The Magazine For Pump Users Worldwide

May 2006

PUMPS & SYSTEMS

pump-zone.com

New Depths of INNOVATION

Also Inside:

Oil & Gas Applications

Online Pump Monitoring

Pump Industry Snapshots

Advances in Materials & Coatings

Special Section: EASA

Recirculation Gets Sticky

Keith Mort, Franklin International

A pump was needed for a recirculation test of adhesive foam stability. Four different pump delivery systems were evaluated, but only one did not fail.

The purpose of this project was to develop a foam stability test method for testing pressure sensitive adhesives (PSAs).

The recirculation test method was developed around an existing method designed by Ultra Additives (Bloomfield, NJ) that can clearly characterize the rate of foam build and dissipation. The design for foam stability testing requires a PSA to be recirculated at 10-gph to 15-gph into a 500mL-graduated cylinder.

A pump delivery system is needed to recirculate the adhesive. Several systems were examined, ranging in technology, operator usability and cost.

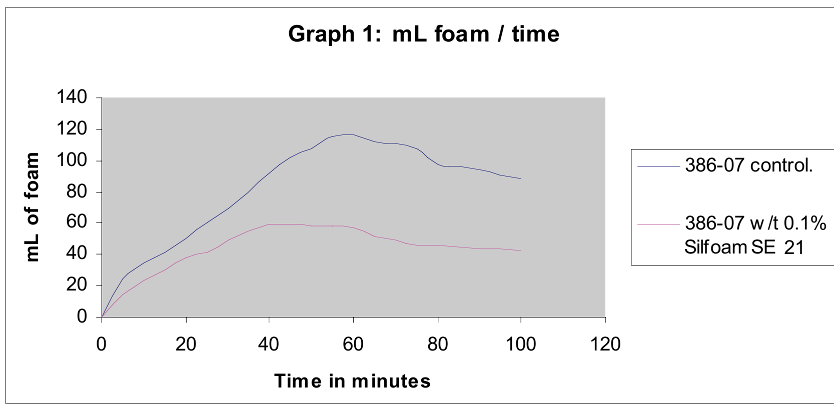

Chart 1. Measuring the foam characteristics of PSAs.

Test Method

The design requires a glass 500mL-graduated cylinder with a ¼-in external port located at the bottom. The cylinder port is connected to the inlet side of a pump.

As the pump cycles it will pull the PSA through the system and out the pressure port of the pump. The adhesive pours through the top opening of the cylinder to complete the recirculation process. The flow should be a consistent stream at about 10-gph to 15-gph.

Foam is created during the recirculation process and the mL graduation lines on the side of the cylinder are used to measure the level of foam build over time. Data points are recorded every five minutes, up to one hour. The pumping system is then turned off and the rate of foam dissipation is observed and recorded.

The graph below is an example showing how foam characteristics of PSAs can be measured.

The blue line is Covinax 386-07 (control) adhesive and the pink line is Covinax 386-07 with 0.1 percent Silfoam SE 21 defoaming agent.

Foam is building as the pump recirculated the adhesive and a measurement was taken every five minutes. The adhesive flow rate was set to 10-gph. The recirculating pump was shut off after 60 minutes and the foam dissipation was recorded. This type of testing is beneficial because adhesive foam stability can be clearly characterized. The data points were loaded into an Excel spread sheet.

Important Guidelines to Follow

- The adhesive is recirculated at a regulated continuous flow, in order to accurately compare the measurement of foam build over time.
- High shear will cause the adhesive to coagulate and produce grit. Therefore the system must not restrict the flow.
- The pumping system must be fully primed before the test can begin and the level of adhesive in the cylinder should start at 200-ml.
- A timer is needed to take measurements every five minutes, up to 60 minutes.

Equipment

Four different pumping systems, each one from a different pump manufacturer, were tried in developing this test method.

The pumping systems evaluated were a peristaltic pump, a ¼-in double diaphragm pneumatic pump, a lab piston pump and a positive displacement pump.

The first system was a $700 peristaltic pump. The pumping technology involves three points of contact compressing a hose arranged in a C-shape. The speed of the pump head can be set to turn constantly, but it failed to work well because the compression points of the pump head created excessive flow pulses. This is the reason a consistent flow of adhesive was not achieved. The erratic "spitting" of adhesive would work against foam building.

The next system was a $400 ¼-in double diaphragm pneumatic pump. It required two needle valves and an accumulator to regulate flow and deliver a smooth stream of adhesive. The system failed because it produced high liquid shear and would constantly clog the valves. It also was not operator-friendly because of the difficulty in pump calibration. Due to these factors, and the lack of repeatability, this pumping system was eventually abandoned.

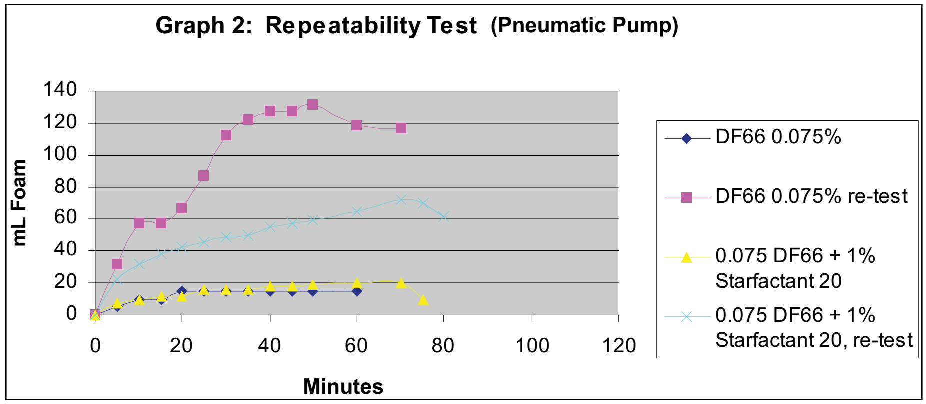

Chart 2. Measuring the repeatability of the pneumatic system during recirculation.

The graph below illustrates the problem in repeatability. Two different PSAs were recirculated using the pneumatic system, and then repeated. Note the inconsistent measurement of foam build.

The $700 lab piston pump also failed. The high shear spindle movement would cause the pumping system to lock up when the PSA would make contact. Under extreme shear, the PSA will tend to gum up and coagulate.

The last pump tried was the $3000 positive displacement pump. This pump worked well because of its true positive displacement design. The unique design, unlike the peristaltic pumps, has a single roller that compresses the low friction hose through more than 360 degrees of rotation (see Figure 1). This configuration will allow continuous liquid flow at low shear and will consistently displace the volume of adhesive inside the hose.

The positive displacement of the roller compressing the hose at a constant speed requires the liquid to move at the same rate despite liquid viscosity. The revolution of the pump is controlled by a variable speed drive. A single roller is better than multiple rollers because it squeezes the hose only once per revolution.

Figure 2 on the next page illustrates the recirculation system using the positive displacement pump. Note that the flow of liquid through the center of the cylinder is continuous. The best way to regulate the flow pulses is to place an accumulator on the out-feed of the pump. Adding a standpipe directly to the positive displacement pump's out-feed worked well.

Figure 1. The positive displacement pump used in the trials. The full 360 degrees of hose allow more flow per revolution and fewer pulses than hoses arranged in a C-shape.

Conclusions & Recommendations

After testing several different types of pump configurations and flow control valves, the only acceptable system was the positive displacement pump.

It is the most expensive system, but also has the most accurate delivery system. The pump is also relatively easy to operate and clean. A full 360 degrees of hose is better than a hose arranged in a C-shape because more flow per revolution is achieved with fewer pulses.

The requirement for conducting foam stability with PSAs is not easy to achieve because of the tackiness of the glue and the wide range of viscosities. Ultra Additives designed the recirculation test method to determine the foam stability of detergents.

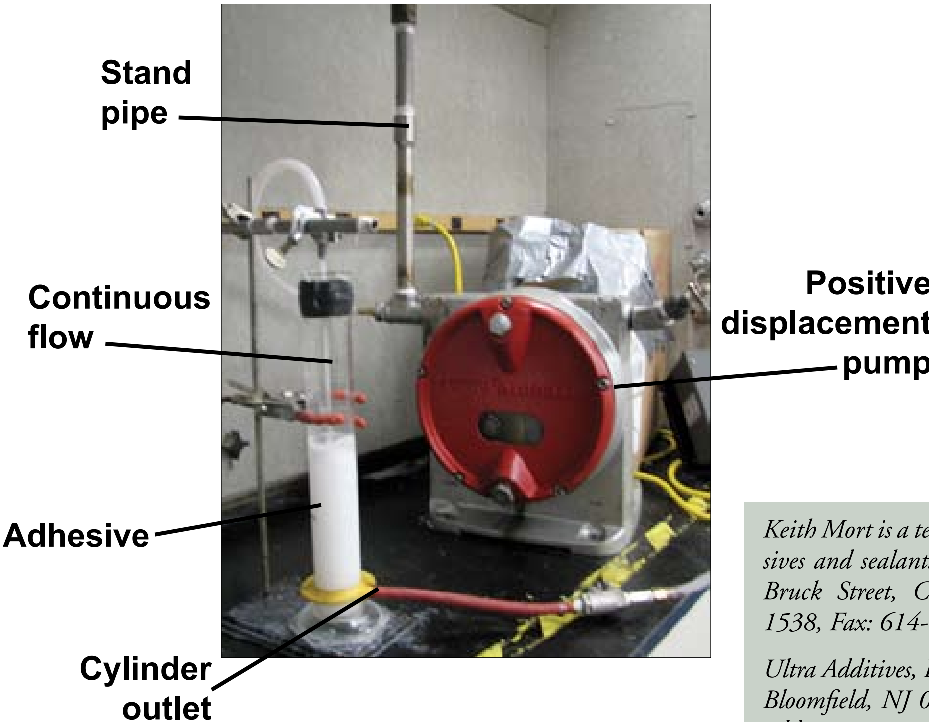

Figure 2. Positive displacement pump recirculation system.

Detergents are generally low viscosity and are not tacky. However, their fundamental design, coupled with our testing modification and methodology, could prove beneficial in identifying characteristics of PSA foam stability.

Note: Recommendations made in the preceding report are based upon controlled laboratory conditions. Product use and process fit must be verified by the user of the adhesive in their manufacturing process and with production materials.

P&S

Keith Mort is a technical specialist of industrial adhesives and sealants for Franklin International, 2020 Bruck Street, Columbus, OH 43207, 614-445-1538, Fax: 614-445-1555, www.franklini.com.

Ultra Additives, LLC is located at 1455 Broad Street, Bloomfield, NJ 07003, 973-279-1306, www.ultra-additives.com.