White Paper

# High Flow AFFINITY™ GA POE-based Hot Melt Adhesives

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Dow Elastomers

## Abstract

The introduction of hot melt adhesives (HMAs) based on high flow AFFINITY™ GA Polyolefin Elastomers (POEs) has been one of the most important events in the HMA market in the last 40 years. These novel polymers present an exceptional opportunity to formulate HMAs which can deliver excellent adhesion at both low and high use temperatures, with unsurpassed processability, and excellent value for the end user. This paper summarizes some of the important attributes of these polymers and HMAs made from these polymers and EASTOTAC[(1)] tackifier resins.

## Introduction

High flow HMAs based on AFFINITY™ GA POEs combine impressive performance with customer-demonstrated cost savings. These adhesives surpass their competition in processability, performance, cosmetic appearance, and – most importantly – cost efficiency for end users. AFFINITY™ GA POE-based HMAs offer high mileage due to their combination of aggressive bonding and lower density. They run clean and virtually char-free, resulting in savings in maintenance expenses such as filters and nozzles. This means end users experience much lower rates of line shut down and, in turn, lost production. Additionally, the ease of cleaning spilled or misfired beads from machinery and the lack of angel hair or spider webs result in more savings in terms of reduced labor costs. Reduced wear and tear on equipment, primarily due to the low acid content of the base polymer, has also been documented. HMAs made from AFFINITY™ GA polymers offer a wider service temperature range than traditional ethylene vinyl acetate (EVA)-based hot melt adhesives.

The clarity of the AFFINITY™ GA product in molten form and its much improved heat stability compared to competitive polymers results in better color and increased intervals between product changes in the melt tank. Finally, the lack of odor and smoke from the product helps improve workplace conditions. These attributes are summarized in Table 1. Use of these polymers in a wider variety of applications has been discussed in [1-2], and specifically as a flow modifier for thermoplastic polyolefins (TPOs) in [3-4].

AFFINITY™ GA POEs are novel polyolefins manufactured using INSITE™ Technology. These polymers have distinct low density and low molecular weight combinations for polyolefins. They are designed to be used in hot melt and hot melt pressure sensitive adhesive formulations in a variety of applications, including:

- Case and Carton Sealing
  - Folding Carton Sealing
  - Corrugated Container Closure
  - Tray Forming
  - Pallet Stabilization
- General Packaging
- Bottle Labeling
  - Roll Feed
  - Magazine Feed
- Graphic Arts
  - Lay-flat
  - Hard Cover
  - Soft Cover
- Multi-wall and Specialty Bag
  - Film Laminating
  - Pinch Bottom
  - Spot Paste
  - Valve Assembly
  - Longitudinal Seam and Bottom Paste
  - Plastic Bags
  - Vacuum Bags
  - Security Bags
  - Wax Bags
- Nonwoven Hygienics
  - Diaper Construction
  - Core Stabilization

**Table 1:** Performance Attributes of High Flow AFFINITY™ GA Polymers

| Performance Attribute | Observations |
|---|---|
| Increased mileage | Reduced adhesive usage, lowers cost as much as 10-15%, depending on application. |
| Reduced gel and char formation | No plugged filters and nozzles, reduced downtime and lost production. |
| No stringing and spider webbing | Enhanced package appearance, reduced labor cost, reduced downtime. |
| Improved thermal stability | Excellent control of viscosity resulting in precise control of bead size and bead placement. |
| Wide service temperature range | Final bonds resist extreme heat and cold; helping reduce waste, product returns, and replacement costs. |
| Color/clarity | Enhanced package appearance. |
| Clean machining | Reduced wear and tear on equipment, reduced downtime. |
| Odor free | Offers enhanced working environments. |

[(1)]EASTOTAC is a trademark of Eastman Chemical Company
™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

## Test Methods

### Polymer Test Methods

The differential scanning calorimetry (DSC) data were gathered on a TA Q1000 using 5-8 mg of sample pressed into a thin film. The sample was heated to 180°C and kept isothermal for three minutes to ensure complete melting (first heat). The sample was then cooled at 10°C/min to -90°C and kept isothermal for three minutes. The sample was then heated to 150°C (second heat) at 10°C/min. The second heat curve and data are reported in this work. Additionally, the crystallization temperature from the cooling curve is reported.

The viscosity data were measured both by dynamic mechanical spectroscopy (DMS) and by capillary rheometry. The DMS data were gathered on a Rheometrics ARES with 50 mm parallel plates in a nitrogen purge at 150 percent strain. A separate sample was used at each temperature of 110, 150, and 190°C, with each frequency sweep being conducted from 0.1-100 rad/s. The capillary data were gathered on a Goettfert Rheograph 2003 with a 0.5 mm diameter die and 30 length-to-diameter die ratio from 100-10,000 $s^{-1}$. An overview of the DMS and capillary data is presented in this work.

Density was measured according to ASTM D 792 [5]. Brookfield viscosity was measured according to ASTM D 3236 on a Brookfield LVDVII+ with Thermosel [6]. Data are reported at either 177°C, the conventional HMA testing temperature, or 121°C, the temperature commonly used for low application temperature hot melt adhesives (LATHMAs). The melt index at 190°C with a 2.16 kg weight was estimated based upon the Brookfield viscosity [7].

### HMA Methods

Gardner color was determined as a function of time at the application temperature for the HMA [8]. Approximately 25 g of adhesive was placed in a 4-oz glass jar and loosely wrapped with aluminum foil. Several samples were prepared for each HMA and placed in a forced air oven. The HMA was removed from the oven at the desired time and immediately decanted into a Gardner color tube. The Gardner color was determined as described in [9] using a Gardner Delta Illuminator.

The peel adhesion failure temperature (PAFT) and shear adhesion failure temperature (SAFT) were determined on 40-lb virgin Kraft paper coated at 177°C for AFFINITY™ GA 1950 and 121°C for AFFINITY™ GA 1900. The adhesive thickness was 25 ± 5 mil and the bond configuration for the Kraft coupons was 1" x 3" with a 1" x 1" bond overlap. The samples were conditioned overnight at 23°C and 50 percent relative humidity. The PAFT weight used was 100 grams and the SAFT weight was 500 grams as described in [10]. The starting temperature was 30°C with a ramp rate of 0.5°C/min.

Heat stress data were based on Jefferson Smurfit virgin and recycled corrugated cardboard with conditions similar to that for PAFT and SAFT; a weight of 500 g was used. For fiber tear, a 1/8-1/4" bead was used on cardboard coupons of 2" x 2.5" overlapped crosswise with the bond formed by light finger pressure. The samples were conditioned overnight at 23°C and 50 percent relative humidity, with those at freezer conditions being kept for 30 minutes at the desired temperature. The fiber tear assessment was based on samples which were pulled apart by hand.

For the PAFT, SAFT, and heat stress studies, ten samples were measured in order to report the standard deviations; for fiber tear, three samples were used. Error bars are reported as the product of the standard deviation and the *t* distribution or Student's *t* at the 95 percent confidence level or at an [symbol] = 0.025 [11]. For the PAFT, SAFT, and heat stress studies where error bars are reported, the Student's *t* is 2.262.

## Polymers

AFFINITY™ GA 1950 POE and AFFINITY™ GA 1900 POE are high flow polymers intended for use in hot melt adhesives for case and carton sealing and graphic arts applications. AFFINITY™ EG 8200G Polyolefin Plastomer (POP) is a low melt index polymer suitable for use in diaper construction and graphic arts applications. The physical characteristics of these polymers are shown in Table 2.

**Table 2:** Physical Properties of Adhesive Grade AFFINITY™ GA POEs(1)

| Polymer | Density ($g/cm^3$) | Melt Index, g/10 min (190°C, 2.16 kg weight) | Viscosity, cP @ 177°C | Tm (°C)(2,3) | Tc (°C)(2,3) | % Crystallinity(2,3) | Tg (°C) (2,3) |
|---|---|---|---|---|---|---|---|
| AFFINITY™ GA 1900 POE | 0.870 | 1,000(4) | 8,200 | 68 | 54 | 16 | -58 |
| AFFINITY™ GA 1950 POE | 0.874 | 500(4) | 17,000 | 70 | 53 | 18 | -57 |
| AFFINITY™ EG 8200 G POP | 0.870 | 5 | – | 63 | 46 | 16 | -53 |

(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.
(2) Tm: Melting Temperature; Tc: Crystallization Temperature; Crystallinity: (Heat of Fusion in J/g)/292 J/g) x 100; Tg: Glass Transition Temperature
(3) Dow Method. Test protocols and additional information available upon request.
(4) Value is approximate; points are outside normal testing range.

DSC heating curves of AFFINITY™ GA 1950 and GA 1900 POE are shown in Figure 1. It should be noted that the low crystallinity and low molecular weight (low viscosity) of these polymers are primarily responsible for their excellent performance in HMAs. Figure 2 shows the viscosity of these two polymers as a function of shear rate and temperature. It should also be noted that these polymers exhibit Newtonian behavior up to about 1,000 sec$^{-1}$. Much more detailed structure/property relationships of this general class of polymers are discussed elsewhere [12].

## HMA PERFORMANCE

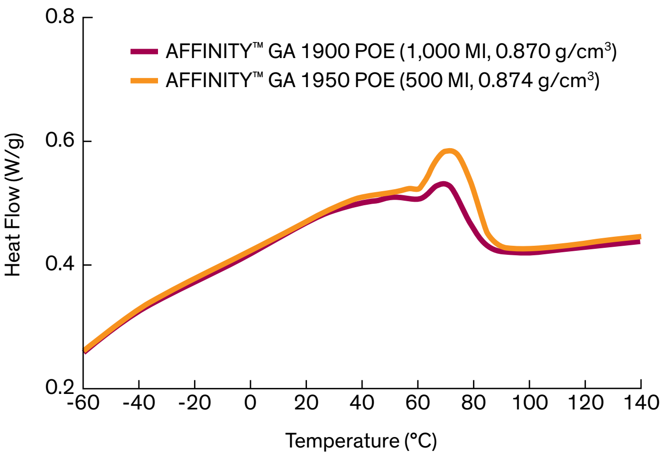
Table 3 (page 5) shows HMA formulations prepared using AFFINITY™ GA 1950 and GA 1900 POEs with different tackifying resins. The attributes and properties of these formulations will be discussed in this section.

### Cost Savings

High flow HMAs based on AFFINITY™ GA polymers help lower overall cost as compared with EVA- or ethylene-n-butyl acrylate (EnBA)-based HMAs. In one case study, a pound of AFFINITY™ GA POE-based HMA sealed significantly more cases than a pound of incumbent HMA. The mileage advantage in this case study resulted in savings of 10 to 15 percent. These savings were primarily based on aggressive bonding, improved thermal stability, and lower density. Additional savings were achieved due to the ability to bond to a wide range of substrates, reduction in waste, reduction in maintenance, and lower inventory due to a wide service temperature range.

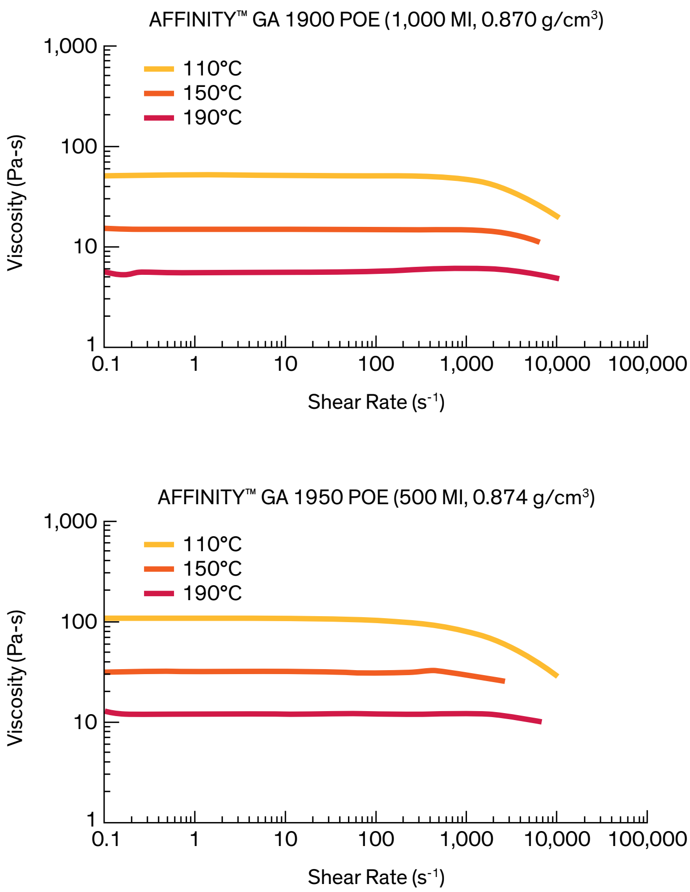
In another case study, a Dow plant, which used to change filters and nozzles on a monthly basis and, therefore, experienced significant downtime, switched from an HMA based upon EVA to an HMA based upon AFFINITY™ GA 1950 POE, and operated with no downtime and no need to change nozzles and filters for a period of 18 straight months.

**Figure 1:** DSC Heating Curves of High Flow AFFINITY™ GA POEs (1)



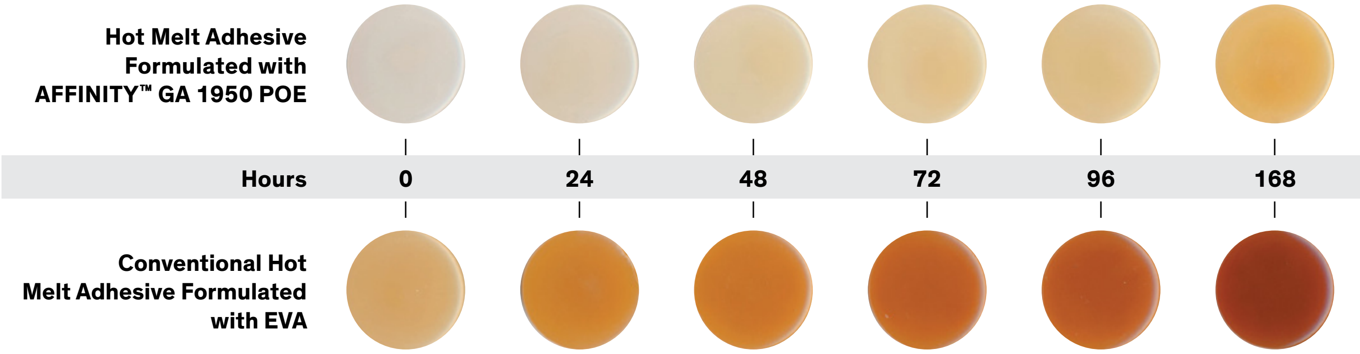

(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

**Figure 2:** Viscosity of High Flow AFFINITY™ GA POEs (1)




(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

**Figure 3:** Color Stability of HMAs Formulated at 177°C for 168 hours (7 days) with Selected Base Polymers[1]




[1] Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

**Table 3:** HMA Formulations Using AFFINITY™ GA 1900 and GA 1950 POEs and Selected Tackifiers[1]

| Component (wt%) | AFFINITY™ GA 1900 POE | | | AFFINITY™ GA 1950 POE | | |
|---|---|---|---|---|---|---|
| | EASTOTAC[2] H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | EASTOTAC H-130R | EASTOTAC H-142R | Experimental Tackifying Resin |
| AFFINITY™ GA Polymer | 29.5 | 29.5 | 29.5 | 34.5 | 34.5 | 34.5 |
| Tackifying Resin | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 40.0 |
| Paraflint[3] H2 | 35.0 | 35.0 | 35.0 | 30.0 | 30.0 | 25.0 |
| Irganox[4] 1010 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies.
[2] EASTOTAC is a trademark of Eastman Chemical Company
[3] Paraflint is a registered trademark owned by Sasol Wax Americas, Inc., Moore & Munger Inc.
[4] Irganox is a trademark of Ciba Specialty Chemicals Corporation

**Table 4:** Gardner Color as a Function of Time at the Application Temperature for Selected HMA Formulations[1]

| Gardner Color | AFFINITY™ GA 1900 POE | | | AFFINITY™ GA 1950 POE | | | EVA-based LATHMA |
|---|---|---|---|---|---|---|---|
| | EASTOTAC[2] H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | EASTOTAC H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | |
| Initial | 1 | 2 | 2 | 3 | 3 | 2 | 5 |
| @ 12 hrs | 3 | 3 | 5 | 4 | 4 | 5 | 8 |
| @ 24 hrs | 3 | 3 | 5 | 5 | 4 | 5 | 11 |
| @ 36 hrs | 5 | 3 | 5 | 6 | 5 | 6 | 11 |
| @ 48 hrs | 5 | 3 | 5 | 5 | 6 | 6 | 12 |
| @ 96 hrs | 6 | 3 | 6 | 11 | 8 | 11 | 13 |
| @ 200 hrs | 9 | 4 | 7 | 13 | 13 | 11 | 14 |

[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies.
[2] EASTOTAC is a trademark of Eastman Chemical Company

### Color Change and Gardner Color

Formulations based on high flow AFFINITY™ GA POEs produce exceptionally clear and virtually odor-free hot melt adhesives. This is attributed partly to the polymer component and partly to the hydrocarbon tackifiers used in the formulations. Figure 3 (page 5) compares the color change of an HMA based on AFFINITY™ GA 1950 with that of an EVA-based HMA at 177°C for up to seven days. Table 4 (page 5) shows the Gardner color as a function of temperature for the HMA formulations in Table 3, (page 5), plus one EVA-based HMA. As can be seen, both the initial and aged color is substantially improved for the adhesives formulated with AFFINITY™ GA polymers. These properties make HMAs based on high flow AFFINITY™ GA POEs a preferred product when improvement in cosmetic aspects of the packaged goods and work environment conditions are needed.

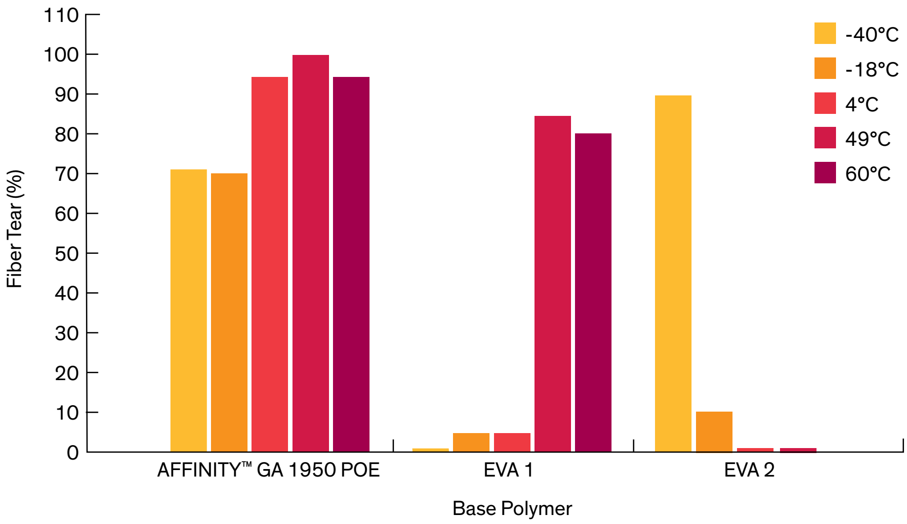
### Percent Fiber Tear

Hot melt adhesives formulated with high flow AFFINITY™ GA polymers provide excellent adhesion to a wide variety of substrates due to the low crystallinity and the very low molecular weight of these polymers. These include the many difficult-to-bond coatings used in the production of folding cartons. This aggressive bonding is maintained over a wide temperature range. HMAs based on EVA polymers and other competitive HMAs are not comparable to the performance of high flow HMAs based upon AFFINITY™ GA POEs. Typical percent fiber tear results for three different HMAs are shown in Figure 4.

### Service Temperature Range

HMAs based on high flow AFFINITY™ GA POEs exhibit exceptional performance at both ends of the temperature scale, due to the very low glass transition temperatures of the polymers and the heat resistance offered by the optimum tackifiers. These polymers are an excellent choice when the packaging needs call for freezer-to-microwave exposure. Formulations prepared with AFFINITY™ GA POEs have the potential to save money for both the formulator and the end user, as the number of HMAs kept in inventory and on the plant floor can be reduced. One HMA can solve both the low temperature and high temperature needs of the line operator. Frequent changes from one HMA grade to another will no longer be necessary. The service temperature ranges for HMAs based upon AFFINITY™ GA POEs and EVA are shown in Figure 5 (page 7).

**Figure 4:** Percent Fiber Tear of HMAs Formulated with Selected Base Polymers at Various Temperatures[1]



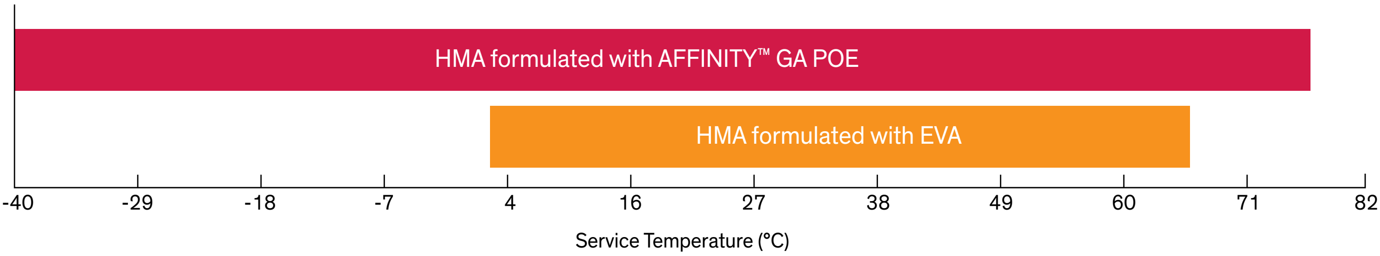

[1] Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

### PAFT, SAFT, and Heat Stress

High upper service temperature, as measured by peel adhesion failure temperature (PAFT), is very important for warehouse storage purposes, especially in warm climates. HMAs based on AFFINITY™ GA POEs offer exceptional PAFT performance when compared with competitive samples. Formulations that offer PAFT values in excess of 71°C have been prepared. Use of high performance HMAs based on AFFINITY™ GA polymers could reduce the failure rate in cases sealed with these HMAs, thus reducing returned boxes and associated expenses.

Table 5 shows the PAFT, shear adhesion failure temperature (SAFT), heat stress, and onset and full fiber tear temperatures for both conventional and low application temperature HMAs measured on the samples in Table 3 (page 5). The last column in Table 5 summarizes the results of a commercially available EVA-based LATHMA.

**Figure 5:** Service Temperature Range of HMAs Formulated with Selected Base Polymers[1]




[1] Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

**Table 5:** PAFT, SAFT, Heat Stress, and Onset and Full Fiber Tear of Selected HMA Formulations[1]

| Temperature (°C) | AFFINITY™ GA 1900 POE – Low Application Temperature (121°C) HMA | | | AFFINITY™ GA 1950 POE – Conventional Application Temperature (177°C) HMA | | | EVA-based LATHMA |
|---|---|---|---|---|---|---|---|
| | EASTOTAC[2] H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | EASTOTAC H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | |
| Average PAFT<br>Standard Deviation | 72<br>4.1 | 70<br>4.2 | 66<br>2.4 | 70<br>4.9 | 76<br>2.7 | 66<br>3.5 | 56<br>4.2 |
| Average SAFT<br>Standard Deviation | 87<br>4.3 | 96<br>2.9 | 92<br>1.7 | 98<br>2.8 | 96<br>2.5 | 99<br>1.4 | 74<br>2.1 |
| Average Heat Stress<br>Standard Deviation | 81<br>6.5 | 84<br>5.2 | 87<br>4.9 | 93<br>13.0 | 91<br>4.0 | 94<br>9.0 | 86<br>3.7 |
| Onset of Fiber Tear – Virgin Corrugated | -29 | -12 to -9 | -12 to -9 | -46 | -40 | -46 | >2 |
| Full Fiber Tear – Virgin Corrugated | -12 to -9 | -7 | -7 | -18 | -18 | -18 | >2 |
| Onset of Fiber Tear – Fiber Tear Recycled | -29 | -12 to -9 | -12 to -9 | -46 | -40 | -46 | >2 |
| Full Fiber Tear – Fiber Tear Recycled | -12 to -9 | -7 | -7 | -18 | -18 | -18 | >2 |

[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies.
[2] EASTOTAC is a trademark of Eastman Chemical Company

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The results for PAFT, SAFT, heat stress, and fiber tear are shown pictorially in Figures 6-9 along with the error bars of the measurements. The average PAFTs of the HMAs based on AFFINITY™ GA polymers were 66-76°C as compared to 56°C for the EVA-based HMA. Similarly, the SAFTs were much improved for the AFFINITY™ GA POE-based HMAs at 87-98°C compared to 74°C for the EVA-based HMA. Onset of and full fiber tear for HMAs based on AFFINITY™ GA POEs were also impressive at -40 to -46°C and -18°C, respectively for the conventional application temperature adhesives, and at -12 to -29°C and -12 to -7°C, respectively for the LATHMAs. In comparison, the fiber tear results for the EVA-based HMA were all poor at > 2°C. Heat stress results for the LATHMAs were comparable at 81-86°C for those based on AFFINITY™ GA polymers and 86°C for the EVA. The conventional HMA heat stress results were substantially higher for those based on AFFINITY™ GA POEs at 91-94°C.

### Viscosity and Thermal Stability

Table 6 (page 9) shows the viscosity values of the HMAs tested measured at application temperature as a function of time. The thermal stability of HMAs based on AFFINITY™ GA 1900 and GA 1950 POEs is clearly outstanding. These formulations owe their stability to both the pure hydrocarbon nature of the backbone (no double bonds or oxygen atoms as in the case of styrenic

**Figure 6:** Peel Adhesion Failure Temperature (PAFT) for Selected HMA Formulations[1]

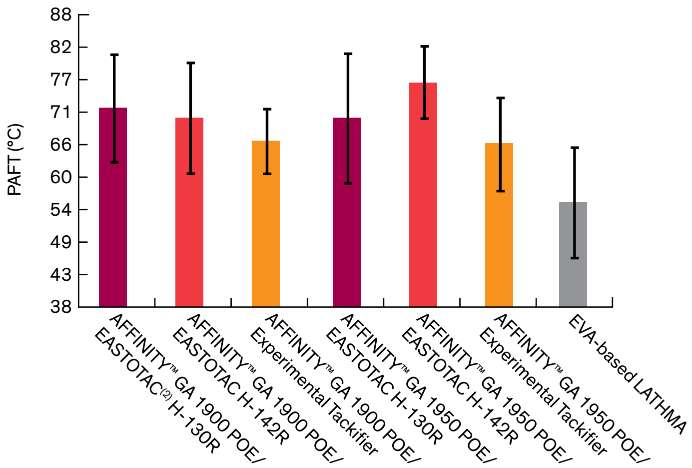



**Figure 7:** Shear Adhesion Failure Temperature (SAFT) for Selected HMA Formulations[1]

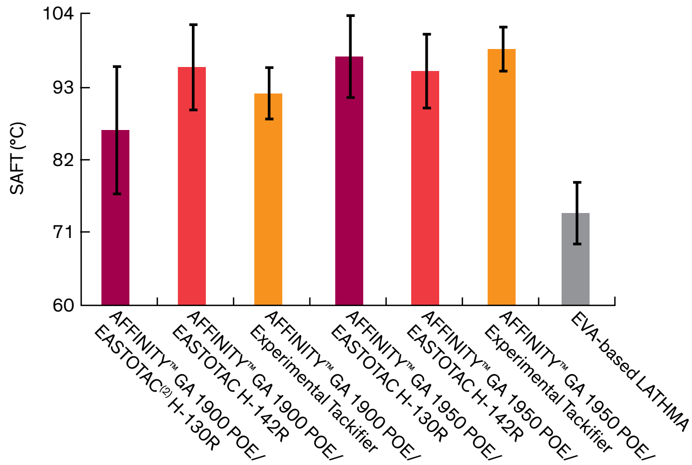



**Figure 8:** Heat Stress Data for Selected HMA Formulations[1]

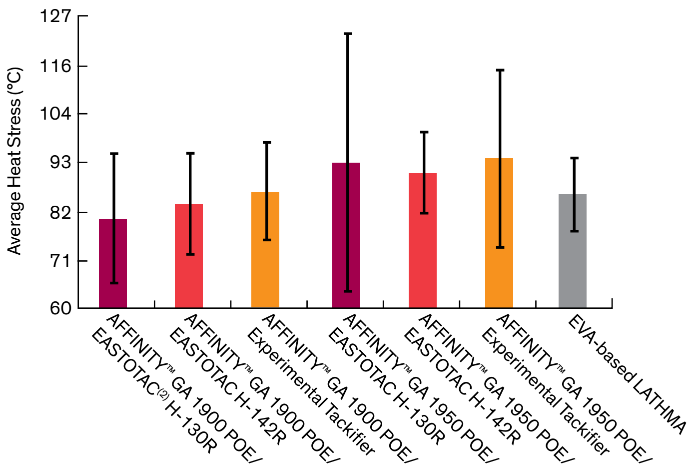
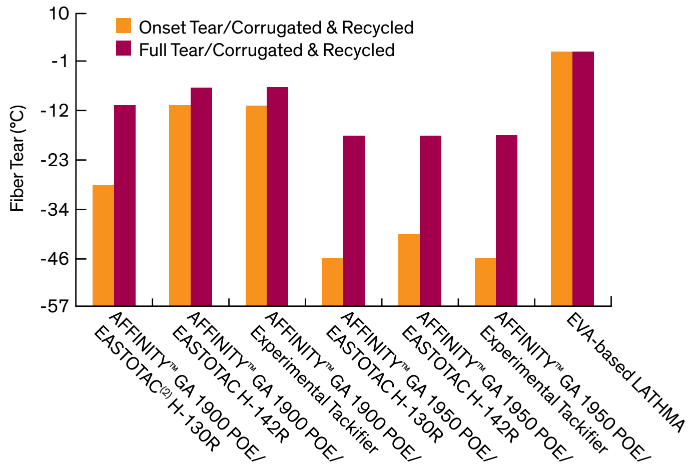



**Figure 9:** Fiber Tear Data for Selected HMA Formulations[1]




[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies. [2] EASTOTAC is a trademark of Eastman Chemical Company
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block copolymers or EVA) and the type of tackifying resins used in the preparation. As shown in Table 7, most of these formulations were comparable in terms of the percent change in viscosity, with a maximum of 3 to 9 percent at 177°C and 0 to 4 percent at 121°C. Note in most of these cases that the viscosity at over 8 days (200 hours) was less than these maximum values, indicating that much of this change was due to the experimental error of the test. In this study, one EVA was tested at only the low application temperature of 121°C and showed comparable results with a maximum viscosity change of 3 percent.

In another study, viscosity change as a function of time was measured for HMAs based on an AFFINITY™ GA polymer and an EVA at the 177°C application temperature. These results are shown in Figure 10 (page 10). The excellent performance of the AFFINITY™ GA POE-based HMA over that of the EVA is clearly evident at the conventional application temperature. The HMA based on the AFFINITY™ GA resin showed essentially no change in viscosity over seven days, while the EVA-based system showed substantial changes after one day and a change of 65 percent over seven days.

**Table 6:** Viscosity Change as a Function of Time at the Application Temperature for Selected HMA Formulations[1]

| Viscosity (cP) | AFFINITY™ GA 1900 POE – Low Application Temperature (121°C) HMA | | | AFFINITY™ GA 1950 POE – Conventional Application Temperature (177°C) HMA | | | EVA-based LATHMA |
|---|---|---|---|---|---|---|---|
| | EASTOTAC[2] H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | EASTOTAC H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | |
| Initial | 1092 | 1127 | 1037 | 597 | 772 | 538 | 1055 |
| @ 12 hrs | 1102 | 1132 | 1030 | 610 | 765 | 587 | 1050 |
| @ 24 hrs | 1102 | 1147 | 1025 | 620 | 740 | 577 | 1055 |
| @ 36 hrs | 1105 | 1150 | 1035 | 607 | 750 | 570 | 1065 |
| @ 48 hrs | 1102 | 1175 | 1025 | 607 | 763 | 567 | 1052 |
| @ 96 hrs | 1117 | 1175 | 1025 | 597 | 795 | 580 | 1055 |
| @ 200 hrs | 1110 | 1135 | 1035 | 602 | 790 | 570 | 1085 |

**Table 7:** Percent Change in Viscosity as a Function of Time at the Application Temperature for Selected HMA Formulations[1]

| Change in Viscosity (%) | AFFINITY™ GA 1900 POE – Low Application Temperature (121°C) HMA | | | AFFINITY™ GA 1950 POE – Conventional Application Temperature (177°C) HMA | | | EVA-based LATHMA |
|---|---|---|---|---|---|---|---|
| | EASTOTAC[2] H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | EASTOTAC H-130R | EASTOTAC H-142R | Experimental Tackifying Resin | |
| Initial | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| @ 12 hrs | 1 | 0 | -1 | 2 | -1 | 9 | 0 |
| @ 24 hrs | 1 | 2 | -1 | 4 | -4 | 7 | 0 |
| @ 36 hrs | 1 | 2 | 0 | 2 | -3 | 6 | 1 |
| @ 48 hrs | 1 | 4 | -1 | 2 | -1 | 5 | 0 |
| @ 96 hrs | 2 | 4 | -1 | 0 | 3 | 8 | 0 |
| @ 200 hrs | 2 | 1 | 0 | 1 | 2 | 6 | 3 |
| Minimum | 0 | 0 | -1 | 0 | -4 | 0 | 0 |
| Maximum | 2 | 4 | 0 | 4 | 3 | 9 | 3 |

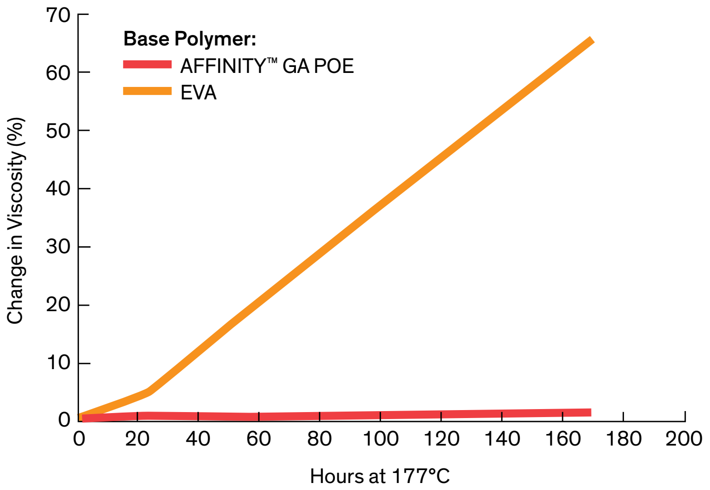
[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies. [2] EASTOTAC is a trademark of Eastman Chemical Company

## Tackifier Selection

The performance of a hot melt adhesive is highly related to the compatibility of its components. As the tackifier is one of these critical components, studies were undertaken to assess the compatibility of AFFINITY™ GA polymers with several types of tackifiers. The compatibility of a resin with a given polymer depends mainly on its polarity and to a lesser extent on its molecular weight. The high molecular weight fraction of the resin, measured by its *Mz* value, may lead to symptoms of incompatibility such as turbid melts or migration upon aging. Therefore, it is customary to measure the compatibility of a hot melt adhesive by determining its cloudpoint. There are, however, several problems with this method – including the fact that it is time-consuming and that the wax component can often obscure the cloudpoint.

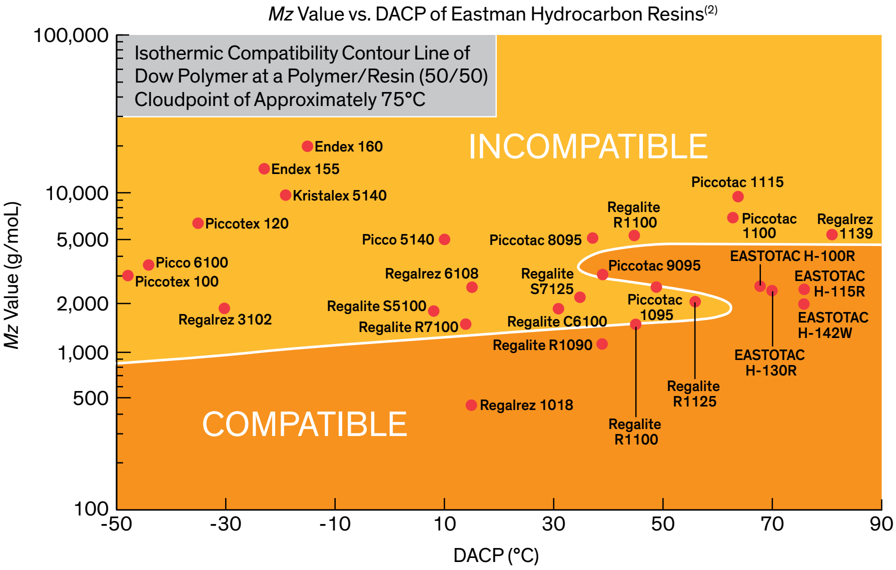
To avoid these issues, dual polymer/resin (1:1) cloudpoint measurements or the Hercules modified diacetone (MDA) alcohol method was used [13-14]. An isothermal compatibility contour for AFFINITY™ GA 1900 and GA 1950 POEs is shown in Figure 11. In this plot, the logarithm of the molecular weight (*Mz*) is plotted as a function of the resin polarity (lower DACP – or diacetone alcohol cloud point – value corresponds to increasing polarity) for several types of tackifiers. Fully or partially hydrogenated C5 and C9 tackifiers are shown to be compatible with AFFINITY™ GA polymers. In particular, EASTOTAC[1] tackifier resins show excellent compatibility with AFFINITY™ GA POEs.

**Figure 10:** Viscosity Stability of HMAs Formulated with Selected Base Polymers[1]




[1] Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

**Figure 11:** Isothermal Compatibility Contour for AFFINITY™ GA POEs[1]




[1] Data courtesy of Eastman Chemical Company. Information represents North American-grade tackifiers. Equivalent grades are available in other geographies.
[2] Products shown are trademarks of Eastman Chemical Company

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## Summary

Novel high flow AFFINITY™ GA Polyolefin Elastomers offer distinctive properties which deliver exceptional performance in hot melt adhesives (HMAs). Designed to be used in both conventional and low application temperature HMAs, these polymers offer the potential to save money for both the HMA manufacturer and the end user.

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