NUMBER 4817-1 (Supersedes 4817)

Gafquat™ 440, 755N, 755N-P, 755N-O and HS-100, HS-100-O polymers

Cationic conditioning copolymers

Introduction

Gafquat polymers, including the traditional Gafquat 440 and 755N polymers, as well as a more recent addition to the polymer series, Gafquat HS-100 polymer, are film-forming cationics designed especially for use in personal care. They offer a combination of film-forming and substantivity properties for both hair and skin care products.

Gafquat polymers can be used to create innovative hair care products offering both fixative and conditioning benefits. In skin care products, Gafquat polymers contribute a smooth, silky feel to skin.

Benefits

Gafquat polymers are well known for their excellent performance characteristics, including the following attributes:

- Good wet and dry combing
- Good curl retention in leave-on hair styling products
- Builds body
- Manageability
- Thermal/mechanical protection (Gafquat 755N polymer range)
- Clear, non-tacky films
- Improves foam aesthetics
- No resin build-up
- Easy shampoo removability
- Enhanced hair luster
- Smooth skin application with desirable after-feel
- Excellent stability at pH extremes (Gafquat HS-100 polymer)

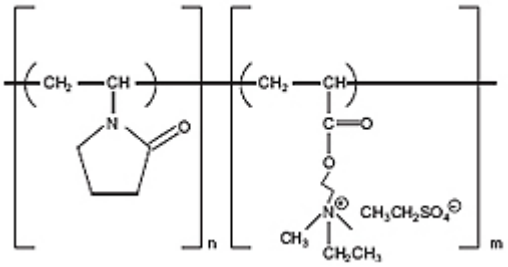
Applications

Gafquat polymers provide real benefits to consumers in a wide range of products:

- Hair styling products – mousses, gels, glazes, lotions and styling sprays
- Hair conditioners
- Shampoos
- Skin creams and lotions
- Moisturizing creams
- Shaving products
- Liquid soaps

Chemistry

Gafquat™ 440 and 755N polymers

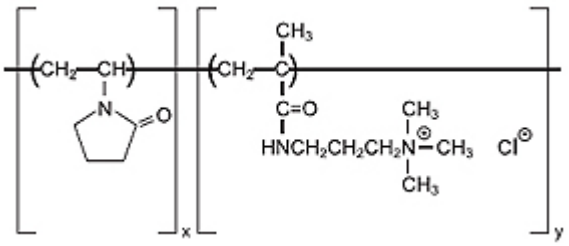


INCI name: Polyquaternium-11

Copolymers of vinylpyrrolidone and dimethylaminoethylmethacrylate, quaternized with diethyl sulfate

Gafquat 755N-O polymer preserved with Optiphen™ preservative.

Gafquat HS-100 polymer



INCI name: Polyquaternium-28

Copolymer of vinylpyrrolidone and methacrylamidopropyl trimethylammonium chloride (MAPTAC).

Gafquat HS-100-O polymer preserved with Optiphen preservative.

Typical Properties

Product Data[3]	Gafquat 440 polymer	Gafquat 755N polymer	Gafquat HS-100 polymer
Physical form (25°C)	Viscous liquid	Highly viscous liquid	Highly viscous liquid
Vehicle	Ethanol	Water	Water
Solids content (%)	28 -32	19 - 21	19 – 21
pH (as is)		5 – 7	5 - 8
pH (25% aqueous solution, 1 part product, 3 parts water)	7.5 – 9.0		
Viscosity (cps) (Brookfield RVF No. 7 spindle, 25°C		20,000 – 70,000	50,000 – 125,000
Relative viscosity at 25°C (1% in anhydrous ethanol SDA- 40B Cannon-Fenske 200 Viscometer)	2.5 – 3.5		

[3] These data are typical of current production but are not specifications. Current specifications are available on request.

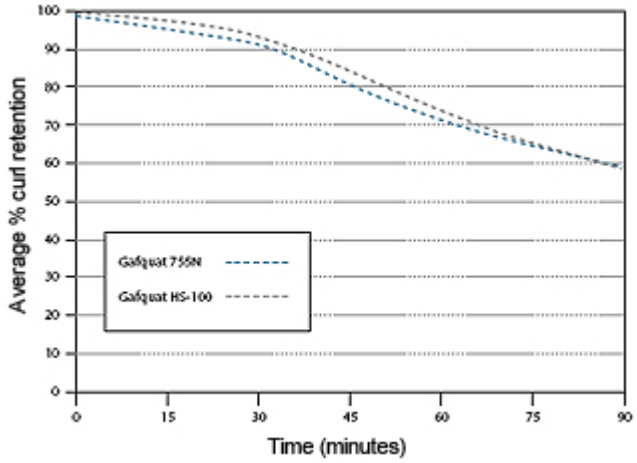
Performance Properties

Hair Styling

Gafquat polymers are widely used in hair styling products designed to be applied to wet hair, since they have the ideal balance of properties for such applications. Being soluble in both water and alcohols, Gafquat polymers can be easily incorporated into aqueous or hydroalcoholic bases for lotions, gels and mousses. Independent market research has shown that Gafquat polymers are favored in these applications for their balance of fixative, conditioning, body, removability and tactile properties. In mousses, Gafquat polymers also promote a stable foam with a smooth, creamy feel.

On wet hair, Gafquat™ polymers give excellent lubricity, promoting easy distribution over the head and easy combing and detangling. When the hair has dried their film forming properties provide the crisp, shiny curls needed for sculpted styles, or the curls can be combed or brushed out with minimal flaking to give hair more body and manageability. Curl retention studies at 2% solids demonstrate Gafquat polymers' excellent hair holding performance when applied from a leave-on styling product.

Gafquat 755N & Gafquat HS-100 polymers – curl retention
(2% solids solution; 90% RH/27°C)



For spray applications, Gafquat 440 polymer is suggested, as its lower viscosity will allow more satisfactory spray break-up.

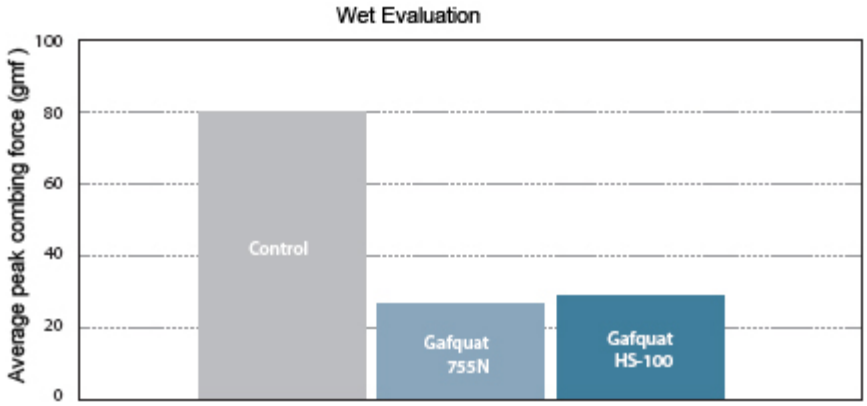
Hair Conditioning

Gafquat polymers are substantive not only by their cationic nature, but also because the pyrrolidone ring structure gives extra affinity for the chemically similar peptide bonds in the hair proteins.

This substantivity makes them ideal conditioning ingredients for either leave-on or rinse-off products, including cream rinses, 2-in-1 conditioning shampoos and treatment conditioners. Substantive deposition of Gafquat polymers is confirmed visually by the well known red dye test[1] on blonde hair. Moreover, the intensity of color developed indicates an optimum level of substantivity, with no undesirable build-up. This has been proved by testing after a series of repeat applications.

The conditioning benefits of the Gafquat polymers are seen first when the hair is still wet in terms of the ease of combing and detangling. These benefits continue to be demonstrable after the conditioning product has been rinsed from the hair (see combing force data below). Easy combing and brushing is also found in the dry state, and the hair has a smooth feel and high luster, since the copolymer forms non-tacky, clear and glossy films. The presence of polymer imparts body to the hair, in contrast to low molecular weight conditioning agents which often lead to undesirable limpness after repeated use.

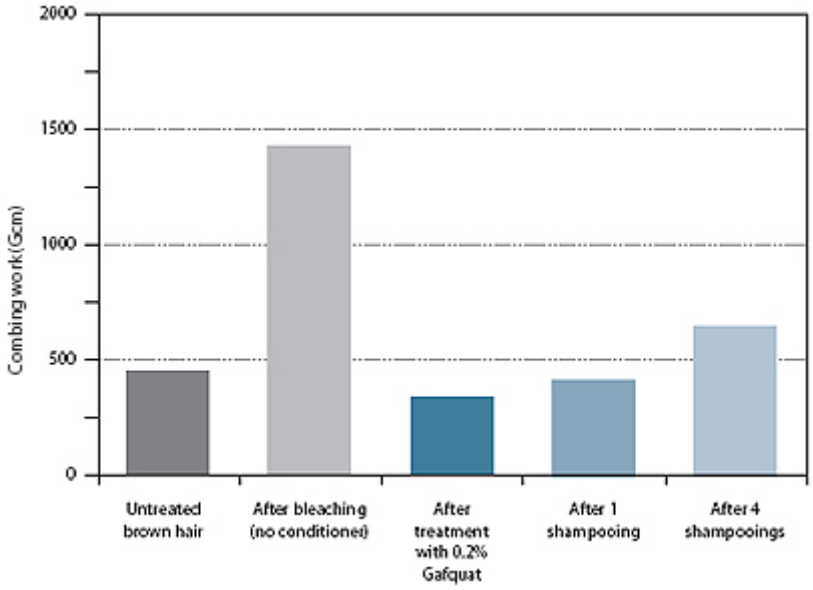
Combing force– Gafquat™ 755N & Gafquat HS-100 polymers



Equipment: Diastron MTT Tensile Tester
Conditions: 24°C / 50% RH
Evaluated as 2% aqueous solution with (2) 30-second water rinses (41°C tap water)

[1]Hewitt GT US Patent 3,769,398
Crawford, R and Robbins, CR; Soc Cosmet Chem 3; 273-278 (1980)

Combing work reduction by Gafquat 755N polymer – bleached hair



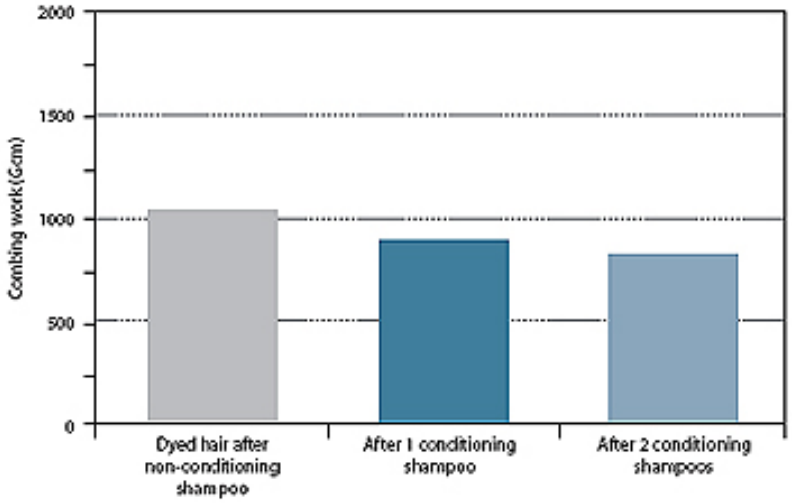
The effects are especially significant on bleached hair where the benefits are retained through repeated washings.

Conditioning Shampoos

Gafquat polymers' anionic and amphoteric surfactant compatibilities are important attributes for conditioning shampoos. Anionic surfactants form a complex with the copolymer, which is solubilized by the presence of excess surfactant. Clear solutions have been made with 2% copolymer and various anionic surfactants over wide detergent concentration ranges. Anionic surfactants evaluated include ammonium lauryl sulfate, sodium lauryl sulfate, sodium laureth-3 sulfate and TEA lauryl sulfate.

Gafquat™ polymers have also been shown in laboratory evaluation to improve the latherability of a sodium lauryl sulfate shampoo. It is important to note that the viscosity profile of Gafquat polymer conditioning shampoos responds well to NaCl addition in salt-thickened systems. However, small anions such as chloride can give rise to turbidity with Gafquat 755N polymer. The graph below shows the improved compatibility imparted by Gafquat 755N polymer from a shampoo

Combing work reduction by Gafquat 755N polymer – dyed hair



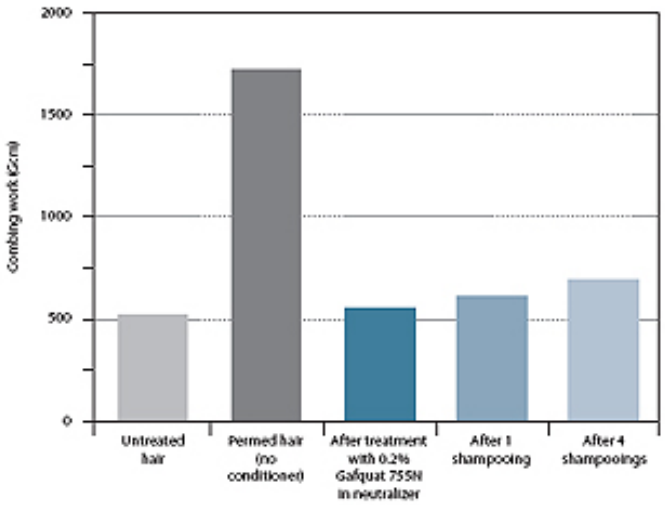
Treatment Conditioners

Hair that is damaged, either chemically or mechanically, can be improved in both feel and appearance by treatment with Gafquat polymer based products. It is well established that the damaged parts of a hair fiber absorb more of a cationic material which means that Gafquat polymer deposits where it is most needed.

Permanent Waving Systems

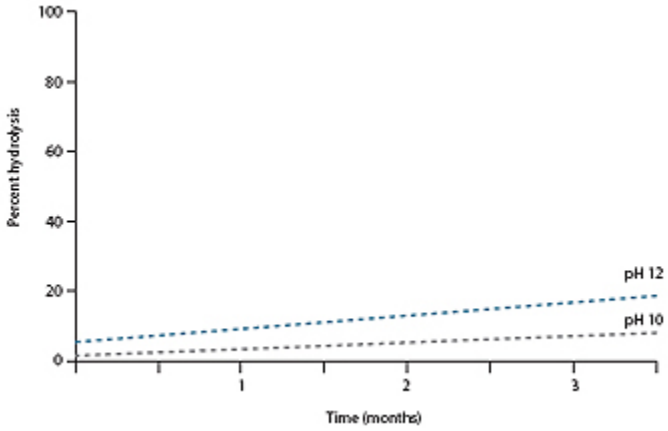
Gafquat™ HS-100 polymer exhibits stability to hydrolysis at pH extremes. This makes it an ideal choice as a conditioning agent in permanent waving systems and hair relaxers.

Combing work reduction by Gafquat 755N polymer – permed hair



Hydrolytic stability, measured as % cationic comonomer hydrolyzed over time at 45°C for pH 10 and pH 12 is shown in the figure below. Similar hydrolytic stability is expected at extreme acid pHs.

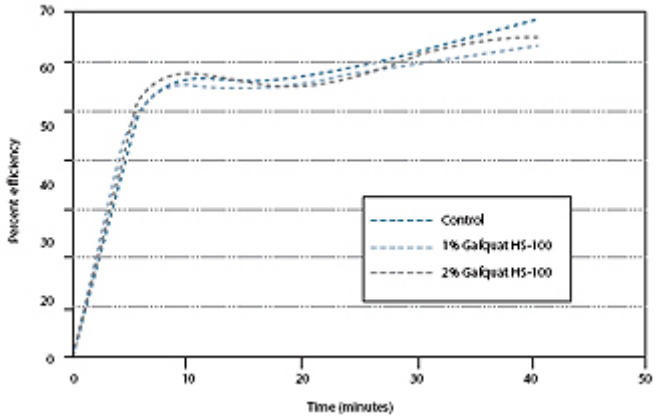
Hydrolytic stability of Gafquat HS-100 polymer at pH 10 and pH 12 at 45°C



Half-headed laboratory evaluations of permanent waving formulations containing Gafquat HS-100 polymer demonstrate conditioning benefits as well as thicker hair with greater body compared to control systems without the polymer. Based on methylene blue dye studies[2], Gafquat HS-100 polymer may reduce hair damage caused by permanent waving systems. In addition, Gafquat HS-100 polymer has no negative effect on perm efficacy.

[2] H. Fishman, HAPPI, Nov. 1986, pg. 60.

Gafquat™ HS-100 polymer – permanent wave percent efficiency vs. time



Skin Care

Gafquat 440 and 755N polymers are also used in all kinds of skin applications. They are used as conditioning ingredients in skin products, where they impart similar benefits to those experienced with polyvinylpyrrolidone (PVP) homopolymer, but with added substantivity because of their cationic nature.

Skin creams and lotions are given an improved smoothness during application, as well as a desirable "after-feel", leaving the skin feeling conditioned and less oily. There is also evidence that these copolymers can increase the effective deposition of other additives such as UV absorbers by suppressing crystallization and promoting more uniform coverage of the skin.

Versatility in Formulation

Gafquat 440, 755N and HS-100 polymers are supplied in solution form which makes them very easy to incorporate into aqueous or alcoholic formulations.

In hair applications, water enhances cationic action and improves hair hold. It should be noted that Gafquat 440 polymer, supplied in alcoholic solution, will go through an insoluble phase, i.e., form a haze to a cloud and back to a haze, on addition of 25% to 90% water at 2.5% solids concentration. In water-based systems therefore, Gafquat 755N or HS-100 polymer may be the polymer of choice. Crystal clear products can be made when using these polymers in conjunction with Stabilize QM polymer (INCI Name: PVM/ MA Decadiene Crosspolymer). It is important to add the Gafquat polymer after the Stabileze QM polymer is neutralized. Some formulators also prefer to dilute the Gafquat polymer with some of the formulation water before adding it to the neutralized thickener.

While Gafquat 755N polymer will function in hair preparations in an alkaline medium it is more ideally suited to neutral or acidic conditions. As previously mentioned, Gafquat HS-100 polymer has greater hydrolytic stability and is suitable for formulations across a wide pH range.

Prototype formulations for hair and skin products are available on request.

Toxicology

Gafquat™ quaternary copolymers have an excellent toxicological profile for personal care products and summaries of the toxicity information are available on request.

Further Information

Fully detailed technical literature on the products featured in this brochure is available upon request from Ashland Inc. offices listed overleaf.