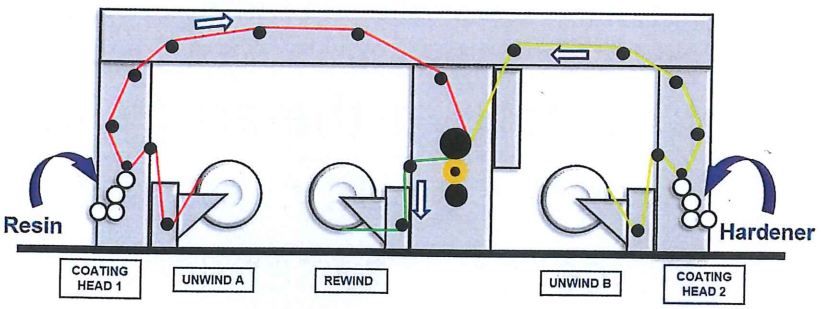
Lamination innovation takes Technology of the Year Award

Joint solventless-adhesive development by Dow Chemical and Nordmeccanica recognized with AIMCAL annual honor.

By Contributing Editor Hallie Forcinio

Dow Chemical Co. (Midland, MI) and Nordmeccanica (Hauppauge, NY) have received the 2017 Assn. of International Metallizers, Coaters and Laminators (AIMCAL) Technology of the Year Award for their jointly developed, solventless-adhesive lamination innovation. The companies were honored at a special ceremony April 26 in conjunction with ICE USA 2017 in Orlando, FL. The judges also presented two Honorable Mentions in the annual competition.



Compatible with most printing inks and substrates, the lamination technology shortens time-to-market, boosts production speeds and cuts costs. Twin coating heads on Nordmeccanica's Duplex SL One Shot™ laminator apply one component of Dow's two-part Symbiex™ solventless adhesive on each web. When the resin-coated and hardener-coated webs meet at the lamination nip, polymerization begins, and the adhesive quickly cures. No mixer is needed, and pot life is no longer a concern. The quick curing produces a measurable bond within 30 mins, allowing quicker quality checks and slitting within 90 mins. Curing inventory is eliminated, and there's no need for hot or thermal-conditioned curing rooms and associated energy consumption. As a result, pouches made from the lamination – even those destined for food contact – can be filled within 24 hrs instead of the typical waiting period of four to six days. In addition, final optical properties are higher, and a significant reduction in adhesive misting boosts production speeds up to 20% vs. traditional solventless lamination.

The judging panel quickly acknowledged the collaborative development effort and novel nature of the resulting two-part adhesive and application technology. "Using a two-component adhesive without a Meter Mixer Dispenser really hasn't been done before," they agreed. "Eliminating worries about pot life is game-changing," noted one judge. "This technology is applicable to thousands of laminators," added another panel member.

The 2017 AIMCAL Technology of the Year Competition judging panel included five well-known experts in the converting field: Tom Bezigian of PLC Technologies (Cicero, NY); Dr. Charles A. Bishop of C.A. Bishop Consulting (Loughborough, UK); Dr. Edward D. Cohen of Edward D. Cohen Consulting, Inc. (Fountain Hills, AZ); Dr. Eldridge M. Mount of EMMOUNT Technologies LLC (Canandaigua, NY); and Dr. David Roisum of Finishing Technologies, Inc. (Neenah, WI). Craig Sheppard, executive director of AIMCAL (Ft. Mill, SC), moderated the judging teleconference.

A more detailed explanation of the technology development is available on page 39.

Duplex laminator and adhesive for ultra-fast curing of solventless adhesives

By Giancarlo Caimmi, Ph.D., corporate commercial director, Nordmeccanica Spa; and Amira Marine, tehcnical service and development, Dow Adhesives

Editor's Note: *This development won the 2017 AIMCAL Technology of the Year. More information on the other winners of the annual competition can be found on page 30.*

Abstract

Market opportunities exist for improvements to solventless lamination applications, including increasing line speeds, eliminating pot-life concerns and reducing downtime. As two leading players in the solventless lamination industry, Dow and Nordmeccanica collaborated on a technological development where each company brought its specific areas of expertise to address these market opportunities. As a result, a new solventless, polyurethane laminating adhesive (SPLA) [ultra-fast curing adhesive] technology, combined with an innovative duplex lamination line, is set to redefine packaging lamination. Launched during drupa 2016 in Germany, these new patent-pending technologies have pioneered development toward ultra-fast curing, which is beneficial in increasing converter efficiencies and minimizing unwanted costs.

Introduction

Solventless laminating adhesives are used increasingly in general and high-performance, flexible food-packaging applications. The primary benefits of solventless adhesives are reduced energy consumption, as compared to water-based and solvent-based adhesives, and reduced emissions, as compared to solvent-based adhesives. Further, solventless laminating equipment often is simpler in design and operation. Despite the many benefits of solventless adhesives, there still remain potential areas for improvement. These include extending adhesive pot life, reducing machine downtime related to equipment cleaning, implementing higher production speeds, shortening time-to-market for final packages, eliminating mixer pumps and allowing for quality checks at early stages of the process to limit waste. Addressing the aforementioned areas for improvement can yield significant operational cost and productivity benefits for converters.

The new technology

Dow and Nordmeccanica first met in the winter of 2014 with a desire to develop a new, game-changing, solventless lamination technology, essentially *Solventless Lamination 2.0*. We were able to go from the initial idea to a public announcement of an innovative technology at drupa 2016 in less than 18 months.

The evolution that eventually made for the innovation would not have been possible without the collaboration of two industry leaders. Technical difficulties, economic advantages and side effects were meticulously evaluated, but eventually it was the field test that allowed for the real analysis of advantages and disadvantages of the new technology. Using a prototype machine, the research team was able to thoroughly test the technology and evolve the adhesive formulations and the machine designs for almost a year before the public announcement.

The technology is elegant and intuitive. The adhesive remains a 100% solid, two-component system re-imagined for a fast-curing system. Machine design requires the implementation of a specific layout to accommodate the re-imagined adhesives. Basically, what is changed is the point during the lamination process at which the two components of the solventless adhesive come into contact. In traditional application, a meter-mixer-dispenser delivers to the coating head the fully mixed adhesives ready to be coated. Because the two components are mixed at an early stage of the process, the adhesive is in the process of polymerizing and has a limited useful pot life.

In fact, in traditional solventless lamination, to give the pot life some realistic duration to properly allow for process handling, the polymerization is intentionally slowed down. The effect is that the entire laminating process is slowed, resulting in a longer time to the next converting step (usually slitting) and a longer time to the primary aromatic amine ("PAA") decay for safe food contact. The safe food contact step in traditional 100% solids, solventless lamination takes days, while the time to the next step takes several hours. This forces the use of significant production space for temporary storage during polymerization evolution – ideally, "curing rooms" with temperature and moisture control. The new SPLA adhesive and the new duplex laminator overcome these issues.

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TABLE 1. *Typical physical properties of the new solventless polyurethane laminating adhesive*

Property	Adhesive	Coreactant
Solids %	100	100
Viscosity at 25°C mPas	6500 to 9000	10000 to 15000
Weight/Gallon g/cm^3	1.18	1.1
Mix Ratio	100	100

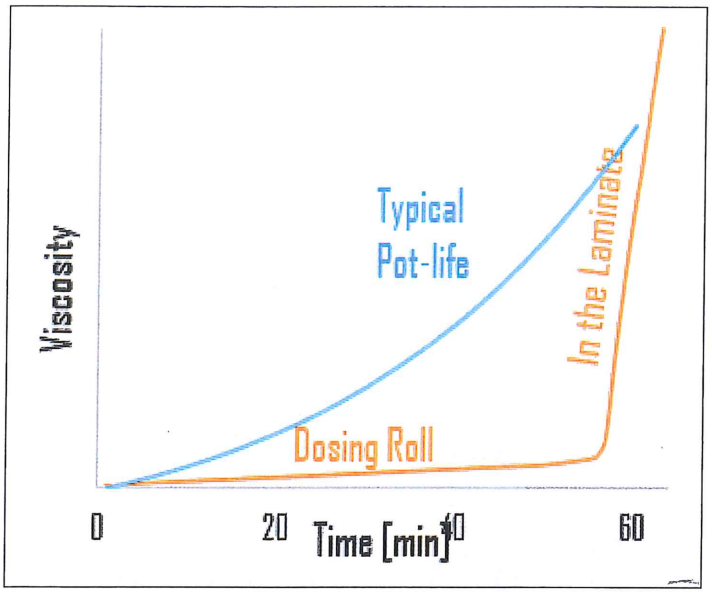

FIGURE 1. *Viscosity of SPLA dosing gap and laminate*

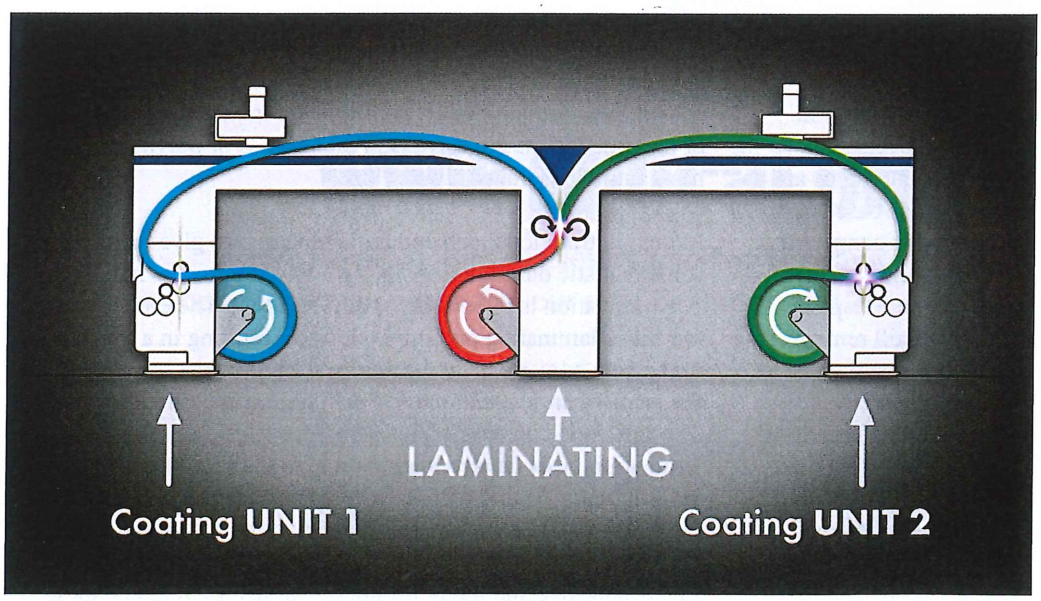

FIGURE 2. *Diagram of duplex laminator web path*

The adhesive

The revolutionary adhesive is a two-component, solventless polyurethane laminating adhesive (SPLA). Table 1 summarizes typical properties of the adhesive. As mentioned previously, some of the fundamental limitations of current laminating processes are combining fast curing, which requires a fast-reacting adhesive, with outstanding pot life, which requires a slower-acting adhesive. With the new SPLA system, we have overcome the pot-life constraint by moving the start of the chemical reaction to the lamination nip and developed the fastest two-component, solventless adhesive in the market today.

The traditional process for a standard adhesive today involves combining the two components in the mixing station, filling the mixed adhesive into the dosing station, applying the adhesive on one web and then bringing that web together to a second web for lamination. The chemical reaction that characterizes the curing of the adhesive and building of the adhesive network through molecular-weight-increase starts after mixing both components. This step is visibly observable by the rapid increase of adhesive viscosity, which is less than ideal. The SPLA system has a very slow reaction into the dosing gap and then moves into a very fast reaction when the adhesive components are combined at the nipping station between the two films so the curing process can be completed as fast as possible (see Figure 1).

The combined SPLA technology and duplex laminator offer three particular advantages. A first advantage enabled by our technology is a faster time-to-market and a reduction in work-in-process. With this simpler, reliable and more flexible lamination process, converters can slit 90 mins after lamination and have the final package food safe and ready for shipping within 24 hrs for most lamination structures. A second advantage observed is a lower cost-in-use due to the reduced line downtime (i.e.: laminator efficiency) and curing inventory. A third advantage includes efficiency improvements thanks to very high web speeds and no mixer, therefore eliminating pot-life concerns.

The laminator

As previously discussed, fast curing is achieved by having the two components of the adhesive come into contact as late as possible into the lamination process. The latest the two components can come in contact is at the lamination nip. Therefore, the new technology involves coating the adhesive components separately on the two webs and bringing them into

contact only at the lamination nip (see Figure 2). At that time, polymerization will be free to evolve as fast as possible. To be able to control such a development, machinery-wise, a few tasks need to be accomplished. First, the machine requires two distinct coating heads, with each head coating one of the two webs to be laminated. The entire process requires a higher level of technology because of the need for coatweight accuracy, the specific web-handling requirements and the lamination nip setup. Reliability of all of the above needs to be guaranteed by the hardware design and the technical solutions implemented.

Two key factors have been taken care of during the development of the new technology:

1. The amount of adhesive needed to properly handle lamination will not change when compared to the traditional technology.
2. Mixing ratio of the two components of the SPLA has been kept in the 1:1 range of values.

Accordingly, each coating station handles approximately 50% of the usual coating weight. This is not a problem once the coating head is the original 5-roller system conceived and patented by Nordmeccanica. Coating weights as low as 0.50 g/m² (0.35 ppr) can be handled reliably on the station, therefore allowing for total ease to handle the range of coating weights required. The original concept of the floating transfer roller patented by Nordmeccanica, the signature solid roller design, the use of digital vector drive motors to control the station, was evolved to deliver consistency of the coating weight at those low values under the most challenging production conditions. Stability of the coating weight is, in fact, paramount because that is the variable in the new technology – taking care of the mixing ratio.

Web handling: This is a critical aspect of the technology in solventless lamination. Nordmeccanica set the ground for reliable handling of critical webs and made possible the evolution of solventless lamination through an innovative approach to web handling. Laminating thin and critical substrates with adhesives characterized by low green bond is state-of-the-art in solventless lamination. Now, in accordance with the requirements of the new technology, the task evolves into the control of two webs, of different chemical and mechanical nature, both coated with warm adhesive, traveling through the machine. Both webs coming at the lamination nip to be laminated under specific pressure requirements are influenced by the need to "mix" the two components of the adhesive at that very point. Most of the solutions implemented are of proprietary nature, but what matters is the result: The new lamination technology was proven reliable under every possible mix of substrates for the flexible packaging industry and for most industrial applications, including foil and paper.

Machine setup time: The presence of two coating heads does not double setup time. This is mainly due to the innovation of the dosing gap being motor-controlled. This upgrade, in one with

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the mixing ratio required by the new adhesive, offers a machine setup time in the same range as traditional technology. Once this benefit is associated to the advantage of the extended pot life of the new adhesive (with the dramatic reduction of programmed and emergency washing of the station due to adhesive aging), it will be easy to understand that the uptime of the machine in the new technology is remarkably short and in the same range of tim as traditional solventless laminating.

Equipment investment: A piece of equipment with two coating heads will be more expensive than a piece of equipment with a single coating head. However, it is also true that the new technology will not require the use of a meter-mixer-dispenser and other hardware associated with traditional solventless lamination. In this case, the attention should be to the overall investment and process simplification. The mixer is, in fact, the hardware that requires the most attention in washing and maintenance. The combined effect: Overall investment for the new laminator is in the territory of a traditional price.

Additional benefits: In addition to the benefits discussed above, the dual coating-head system has another benefit. Namely, having the machine with two coating heads will enforce advantages even when the machine is used with traditional adhesives.

There will be the need to use a mixer, but the two coating-heads design allows the duplex to be run as a virtually zero-downtime laminator. Once running a job, it will be possible to service the other coating-head station in preparation for a new run.

Conclusions

The new technology has been rated by international press as the most significant innovation in coating and lamination in the past 30 years. It required creativity, know-how and expensive investments in R&D to be conceived and developed. The determination of the management of both Dow and Nordmeccanica brought the innovation to the industry in a very short time period. It is well known that every time a game-changing technology is offered, it will not be easy for the developers to win the immediate approval of an industry, but in this case, both a new machine design and a new adhesive formulation have been introduced. Nevertheless, with new SPLA and duplex laminating technology, the ingenuity of the idea, the creative solutions implemented and the reliability of the process should yield rapid market respect. ■

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