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“ADHESIVE LAMINATION: 100% Solid”:

Extended Abstract

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Presentation

Solvent Free lamination evolved in the past 40 years in the industry, from the early days of a European only technology to a market reality globally.

In North America Solvent free lamination went through a significant growth just in the past ten years. Nevertheless its market share is still significantly lower than in the rest of the world. In this paper will be presented the fundamental evolutions of the technology, mainly from the machinery point of view, highlighting the factors that positively influenced growth.

- Technology.

Definition of Solvent free lamination and technical requirements.

Polyurethane Chemistry reaction

Technology is commonly referred to with at least three different names: Solvent Free Lamination, Solvent Less lamination, 100% solid adhesive lamination. The most appropriate technical definition is: 100% solid. The most commonly used in the industry is Solvent Free lamination.

The aim of the technology has been to create an adhesive that was able to be handled (coated) without the need of a vehicle: pure resin, 100% solid. Mostly like thermoplastics but with mechanical stability at high temperatures.

Urethane Chemistry was of help, the reaction between an “isocyanate” group and a “hydroxyl” group generates Urethanes.

The resin (based on isocyanate group) and the catalyst (based on hydroxyl group) are in a fluid state and handled at temperatures in the range:

Room to about 80°C (170 F).

Once mixed at a proper ration the new compound will remain fluid for a limited amount of time. The development of the chemical reaction will have the effect to proportionally increase viscosity until the solid state of the cured adhesive is reached.

Low viscosity for Solvent Free adhesives is in any case something in the range of the thousands cps.

- Historical background.

How Solvent Free evolved in the industry, milestones in the technology.

Research and development on the technology of Solvent Free lamination was approached in the 60s, but only in the second half of the 70s we can assume the new adhesives became a market reality. Europe was the first area to accept the new idea due primarily to the energy crisis that was storming over Europe at that time. During the 80s the technology was expanding all over the world. At the beginning of the 90s a new concept

of compact, simple, Solvent Free laminators opened the expansion of this technology to a huge number of converters. In North America very few pioneers were involved in Solvent Free lamination before 1994. Then in 1994, for the first time, a Solvent Free laminator was exhibited in production in an American Exhibition (PMMI 1994). That event marked the beginning of a significant growth of Solvent Free lamination in North America as well.

- Advantages and disadvantages

A list of advantages connected to the 100% Solid adhesive lamination will include:

- Energy savings: a solvent free laminator will absorb about 25% of the power of a traditional laminator of comparable production performances.
- Emissions: a solvent free lamination process is emissions free.
- Lower Capital Equipment investment.
- Overall lower production costs.

In the list of disadvantages will have to be included:

- Low bond at “green”.
- Technical Limitation on some packaging application, high temperature related: Sterilization, pasteurisation, retort.
- Long curing time and therefore higher inventory costs.

- Curing Time.

Definition of curing time and the difference between green bond, curing time for the next production step and curing time for food contact.

Green bond is the bond available at “green”: immediately after the lamination nip. It is normally very low in 100% solid lamination.

Curing time is intended as the time needed by a Solvent Free adhesive to develop the bond. There are two distinct levels of bond of technical interest:

- Practical definition: Time needed to develop a bond sufficient for the next production step (i.e. slitting or bag making): it is a level of bond in some case as low as 40% of the final one. This level may be achievable just few hours after lamination.
- Chemical definition: it is the time required to achieve the total curing of the adhesive compound or the total disappearance of Free Isocyanate. This level of curing is important in general but in particular it applies to food packaging. To have no Free Isocyanate means no risk of migration of uncured molecules to the packed food. The complete curing of adhesive will require, in function of the actual adhesive, a time in the size of “days”.

- Problems/Solutions.

Summarizing there are technical factors that, influencing the ability to handle with ease Solvent Free lamination, had an impact in the evolution of the technology:

The difficulty to maintain a consistent accuracy in coating weight, due to the physical state of the adhesive.

The difficulty to achieve proper quality levels of the final laminated product, due to the low green bond of Solvent Free adhesives.

The difficulty to handle an adhesive cured by “time” in a safe manner.

Evolutions in technology with the solution of such problems brought eventually Solvent Free lamination to be the “simplest” and safest, not just the most convenient, technology:

Proper Machine design.

Evolutions in the technology of tension control.

Evolutions in the technology of temperature control.

Evolutions in Meter Mixer pump technology.

Development of proper procedures in process handling.

- Coating High Viscosity.

Technology of the coating head.

First legendary disasters in the History of Solvent Free lamination have been generated by not properly understanding the importance of this aspect of the technology.

Due to the viscosity level of the adhesive at the coating head, it is of paramount importance the design of this unit. Various factors will influence the process and all of them have to be properly addressed in order to allow a correct control of the coating weight, mainly under speed variations.

- Physics of the fluid.
- Design of the station.
- Viscosity related aspects.
- Curing related aspects.
- Influence of temperature control.
- Mechanical accuracy related issues.

- Tension Control, Temperature Control, Cleaning.

The fundamental principles in order to master the technology of Solvent Free lamination are summarized in 3 Golden Rules:

- Perfect Temperature Control
- Perfect Tension Control
- Appropriate Cleaning procedures.

Pioneer design figured out clever solutions in order to minimize technical problems related to these issues, but it was not a complete success. It was primarily for difficulties connected with both the proper understanding of the importance of these three rules and the associated difficulty to achieve proper solutions that the technology of the early days was affected. Developments in machine design, electronics and adhesive technology determined the final positive evolution of solvent free lamination. The paper presents, in proper detail, such developments.

- Barrier and non-barrier film lamination.

The latest development in high speed lamination.

The discussed evolution of Solvent Free lamination and the achievement of high production speeds opened the understanding of some of the most important speed-design related issues connected with Solvent Free lamination. The most important factor influencing good quality results in High Barrier film lamination is the distance between the coating and the lamination nip.

- Meter mixer pump technology.

A significant factor in the solvent free lamination made easy.

The ability to run with ease a Solvent Free lamination has been greatly influenced by the latest evolutions in meter mixer pump technology. In 1999 a new design of gear pump controlled systems was presented to the industry. Currently above 80% of the new installations globally include this design.

- 100% Solid adhesive lamination in different markets.

In conclusion a global overview to market shares of Solvent Free lamination in different markets.

Data sourced through the industry confirms that the total market share of SF lamination in Europe exceed 60%, in Asia is almost at 40%, in South America is above 60%, in USA is at about 25%. Tendency in the past few years showed a growth of market share in North America, monitored by the number of Solvent Free laminators installed, rated as the faster increasing on a global scale.