**Foaming of PSA Adhesives for Tape and Label Application**

Mike Fornes & Raza Hayder

PSTC TECH 33
Las Vegas, Nevada
May 12-14, 2010



## Introduction

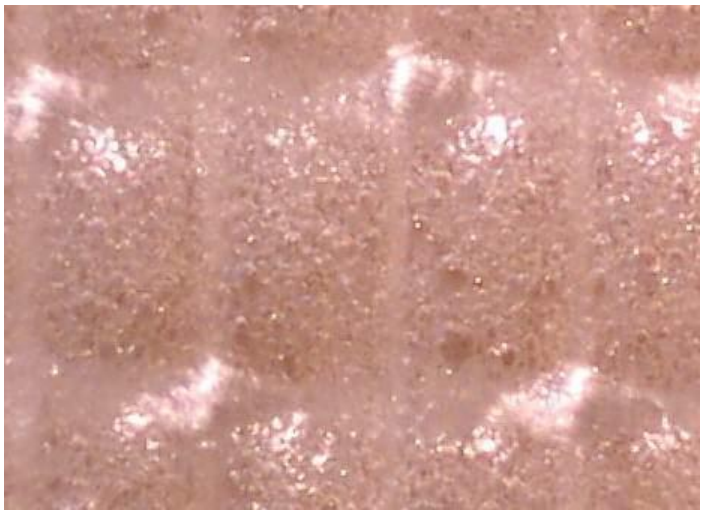
In the world of adhesive dispensing, foaming of single component adhesives has been around for many years and used in many applications. Typically, it is used in sealing of seams, filling of gaps, single-use gasketing and bonding of components. However, use of foamed hot melt adhesives in coating and converting has been limited. This has mainly been due to the lack of exposure of the adhesive foaming process in the coating and converting industry and, until recently, the capabilities of the foam application equipment. This paper covers the application of mechanically-foamed single component adhesives for coating and converting applications.

## Foaming 101

Single component foaming changes the material characteristics of dispensable substances by mechanical means. The foaming process uses a mechanical mixer, pressure and precise introduction of an inert gas to form a single solution. The result is an evenly-distributed solution of an inert gas and base material. Base materials can include adhesives and other thixotropic dispensable substances. Most readily available, clean, dry inert gasses may be used. The most popular is nitrogen from a standard pressurized tank.

Once the solution leaves the pressurized foaming system and enters atmospheric pressure, the gas expands and a closed-cell foam is formed. Depending on the material and gas mixture, the solution can increase from two to four times in volume as it leaves the applicator. A precision control system is required to manage the entire process, including the base material flow, system pressure and volume of gas being introduced.

Sample Bead of Closed Cell Foam



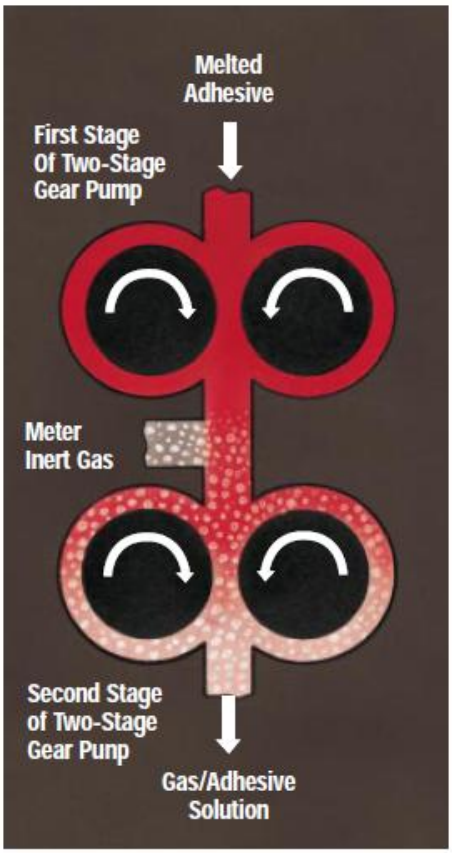
Close-Up of Slot Coated Foamed Hot Melt Adhesive

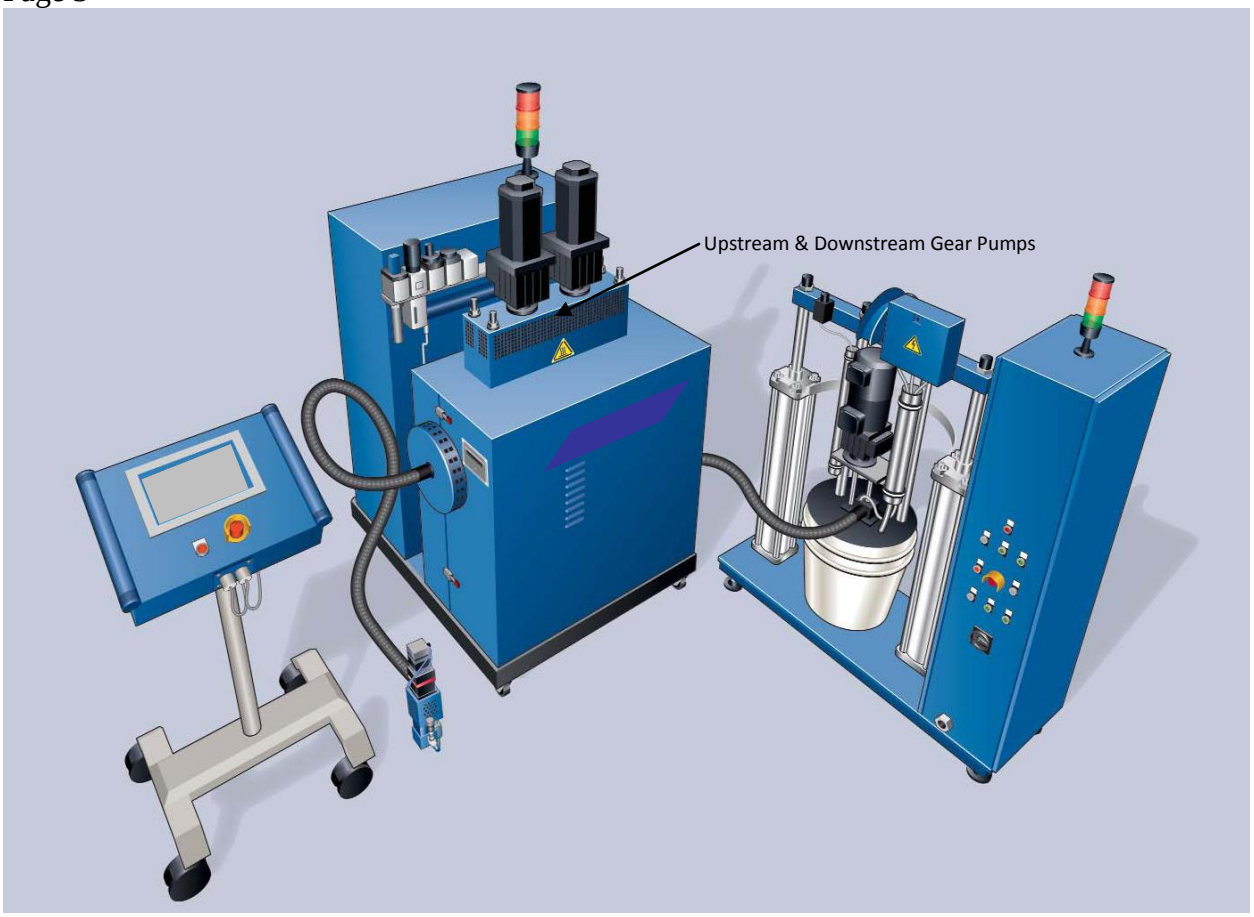
The density of any given volume of adhesive is reduced by replacing it with the inert gas, so the amount of density reduction depends on the amount of gas added. A 40% density reduction means within a given dispensed volume, there is 60% adhesive and 40% gas. Consider a solid quarter-inch adhesive bead compared to a quarter-inch foamed adhesive bead. The quarter-inch foamed adhesive is the same size and takes up the same volume, but contains 25 to 80 percent less adhesive. Density reductions over 50% can sometimes be achieved. You can actually dispense more gas than adhesive.

A typical foam delivery system begins with an unfoamed room temperature or heated base material in pails, drums or pellet/block forms ready for melting. For the purposes of this discussion, we'll continue to assume it's a PSA adhesive. The material can be moved using a piston pump, gear pump, extruder screw or other typical mechanism, depending on the process requirements. A 20L pail of based material is shown in the picture on the following page.

The material is pumped at low pressure into a two-stage gear pump unit designed to force inert gas into solution with the base material. The downstream gear pumps turn at a faster speed than the upstream gear pump, creating a negative pressure between the pumps that draws in the inert gas, which is injected from a tank.
Then additional mix energy is added in a secondary mixing operation for even distribution of the gas in solution.

After the second mixing operation, a device monitors foam density and adjusts in real time the flow of the inert gas into the mixing area. With a gas density setpoint of 40 percent density reduction, for example, it will add more gas if density reduction drops below 40 percent and reduce the gas if the density reduction goes over that set point.

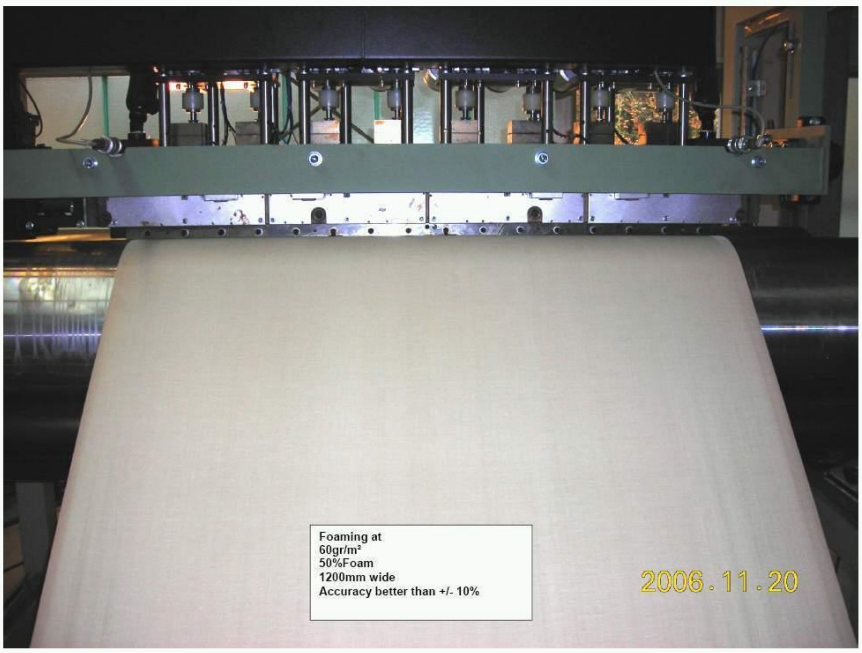





Following the foam delivery system is the dispensing system, which can include a dispensing metering pump to accurately meter the foamed material, a transport hose(s) and a dispensing applicator. The additional dispensing metering pumps provide accurate adhesive add-on during line speed changes. Multiple dispensing metering gear pump will help with cross web distribution for wide web applications. On the following page are pictures of a wide web foamed PSA adhesive application.

*Tape Applications.* Foamed adhesive on tape improves adhesion of the tape to rough surfaces, as the same grams-per-square meter of adhesive applies thicker when foamed. When pressed onto a substrate, the foam cells allow the tape to grab onto 3D surfaces better.

*Label Applications:* One of the reasons that adhesive is applied in such high amounts on labels is so the die cutting does not cut through the release paper. By applying foamed adhesive of the same volume, less adhesive is used, reducing cost. A key in doing this is a very well-controlled nipping gap to maintain the required adhesive height for die cutting.




Foaming @ 60gsm, 50% Density Reduction, 1200mm wide

Slot Coating of Foamed Adhesive

In general, a foam delivery system offers many of the same application possibilities as traditional nonfoaming delivery systems. These include a variety of adhesive spray and contact slot technologies, applying continuous or intermittent patterns. Foam delivery systems allow you to create foam materials from many pumpable high-performance adhesives and sealants in addition to PSA adhesives. Choose the material that delivers the best combination of performance and value for your application. Options include both unheated and heated materials, such as:

- Pressure sensitive adhesives (PSAs)
- Silicones
- Polyurethane reactives (PURs)
- Urethanes
- Plastisols
- Ethylene vinyl acetate (EVAs)
- Butyls
- Many other forms of pumpable thixotropic materials

**The Benefits of Going with Foam**

*Cost savings.* Recent adhesive raw material cost increases, along with a decrease in the availability of resin, have put a significant strain on manufacturers. Foaming allows you to achieve increased function while also using less adhesive, creating significant cost savings.

*Storage.* Using less adhesive also requires less storage space, since you'll need less adhesive on-hand.

*Greater gap filling*. Foaming delivers a unique benefit for irregular surfaces. Since the material expands as it is applied, it can fill in the gaps on an irregular surface such as a nonwoven material. A non-foamed adhesive might just lie on the high points of an irregular surface, but a foamed adhesive can flow into the uneven areas of the substrate, which can create a stronger bond.

*More options, more savings.* Using a foam delivery system can open up a range of thinner and more heat sensitive substrate possibilities that might not have been viable in your process before.

Because foamed adhesives contain less mass of adhesive within the volume being dispensed verses an unfoamed dispense, the overall dispensed volume will dissipate heat more quickly. Quicker cooling allows you to use thinner materials, which can reduce your costs for the film or substrate.

Faster-cooling foamed adhesive can also enable the use of more heat-sensitive substrates. If you've been interested in using a particular web material, but the potential burnthrough caused by solid adhesive prevented it, a foam delivery system can open up that possibility. Foaming adhesive also reduces the weight of adhesives and end products, delivering lighter products with a softer hand and drape.

*Faster set time.* Because foamed adhesive cools more quickly, less chilling is required to cool the adhesive prior to rewinding the web or substrate. In some cases, foamed adhesives' faster set times can even eliminate the need for a chill roll after application.

*Sustainability.* With up to 80 percent reduction of material, foaming clearly decreases raw material use and the energy used to produce them. Additionally, use of inert gas in a mechanical foaming process is a more sustainable solution than chemical multi-component foaming processes, many of which produce VOCs or employ isocyanates.

Adhesive production and processing requires two very limited resources: oil and water. It takes 1 lb. of oil to make 1 lb. of adhesive. So, for every 315 lbs of adhesive saved, 1 barrel of oil and 7,560 gallons of water are conserved. Manufacturers who minimize adhesive usage will not only conserve vital resources, they will also find that their processes are more efficient, more cost-effective and, ultimately, more profitable.

Because many substrates are films made of petroleum, the ability to use a thinner film will save environmental resources as well as costs.

**The Potential of Foam**

The applications for foam delivery systems are virtually endless, but in the coating and converting industry, the technology is relatively new. As knowledge of the technology— and the ease of incorporating the technology— spreads, an ever-growing range of innovative ways to use the benefits of foam will continue to appear. Current applications that take advantage of foam's cost savings and gap-filling feature, include foam tapes and labels for application to rough surfaces and lamination of substrates with rough surfaces.

For more information, please contact:

Raza Hayder
Nordson Corporation
rhayder@nordson.com
Phone: 404-915-1081

Michael Fornes
Nordson Corporation
mfornes@nordson.com
Phone: 678-469-0679