AkzoNobel Surface Chemistry

AMPHOMER® EDGE™ Polymer

Raising the bar in film-forming performance

INCI: Octylacrylamide/Acrylates/ Butylaminoethyl Methacrylate Copolymer

AMPHOMER® EDGE™ polymer is an exceptionally hard holding acrylic film-former that offers market-leading stiffness and unsurpassed high humidity resistance while providing enhanced durability and propellant compatibility compared to AMPHOMER polymer.

Developed for enhanced film strength, AMPHOMER EDGE polymer offers strong films on hair that last throughout typical mechanical and environmental stresses, which provide consumers with longer lasting hold. In addition, AMPHOMER EDGE polymer's hydrophobic/hydrophilic balance has been optimized for wider compatibility in either hydrocarbon and/or dimethyl ether systems, which makes it a great selection for formulators looking to develop global chassis hair spray systems. AMPHOMER EDGE polymer also provides thermal protection properties (refer to US Patent 9,119,972 B2) and acts as a hair shield for hot heating implements such as flat irons and curling wands, helping to protect the hair cuticle from hair damage caused by heat.

Application Areas

AMPHOMER EDGE polymer offers superior performance in aerosol and pump hair sprays that contain high levels of alcohol. In addition, it can be used in hydro-alcoholic or water-based styling aids where strong, long lasting hold is desired:

Application	Suggested Use Level (as supplied)
Aerosol hair sprays	1.0 – 5.0%
Non-aerosol hair sprays	1.0 – 6.0%
Styling gels	0.5 – 2.0%
Styling mousses	0.5 – 2.0%
Creams and lotions	0.5 – 4.0%
Waxes and pomades	0.5 – 5.0%

Features and Benefits

Feature	Benefit
Developed using well-known amphoteric acrylic polymer chemistry	Excellent balance of hold and adhesion properties; historical, proven toxicology and safety profile for easy transition into current formulations
Forms strong films	Long-lasting hold that survives mechanical stress and keeps volume in place for over 24 hours
Optimized hydrophobic/hydrophilic character	Offers unsurpassed style retention in high humidity conditions; improved hydrocarbon and dimethyl ether propellant compatibility compared to AMPHOMER polymer, while maintaining excellent shampoo removability
Optimized polymer molecular weight	Provides superior stiffness and hold while enabling low formulation viscosity and fine spray patterns
Polymer films that can tolerate heat up to 450°F / 232°C conditions	Offers thermal protection and protects the hair cuticle from heat damage when using hot styling tools
Soluble in anhydrous and alcohol-free systems with neutralization	Useful in high alcohol hair sprays and alcohol-free styling aids where strong hold & humidity resistance are desired
Compatible with commonly used formulation ingredients	Robust and reliable performance, ease of formulation

Formulation Guidelines

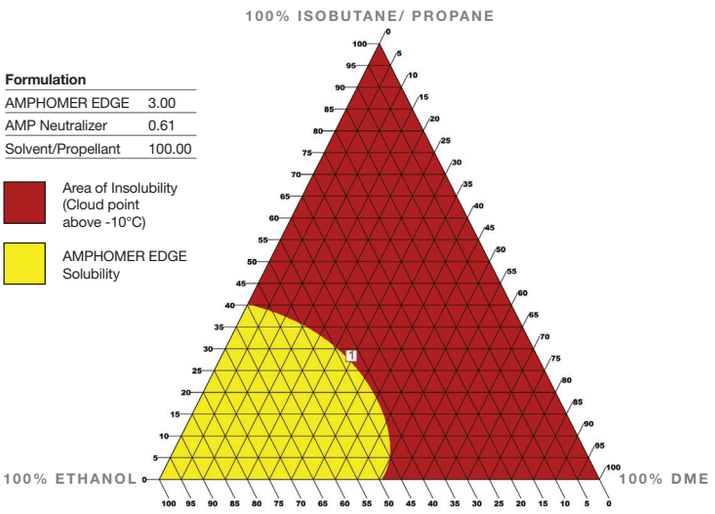
AMPHOMER EDGE polymer is a humidity resistant, extra hard holding hair spray resin. The exact amount to use depends on the hold level desired, amount of propellant in the system, and the types and levels of other additives that may affect the hold properties of the final formulation. The suggested pH range of final formulation is 8.0 – 9.0.

Propellant Systems

AMPHOMER EDGE polymer is highly compatible with hydrocarbon, dimethyl ether, and hydrofluorocarbon propellants (refer to Figure 1). AMPHOMER EDGE polymer and other carboxylated polymers can be made more compatible with hydrocarbon propellants by adding small quantities (1-5%) of water. For optimum hydrocarbon tolerance and resin stiffness, it is recommended that the formulator evaluate partial neutralization with a long chain amine. The balance should then be made up of a primary neutralizer such as AMP (aminomethyl propanol). This may eliminate the need for additional plasticizers in the formulation.

For VOC compliant hair spray formulas, AMPHOMER EDGE polymer may also be used with Hydrofluorocarbon 152A (1,1 difluoroethane) propellant.

Figure 1: Solubility of AMPHOMER EDGE Polymer in Ethanol/Dimethyl Ether/Isobutane-Propane



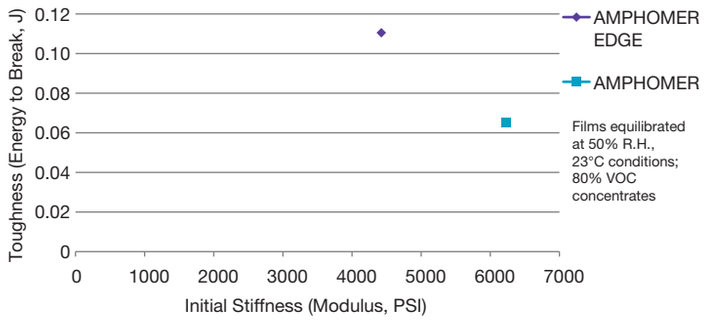
Propellant compatibility and low temperature stability of any polymer blend or additional plasticizer ingredient should be thoroughly evaluated.

Performance Properties

Film Properties

To better understand the film properties of AMPHOMER EDGE polymer compared to an AMPHOMER polymer control, a Sintech tensile unit was used to measure the modulus (initial strength) and the energy required to break the films (film toughness). As seen in Figure 2, the film properties of AMPHOMER EDGE polymer offer a higher energy to break compared to AMPHOMER polymer, indicating a stronger, tougher film. AMPHOMER EDGE polymer's more durable film properties can offer improved long-lasting hold and style endurance.

Figure 2: AMPHOMER EDGE Polymer Film Modulus vs. Energy to Break



On-Hair Subjective Mannequin Head Evaluations

Subjective evaluations were conducted by trained panelists on mannequin heads to determine the performance of AMPHOMER EDGE polymer compared to other fixative polymer technologies in hair spray formulations. Various fixative polymers were compared to AMPHOMER EDGE polymer as the control, using a similar high alcohol hair spray system. In the below studies, each side of the mannequin head was treated with hair sprays comprised of 3% active polymer, where one side was sprayed with the experimental and the other side was sprayed with the control formula. The panelists evaluate both sides of the mannequin and are forced to pick one side over the other for each performance attribute. The data is reported at the 95% confidence level.

Table 1: Subjective Mannequin Head Performance of AMPHOMER EDGE Polymer vs. Hair Spray Fixative Benchmarks in High Alcohol Systems

AMPHOMER EDGE control vs.	Styrene/ Acrylates, 40% AP40	OAA/Acrylates/ BAEMA, 40% DME	Acrylates/t-BA, 40% DME
Beading	NSD	NSD	NSD
Gloss	NSD	NSD	NSD
Stiffness	–	NSD	NSD
Spring	NSD	–	–
Webbing	NSD	–	–
Feel	NSD	NSD	NSD

NSD = no statistical difference

Negative (-) = the experimental (competitive product) is statistically inferior vs.the control

Positive (+) = the experimental (competitive product) is statistically superior vs. the control

Benchmarks Key:
Styrene/Acrylates = Styrene/Acrylates Copolymer
OAA/Acrylates/BAEMA = Octylacrylamide/Acrylates/ Butylaminoethyl Methacrylate Copolymer
Acrylates/t-BA = Acrylates/t-Butylacrylamide Copolymer

The results in Table 1 show that the OAA/Acrylates/BAEMA Copolymer and Acrylates/t-Butylacrylamide Copolymer benchmarks provide inferior spring and webbing compared to the AMPHOMER EDGE polymer control. These properties indicate flexibility and film toughness performance, and should translate into better long lasting hold and durability on hair offered by AMPHOMER EDGE polymer. In addition, the Styrene/Acrylates Copolymer

benchmark shows inferior on-hair stiffness compared to the AMPHOMER EDGE polymer control.

Furthermore, additional subjective evaluations were conducted by trained panelists on mannequin heads to determine the performance of AMPHOMER EDGE polymer compared to an AMPHOMER polymer control in different types of hair spray formulations. Both polymers were compared to each other in 3 different propellant systems: hydrocarbon, dimethyl ether, and hydrofluorocarbon 152A formulas. In the below studies, each side of the mannequin head was treated with hair sprays comprised of 3% active polymer, where one side was sprayed with the experimental and the other side was sprayed with the control formula. The panelists evaluate both sides of the mannequin and are forced to pick one side over the other for each performance attribute. The data is reported at the 95% confidence level.

Table 2: Subjective Performance of AMPHOMER EDGE Polymer vs. AMPHOMER Polymer Tested from Various Propellant Systems on Mannequin Heads

AMPHOMER control vs.	AMPHOMER EDGE 40% Propane/Butane	AMPHOMER EDGE, 40% Dimethyl Ether	AMPHOMER EDGE, 10% Water/33% 152A
Beading	NSD	NSD	+
Gloss	NSD	NSD	NSD
Stiffness	NSD	NSD	+
Spring	+	+	+
Webbing	+	+	+
Feel	NSD	NSD	NSD

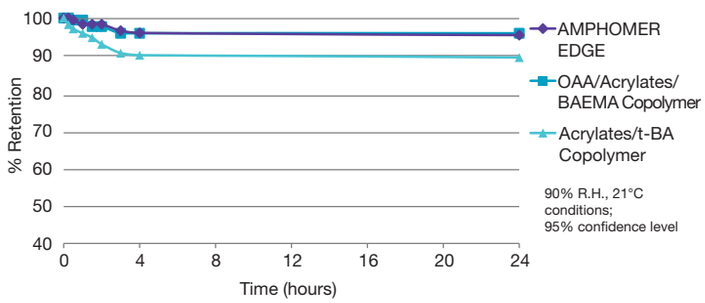
NSD = no statistical difference
Negative (-) = the experimental (AMPHOMER EDGE polymer) is statistically inferior vs. the control
Positive (+) = the experimental (AMPHOMER EDGE polymer) is statistically superior vs. the control

The results in Table 2 indicate that regardless of propellant system, AMPHOMER EDGE polymer provides superior spring and webbing compared to the AMPHOMER polymer control in all systems. These properties indicate excellent flexibility and strong film toughness performance, and should translate into better long lasting hold and durability on hair. The comparison in hydrofluorocarbon 152A systems shows that AMPHOMER EDGE polymer formulation also provides superior stiffness and less beading on hair compared to the AMPHOMER polymer benchmark.

High Humidity Curl Retention

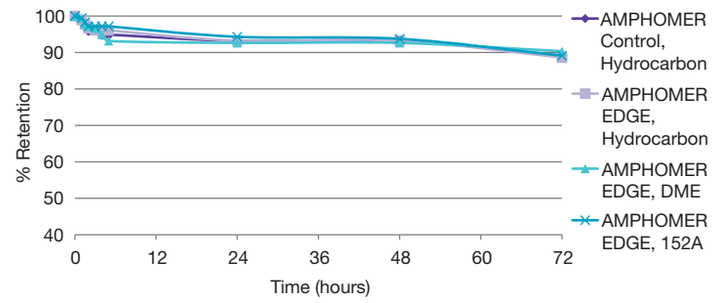
AMPHOMER EDGE polymer was compared to well-known fixative polymers for high humidity curl retention performance in aerosol hairspray systems. All formulations contain 3% active polymer and use approximately 40% dimethyl ether propellant. Figure 3 shows that at 21°C and 90% relative humidity conditions, AMPHOMER EDGE polymer is statistically superior to Acrylates/t-Butylacrylamide Copolymer from the 2 to 24 hour time interval, indicating improved long-lasting hold and style retention.

Figure 3: High Humidity Curl Retention of AMPHOMER EDGE Polymer vs. Hair Spray Fixative Benchmarks in High Alcohol DME Systems



The high humidity curl retention study was carried out further to illustrate the AMPHOMER polymer technology's long lasting performance. As highlighted in Figure 4, AMPHOMER EDGE polymer formulations offer no statistically significant differences in style retention compared to an AMPHOMER polymer control, as measured by high humidity curl retention after 24 hours at 90% relative humidity and 21°C conditions. Even after 72 hours, all of the hairsprays maintain approximately 90% retention in high humidity conditions.

Figure 4: High Humidity Curl Retention of AMPHOMER EDGE Polymer vs. AMPHOMER Polymer in Anhydrous Hair Spray Formula



90% R.H., 21°C conditions
All formulas using 3% polymer, neutralized to 100% with AMP-Ultra PC 1000

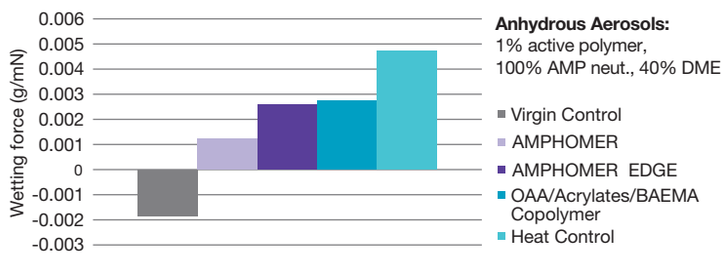
Thermal Protection: Wetting Force Analysis

Market trends have continued to demonstrate that thermal protection is a significant attribute to a styling product. Many consumers today are more concerned with the health of their hair and therefore look for some type of protective aspect within their hair care products.

Thermal protection properties of AMPHOMER EDGE polymer compared to other film formers were measured via wetting force analysis. Wetting force analysis is an effective way to measure the effect of treatment temperature on the deposition and substantivity of polymers applied to the surface of hair. Wetting force is correlated with the contact angle of water on the surface of a hair fiber. This is implicitly correlated with the degree to which a single hair fiber is damaged. Hair fibers are more hydrophilic when damaged so the larger the wetting force, the more damaged the hair fiber.

Figure 5 shows the wetting force of each polymer after a heat treatment process which involved 15 cycles of applying the appropriate polymer spray, applying heat via flat iron at 450°F / 232°C for 2 minutes, then washing and drying the hair tress. Based on these results, AMPHOMER polymer provides the best thermal protection, while AMPHOMER EDGE polymer offers a significant protection improvement vs. the heat treated control.

Figure 5: Wetting Force Analysis* of AMPHOMER Polymers vs. Virgin and Heat Treated Controls



Wetting force measured using Kruss K-14 dynamic tensiometer on hair after treatment with a 450°F (232°C) flat iron for ten cycles; The larger the wetting force, the more damaged the hair fiber

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AkzoNobel creates everyday essentials to make people's lives more liveable and inspiring. As a leading global paints and coatings company and a major producer of specialty chemicals, we supply essential ingredients, essential protection and essential color to industries and consumers worldwide. Backed by a pioneering heritage, our innovative products and sustainable technologies are designed to meet the growing demands of our fast-changing planet, while making life easier. Headquartered in Amsterdam, the Netherlands, we have approximately 45,000 people in around 80 countries, while our portfolio includes well-known brands such as Dulux, Sikkens, International, Interpon and Eka. Consistently ranked as a leader in sustainability, we are dedicated to energizing cities and communities while creating a protected, colorful world where life is improved by what we do.

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