



The Chemmunicator

Welcome to this issue of *The Chemmunicator*, a quarterly publication of Chemsultants and ChemInstruments.

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Don't let another year slip away with unfinished projects on your schedule!

Year end is approaching fast.

Do you still have budget monies that need to be spent before year end? Are product samples languishing in your lab waiting to be tested? Do you still have product development tasks to complete?

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Contact: Dave McCann at 440-974-3080 Ext. 111 or by email to dmccann@chemsultants.com

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A suggested approach to coating of hot melt adhesives on lab coaters: Models HLC-100, HLC-101, & HLCL-1000 By Keith Muny

There may well be a speed limit to coating certain hot melt adhesives at certain temperatures. Since the typical lab coater uses a **knife-over-roll method**, the adhesive being metered between the rolls as it passes through them is subjected to a laminar flow pattern that is affected by **adhesive temperature, coating speed, and metering gap**.



We set the gap to 5 mils when we want to get 1 mil coated of 10,000 to 15,000 cps adhesive. If the adhesive were water thin, we would use a 1 mil gap to get 1 mil coated of adhesive. Using those two data points, one can draw a line that should predict the proper gap for each adhesive viscosity. Newtonian viscosity behavior, dilatency, and thixotropy may also figure heavily into the equation, especially during the first 1-2 feet of coating startup.

If the adhesive has a viscosity of X at 150°C, X/3 at 190°C, and 3X at 120°C we have different coating situations that will develop. It is the slow moving layers of adhesive that are actually metering the faster moving layers. Looking at the profile of the two rolls, paper or film being coated, and the adhesive (see drawing #1 below), we notice first that the moving paper is what pulls the adhesive mass through the metering gap. If velocity vectors are drawn, the layer closest to the paper would match the speed of the paper. The layer closest to the top metering bar would almost be stationary. For the sake of simplicity, assume that the adhesive can be divided into 6 layers. Layer 1 is closest to the paper and layer 6 is closest to the top metering bar. During the first inches of pull, only layers 1 and 2 are moving. As the coating process stabilizes layers 3 and 4 start to move and a velocity gradient stabilizes for them. The velocity gradient of layers 1 through 4 maintains the same relationship until one or more parameters change. The dV factor is calculated as a constant when $dV=V_n-V_{n-1}$; where $n=1$ to 4 in this case.

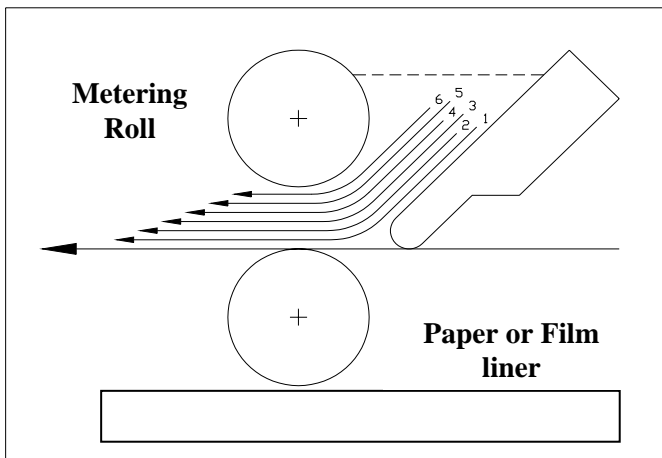
Parameters that can change are temperature, velocity of the paper, viscosity of the adhesive, and quantity of adhesive in the reservoir. As long as none of the variables change significantly, the coating weight should stay within a +/-5% window once the point of laminar flow equilibrium is reached and dV remains constant. The greater the metering gap, the higher the coating weight. This is due to the greater amount of adhesive at the end of the pull since there are more layers to start moving. If the adhesive is warmer, the viscosity is lower. With this scenario, the adhesive layers move easier and the velocity gradient stabilizes quickly, yielding a consistent coating sooner.

So what is the answer? A sample should always be pulled at a constant speed for 18-24 inches before the coat weight is measured. The chosen speed of pull should match the viscosity and rheology of the adhesive. The lab technician's greatest challenge will be when running the adhesive at a temperature that yields a viscosity of around 10,000 cps. As an example, the average gap for a 21 gsm coat weight is 5 mil. This is achieved with great success when used with a laminator to pull the paper or film liner through the coater and laminate a sheet of Mylar to the adhesive at the same time. The system should not be shut down during set up so the laminar flow relationship is always maintained once it is started. Keeping the laminator pulling at 20 inches/min as coat weight measurements are taken, allows the user to adjust speeds up or down to dial in the exact coating weight. Preheating the adhesive sample and using a laminator to pull the liner through at a constant low speed helps make repeatable and consistent coatings. This process is most effectively achieved using the HLCL-1000 combined coater and laminator.

The viscosity curve of Ecomelt 300 for example flattens out after reaching 150°C. A suggestion would be that the user insures that the adhesive level is maintained in the temperature sweet spot for viscosity stability versus some other temperature for example 160°C +/-5°C. That is achieved best by pre melting, covering the reservoir so it won't cool down, maintain the bars at some constant temperature (to be determined by experimentation), coat at a

slow speed such as 20 inches/minute, and discard the first 20 inches of the coated sample before taking a weight check.

Although Reynolds number calculations at these high viscosities may not apply, the concept of turbulence and laminar flow of liquids through confined spaces should hold true.



Custom designed test platforms allow for “real world” product testing

By Keith Muny

Have you found yourself wishing that you could test your product in the way it is being used by your customers? Most tests performed in today’s laboratories center around some form of industry standard test method. These test methods are very good for standardizing sample preparation and testing procedures. They yield results that allow for equal comparison between laboratories throughout the world. The test methods are a very valuable component in evaluating a product’s performance. For many situations, that is exactly what is necessary to describe the overall performance characteristics of a product. Sometimes though, a product is not fully characterized by these tests. The problem, typically, is that it is difficult to relate the results derived from the test method to how a product performs during its use in the “real world”.

Creativity and a mechanical aptitude are key attributes when you devise a test to mimic the effects a product is exposed to in the real world. Some labs may have a tensile tester that could be modified. If so, fixtures could be made to help evaluate real world performance. As universal as tensile testers are, at times it is difficult to generate non-standard test results. You may either have to compromise your information needs due to certain physical limitations of the tensile tester or give up trying to generate better data. The alternative is to design custom test machinery to more closely simulate the process you want to use.

Choosing the direction of custom test equipment is not an easy process. Typically, it doesn’t yield a quick or inexpensive answer. In the end, if it’s truly required, it’s the right path if you achieve a test that really emulates the target situation. Specialized test equipment can yield competitive and manufacturing advantages that easily justify the expense of creating the custom device. Often designing custom test device is not as hard as it sounds, but it will require that you really stretch your thinking. In the more than 20 years that ChemInstruments has been

designing and producing test equipment, we have often produced custom test equipment using standard equipment as a starting point and occasionally, thereby saving significant cost. Sometimes the item that works the best is not at all the item that makes sense to use.

The most difficult aspect of identifying a real world test method for a specific product is breaking down the process in which the product is actually used. You must really think about how the product is affected in the situation where it is being used. If it's a label used on a bottle and you want to know how the curvature of the bottle affects the adhesion, then try to make a peeling fixture that rotates so that the peel angle stays consistent. This could be accomplished by inserting a round piece of wood into the mouth of the test bottle, clamping the wood into the lower jaw of a tensile tester, then further modifying the test fixture. That's not a very difficult example but try peeling the foil lid off of a cup of yogurt, at a constant 45° angle, without spilling the package contents all over the lab!

When the real world scenario is that specific, it's probably time to think about a highly modified or complete custom designed piece of testing equipment. Some additional things to consider when deciding on building a specialized piece of testing equipment are:

- Can this device be used to emphasize your product's superiority over a competitor's product?
- Can the use of this device in the manufacturing process help improve on productivity by minimizing scrap rates?
- Can the use of this device help improve consistency issues with the product and be used as a QA tool?

You might have other reasons to build a custom testing device, but these questions may be a few things to think about that could help justify the payback of building such a device.

Over the years, ChemInstruments has helped many customers work through the decision process and have designed and produced devices to address the specific test parameter need. At times a simple fixture that makes it easier to perform a standard test is sufficient. Other requirements dictate a modification to a standard piece of test equipment that allows the test to be performed quickly enough to become a standard QA component of a manufacturing process. Some requirements demand custom designed test equipment platforms to be used throughout customer facilities worldwide including certified supply chain vendors. This scenario can address not only the need for a test machine, but also a modified test procedure for implementation as part of a total quality system.

Understanding how a product will respond out in the field is a critical component to making a reliable and durable product. Modifying existing equipment, creating custom fixtures, and building customized devices to get real world test data should be a component of your overall testing program approach.

Once you have identified a need to pursue new a test or equipment design, contact ChemInstruments to help you through the process – we have over 20 years of experience helping companies do just that.

Tape Casting – a manufacturing process being used successfully at Chemsultants

by Tom Besselman

One of the newest advances in the formation of ceramic based “films or sheets” has been the use of the tape casting process for the production of thin sheets of ceramic or ceramic filled materials.



Tape casting is a process which uses a suspension of ceramic or metallic particles in a fluid as the starting point. It is typically based on a non-aqueous solvent as the liquid carrier system. In a tape casting process the drying process is evaporative from the surface rather than absorptive. Recently there has developed a growing move to the use of aqueous based tape casting systems.

In the process, we deposit a controlled amount of material on a substrate. Tape casting is also known as doctor blading or knife coating. The "doctor" or knife is a scraping blade for the removal of excess material from a moving substrate being coated. The final dry coating thickness is controlled by the gap between the upper knife and the substrate on which the wet material is coated. The proper gap is related to the rheology of the coating (viscosity), the percent solids of the coating, drying characteristics and line speed. The wet material is then dried to achieve the desired dry coatweight. The substrate acts as a support for the wet coating and allows it to form a film at a desired thickness. Film release characteristics are essential if the final product is to be removed as a free-film later in the process. Silicone coated liners, either paper based or PET, are typically the substrates of choice.

One significant advantage of the tape casting process is that it is the best method for forming large area, thin, flat ceramic or ceramic filled parts. These are most difficult if not impossible to extrude. The thin ceramic or ceramic-filled film is essentially a two dimensional structure since it is large in the web and across web directions and very small or thin (the Z dimension). Today, very thin is defined in microns - the dried thickness range for tape casting is generally from 0.025 mm to 1.25 mm.

Tape casting is currently the process for producing the thin materials used in solid oxide fuel cells (SOFC). These fuel cells are used to efficiently and cleanly convert hydrocarbon fuels to electric power. Chemsultants International recently completed work with a customer who is a world leader in SOFC technology. We helped them successfully transition their manufacturing process from the bench scale, into a continuous roll to roll manufacturing process on the Chemsultants pilot coating lines.