How to formulate simple high-performance hair care products?

Dominique Lemos, Angelia Peavey – SNF France, USA

Introduction

Most hair conditioners and hair masks contain ingredients such as fatty alcohols, cationic surfactants, emulsifiers, oils, and silicones... Usually, formulators must heat these ingredients in order to develop their formulations. Each time formulators modify an ingredient; they must repeat the entire process of heating the entire formulation. This process continues until the formulation is perfected. The development of formulations using heat requires time and energy. So, how can SNF help formulators save on time, energy, and money?

The trend of "less is more" is becoming a requirement. By reducing the number of ingredients in a hair care formulation, consumer companies can reduce the cost of the formulas, save time and energy by using cold process formulations. Companies can pass on these savings to the end-users, which is a win-win situation in today's context.

Inverse Emulsion Polymer Generalities

Inverse emulsions or Liquid Dispersion Polymers (LDPs) are made up of a dispersion of polymer droplets suspended in a continuous phase of oil. An oil-in-water emulsifier allows this dispersion to invert with water and agitation. The polymer is released with agitation, and water is absorbed by the polymer. The polymer swells to build viscosity (Figure 1).
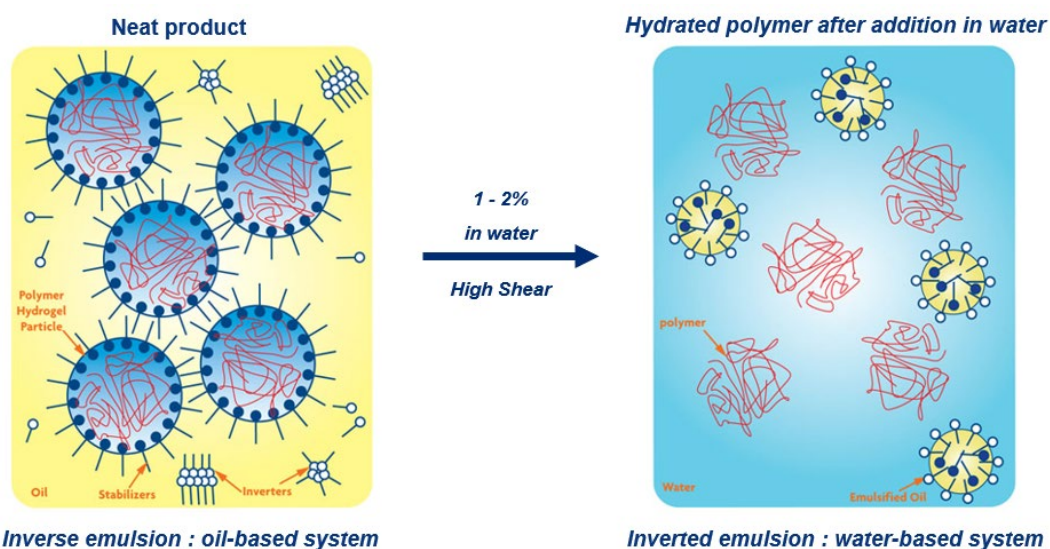

Figure 1 : Liquid Dispersion Polymer

Cationic inverse emulsion polymers can be used to develop formulations at room temperature with no heat required (cold-processed). Formulators can create a wide range of hair care products, from hair conditioners, treatment products, styling products, and transparent conditioning gels to colouring and men's grooming products.

SNF has developed a wide range of cationic inverse emulsions that are water-soluble polymers. The FLOCARE™ Polyquaternium 37 [Poly(2-methacryloxyethyltrimethylammonium chloride)] range contains cationic inverse emulsions in liquid and powder forms.

FLOCARE™ ET 1237 PP1 [Polyquaternium-37 (and) Mineral Oil (and) PPG-1 Trideceth-6] and FLOCARE™ ET 1737 GPG [Polyquaternium-37 (and) Propylene Glycol Dicaprylate/Dicaprate (and) PPG-1 Trideceth-6] are traditional cationic inverse emulsions polymers in liquid form.

FLOCARE™ PSD 1037 LV and FLOCARE™ PSD 1037 XT (Polyquaternium-37) are cationic inverse emulsions polymers that have been spray dried. The cationic polymers are spray dried using a unique technology developed by SNF, resulting in multifunctional, highly concentrated, and white, free-flowing powders. FLOCARE™ PSD 1037 XT also enables making transparent formulations and provides secondary benefits like softness.

Polyquaternium 37 Cationic Inverse Emulsion Polymer Study

This article's study will focus specifically on FLOCARE™ Polyquaternium 37 range for hair care. The research will demonstrate how formulators can create conditioners using FLOCARE™ Polyquaternium 37 with minimum ingredients but excellent performance. These polymers help solve some of challenges (such as softness, straightening properties, and conditioning) that formulators typically face when creating hair care products.

Thickening
Polyquaternium-37 (PQ-37) inverse emulsion polymers deliver thickening properties over a wide pH range. The cationic inverse emulsion polymers are multifunctional polymers that act not only as emulsifying agents but as conditioning agents also. They are pre-neutralized and easy to disperse. Formulating with cationic inverse emulsion systems yield high viscosity ranges at low dosage, delivers unique textures ranging from light to heavy, from sprayable to creams/masks, and gives stable designs over a wide pH range (3 – 10).

Softness
The first challenge in the study was to determine if Polyquaternium 37 range have an impact on the softness of hair tresses. The smoothness of the hair was analyzed using XFluo 3D® Microscopy technology by KAMAX[i]. XFluo® 3D Microscopy technology is an optical technique based on fluorescence that allows the quantification and qualification of various biological targets. Thanks to XFluo® 3D, the mapping of the surface condition of hair cuticle keratin is possible by characterizing it in a quantitative and qualitative way:
- by obtaining very high-definition 3D visuals
- by calculating the surface roughness of the hair

The study was conducted on hair tress of 1 gram and 20 cm long moderately sensitized (Level 2) by 3 successive bleachings in simplex medium (supplier SP Equation[ii]).
20% weight hair tresses were treated with a solution of 1% Polyquaternum 37 polymer solution in water.
The two variations of Polyquaternium 37 were evaluated: Polyquaternium 37 (and) Propylene Glycol Dicaprylate/Dicaprate (and) PPG-1 Trideceth-6 emulsion and Polyquaternium-37 powder forms, respectively.

The hair tresses were treated with each polymer solution then evaluated versus an untreated hair tresses (= placebo).

Softness Evaluation Method:
- 0.2g of each 1% Polyquaternium 37 solution in water was applied to the hair tress for 30 seconds.
- Next, the solution was allowed to deposit on the hair for 1 minute.
- Then the hair tresses were rinsed for 30 seconds under running water at room temperature.
- Finally, the hair tresses were allowed to dry for one night in chambers at 21°C and 50% relative humidity.
- The hair tresses were removed from the chambers and evaluated using XFluo® 3D Microscopy. For each hair tress tested with the Polyquaternium-37 solution and the placebo, 18 hair segments were analyzed and one XFluo® 3D measurement was performed per hair segment (= roughness measurement).

Figure 2 shows the results of hair roughness for each group of hair segments. As you can see from the figure, the hair tresses treated with Polyquaternium 37 solutions displayed a reduction in hair surface roughness by nearly 34% versus the placebo (= no polymer).
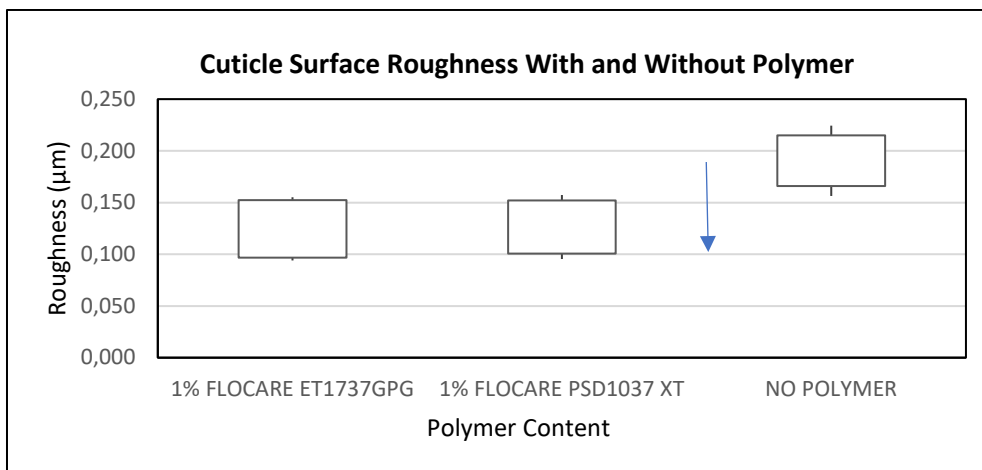

Figure 2: Cuticle Surface Roughness Measurements

The qualitative analysis (Figure 3) corroborates the quantitative analysis. Indeed, as represented in the pictures, the hair tresses treated with the Polyquaternium 37 range are visually similar with a small number of open scales. However, we observe that the untreated hair tress has many open scales (widely visible black grooves) which indicate hair roughness.
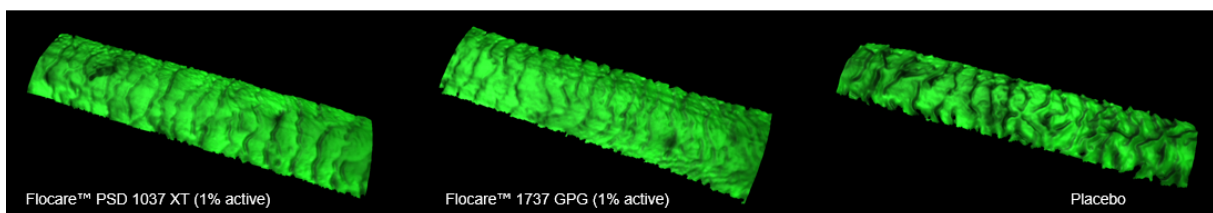
Figure 3: Cuticle Roughness Photos with and without FLOCARE™ PQ-37

Straightening benefit (non-permanent)

Many consumers have different demands for their hair care products. Some consumers want products that reduce hair fly aways, straighten, and resist humidity. Polyquaternium 37 powder was evaluated in a minimalist formulation to determine if it helps provide straightening and humidity resistance benefits. A simple cold process formulation containing 5 ingredients: water, Polyquaternium 37 powder (2%), glycerin (2%), jojoba oil (3%) and tocopherol (0.05%) was compared to hot process finished products from the professional market[iii] containing silicones.

Figure 4: Hair Tress Observations in Climatic Chamber

Results:

Each product (15% by weight of product/tress) was evaluated using natural textured hair tresses (Walker Type 3). The hair tresses were dried and flat ironed (5 times 230°C) and then placed into a climatic chamber.

Observation photos were taken at T=0, T=4hr, and T=24hr (Figure 4).

At T=0, all the hair tresses appeared equivalent. However, results indicated a volume reduction after 4 hr. and 24 hr. in a climatic chamber @ 25°C and 80% humidity for both professional products.

After 24 hr., the minimalist formulation containing Polyquaternium 37 powder performs better than the professional benchmarks containing silicones.

Polyquaternium-37 range allows one to create minimalist formulations while maintaining excellent straightening performance (non-permanent straightening).

Conditioning Performance

Polyquaternium 37 powder XT can be used to create transparent formulations. An innovative minimalist clear conditioner formulation was developed to show broad use potential of Polyquaternium 37 powder XT. This formulation satisfies the market demand for innovation, creativity, and simplicity without compromising on conditioning performances. The formulation contains Polyquaternium 37 powder XT (1%), Hydroxypropyl Guar Hydroxypropyltrimonium Chloride (0.50%), aloe vera juice (3%), preservative, and water.

Its performance characteristics were evaluated on Caucasian and Textured hair. The cold processed formulation showed equivalent wet combability results on Caucasian hair compared to a hot process mass market conditioner containing BTAC (Behentrimonium Chloride). The formulation also was evaluated on textured hair, and results indicated enhanced softness on lengths and tips in both wet and dry state. Also, a better gliding sensation was felt during the rinsing stage.

Conclusion

SNF has developed a range of cationic rheology modifiers that are multifunctional, vegan, and sustainable. The Polyquaternium-37 range products thicken, emulsify, and provide texture to formulations. To meet today's sustainability demands, SNF offers the Polyquaternium-37 range that is cold processable, easy to disperse, and does not require neutralization for the polymer to hydrate or thicken. Polyquaternium-37 range products provides excellent wet combability, exceptional conditioning, and softness-enhancing properties to hair, thus providing a new way to create conditioners!

If you need more information or samples FLOCARE@snf.com

website https://snf.com/industry/personal-care/

---

[i] https://kamax-innovative.com/

[ii] http://www.spequation.com/fr/

[iii] **Professional straightening cream** : WATER, PVM/MA COPOLYMER, POLYIMIDE-1, GLYCERIN, GLYCERYL ACRYLATE/ACRYLIC ACID COPOLYMER, CAPRYLYL GLYCOL, PHENOXYETHANOL, CYCLOPENTASILOXANE, GUAR HYDROXYPROPYLTRIMONIUM CHLORIDE, ACRYLIC ACID/VP CROSSPOLYMER, SODIUM POLYACRYLATE, FRAGRANCE (PARFUM), TETRASODIUM EDTA, PEG-4 DILAURATE, PEG-4 LAURATE, IODOPROPYNYL BUTYLCARBAMATE, PEG-4, DISODIUM EDTA, BENZYL ALCOHOL, BENZYL BENZOATE, BUTYLPHENYL METHYLPROPIONAL, CITRAL, HEXYL CINNAMAL, LIMONENE, LINALOOL

Premium Straightening cream : WATER, CETEARYL ALCOHOL , AMODIMETHICONE , CETYL ESTERS ,BEHENTRIMONIUM CHLORIDE, PHENOXYETHANOL ,GLYCERIN , ISOPROPYL ALCOHOL , TRIDECETH-6 , VITIS,VINIFERA SEED OIL / GRAPE SEED OIL , HEXYL CINNAMAL, GUAR HYDROXYPROPYLTRIMONIUM CHLORIDE, CHLORHEXIDINE DIHYDROCHLORIDE , LINALOOL, BENZYL,BENZOATE, CETRIMONIUM CHLORIDE, HYDROXYPROPYLTRIMONIUM HYDROLYZED WHEAT,PROTEIN , LIMONENE, MAGNESIUM ACETATE, ALPHAISOMETHYL,IONONE , 2-OLEAMIDO-1,3-OCTADECANEDIOL, CITRIC ACID , BENZYL ALCOHOL , ASPARTIC ACID ,GLYCINE, ARGININE, GLUTAMIC ACID , EUGENOL ,FUMARIC ACID , TOCOPHEROL , HELIANTHUS ANNUUS,SEED OIL / SUNFLOWER SEED OIL , ROSMARINUS,OFFICINALIS (ROSEMARY) EXTRACT , PARFUM /FRAGRANCE .