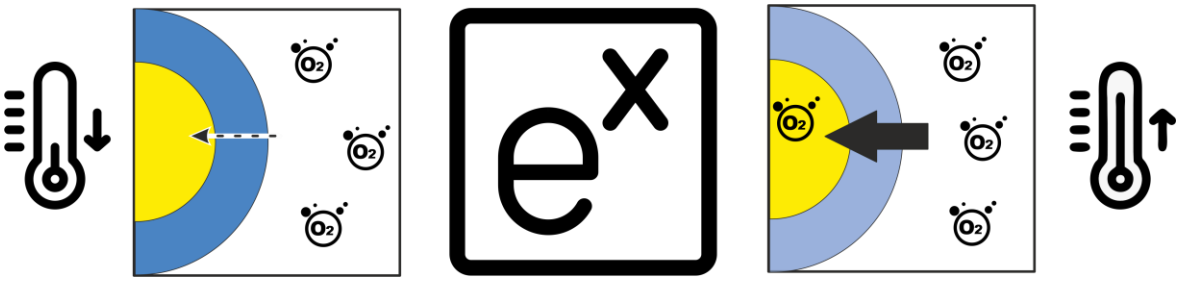


Baumer hhs has used a different approach by introducing a two-zone tank. This innovative design divides the tank into two zones: a heated lower zone where the adhesive reaches its processing temperature and an unheated upper zone where the hot melt slowly softens at a lower temperature. This unique setup creates a temperature gradient during operation, providing a cooler protective cover to prevent the adhesive from burning.

Our system guarantees optimal performance with features such as an automated granulate conveyor to ensure a sufficient filling level. During production stops, a gradual temperature reduction safeguards the adhesive, ensuring consistent quality.

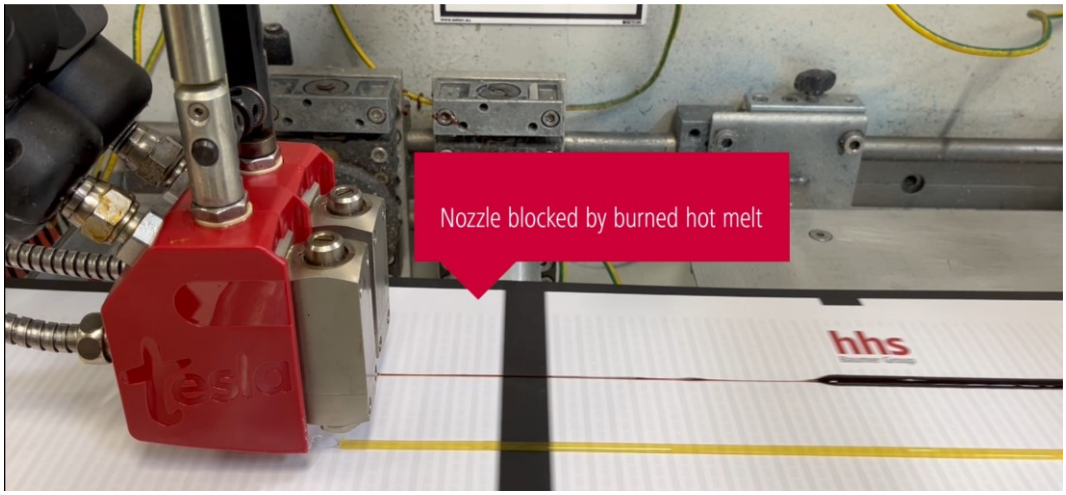
IV. The Mystery of the Remaining Charring

The mystery of the remaining burns was swiftly unraveled. Engineers from Baumer hhs conducted tests on various hot melt hoses to simulate burns. Upon examination, it was revealed that the adhesive around the metal connections showed no signs of burning, while the area around the flexible hose displayed clear signs of burning, identifiable by the different discolorations. This stark contrast indicates that the metal connections provide gas-tightness, which is lacking in the areas where the heated adhesive is transported through silicone or PTFE hoses.



Literature research has demonstrated that oxygen diffusion through thermoplastic tubing undergoes an exponential increase as temperature rises. At room temperature, silicone or PTFE tubing is relatively impermeable, but at higher temperatures, it exhibits significant permeability. This poses a critical concern as a small amount of hot melt comes into contact with a large internal surface area of the tubing.

The search criteria were crystal clear: the goal was to pinpoint hoses that are gas-tight, flexible, and capable of withstanding high pressure. It was therefore obvious to concentrate on solutions tailored for the gas industry. After all, absolute leak-proofing is essential for gas transport lines to prevent any loss of gas.



A comparison was conducted between a newly developed hot melt hose featuring a metal core and three different hot melt hoses with a plastic core. Following an equal heating period, noticeable alterations in both the color and viscosity of the hot melt were observed in the plastic core hoses, while the hot melt in the metal core hose remained unchanged, retaining its initial clarity. These findings are quite straightforward and do not necessitate an intricate scientific explanation.

V. The hot melt hose with metal core - a novelty?

The developers at Baumer hhs initially considered applying for a patent for their innovative solution. However, after discovering that the concept of using a metal hose as a gas-tight inner core for hot melt hoses was not entirely new, they decided against filing their

own patent application. To their surprise, a major competitor later applied for a patent for the same idea and successfully obtained a European patent after negotiations. This caused delays in the commercialization of the new hot melt hoses. However, through joint proceedings with two other industry partners, the patented idea was eventually recognized as not patentable in opposition proceedings, leading to the complete revocation of the competition's patent by the Opposition Division of the European Patent Office on 8 May 2024.

This significant development now provides users with the opportunity to completely avoid or significantly reduce problems with hot melt application caused by charring of the adhesive, which typically leads to production disruptions.

VI. Additional benefits of the Xmelt DF hot melt hoses

One additional major advantage is the increased longevity of the solution. When examining the primary causes of hot melt hose failure, two key factors emerge. The main reason for hot melt hose replacement is coking, resulting in a gradual buildup of burnt hot melt on the inner hose walls. These issues are eliminated when using a metal inner core. Another cause of failure is the embrittlement of thermoplastic PE/PTFE or silicone inner cores due to continuous heat exposure, necessitating replacement at least once a year. Metal inner cores do not suffer from such embrittlement. The use of high-quality stainless steel for the inner core prevents corrosion, resulting in a 2 to 3 times longer service life for hot melt hoses with a metal inner core. While these hoses are more expensive due to the materials used and the complex production process, they lead to a reduction in the high spare parts costs associated with hot melt systems.

It is not practical to make just one component of a hot melt hose more resistant and durable. Durability should be evident in the entire hose structure. This is why Baumer hhs has replaced the standard textile outer fabric used for hot melt hoses with a robust, abrasion-resistant corrugated TPE hose. This modification enhances overall construction durability, ensuring

a longer service life. Another advantage of the corrugated plastic hose is its watertightness .

An initially unexpected but understandable side effect is the reduced energy consumption of hot melt hoses with a metal core. With an adhesive consumption of 5kg/h, energy consumption was 20% lower compared to a similar hot melt hose with a plastic core. This is due to the superior thermal conductivity of the metal core compared to the relatively thick plastic cores made of PTFE and silicone, which are challenging to modify due to the high pressure load. Additionally, PTFE is known for its excellent insulating properties.
In addition to traditional hot glues, reactive one-component polyurethane adhesives, which react under the influence of water vapor, also benefit from these hot melt hoses. The new hoses are ideal for this purpose, as the metal core is not only gas-tight but also moisture-proof, preventing premature and progressive cross-linking within the hose.

VII. Test it to be convinced

We are confident that our solution will meet your needs, and we want you to be just as convinced. Your own experience is the best proof of concept. Take advantage of our offer to trial Baumer hhs and Nordson compatible standard hoses at a 50% discount until July 15, 2024. Let's also discuss the possibility of testing a complete hot melt system with you.

Thomas Walther
(twalther@baumerhhs.com)

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Autor: Thomas Walther (twalther@baumerhhs.com)