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A New Polymer with a MAXimum Resistance to Electrolytes

Introduction

To make application on target areas easier and in order to be consumer-friendly, cosmetic products require a certain degree of viscosity, which varies in accordance with their specific uses. Thickening polymers are used to provide the right texture, by creating networks within the formulations.

In addition, most skincare and bodycare products contain active ingredients that offer proven effectiveness, which means that the claims made during marketing are respected, which in turn, leads to satisfied customers.

These ingredients are often stress-inducing for formulations and can complicate the task of formulators because, once they are added to the base (essential formula ingredients), they can cause a dramatic and irreversible reduction in viscosity. As a result, stability tests are not satisfactory and the formulations developed cannot be proposed to Marketing departments for launch onto the market. It is, therefore, fundamental to have a thickening polymer that is sufficiently »sturdy« or resistant to the electrolytes generated through the addition of these stress-inducing ingredients to maintain the initial base viscosity level in formulae containing these ingredients.

SepiMAX™ ZEN (INCI: Polyacrylate Crosspolymer-6) was developed to meet this need, providing an ingredient with optimal resistance to electrolytes. It is the ideal technical solution for any formula incorporating stress-inducing ingredients.

Experimental Methods

This new polymer (INCI: Polyacrylate Crosspolymer-6) is a thickening and stabilizing polymer in a powder form produced by precipitation polymerization. Its unusual structure is the result of an experimental design which made it possible to select the highest-performance copolymer for the properties targeted.

Regarding its process, dispersant agitation (deflocculating) is recommended. Sprinkle the polymer over the aqueous phase, initially at low speed (approximately 500 rpm), then at higher speed of around 1,500 rpm and, finally, add the electrolytes present in the formulation.

For cream-gels, it should be added in the oily phase (hot or cold). The polymer may also be left to hydrate for a few hours without stirring; then it can be mixed rapidly by dispersant agitation (deflocculating) to obtain an aqueous gel. Its hydration time is around 10 minutes and depends on the equipment used and the scale required (laboratory, pilot, etc.).

Aqueous gels obtained using this polymer are transparent and a sensorial analysis carried out with a panel of experts described the texture as rich and elegant (non-oily, non-sticky), with a velvety sensation on the skin.

The polymerization process and the chemical processes used were specifically developed to increase hydrophobic interactions in order to obtain high electrolyte resistance.

Main Observations

The polymer obtained is a polyelectrolyte with a high associative behaviour. Its thickening power is governed by two types of interaction:

- Electrostatic repulsions
- Hydrophobic interactions

Depending on the medium, one or other interaction dominates. **Fig. 1** illustrates the microgel, inter-microgel and intra-microgel electrostatic repulsions as well as hydrophobic interaction areas.

An aqueous gel with 2% of polymer was made and its Brookfield viscosity was measured based on the percentage of NaCl added. **Fig. 2** shows the curve obtained on this aqueous gel (Brookfield viscosity measured in mPa.s) based on the percentage of NaCl added. The curve can be divided into 2 parts:

- Part 1: representing a % of NaCl of between 0% and 2%
- Part 2: representing a % of NaCl of > 2%

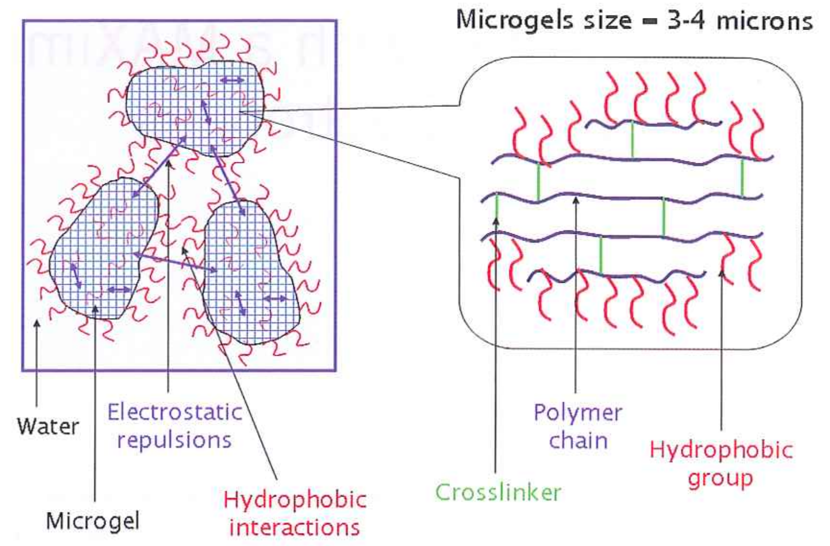

Fig. 1 SepiMAX™ ZEN's mechanism: interactions

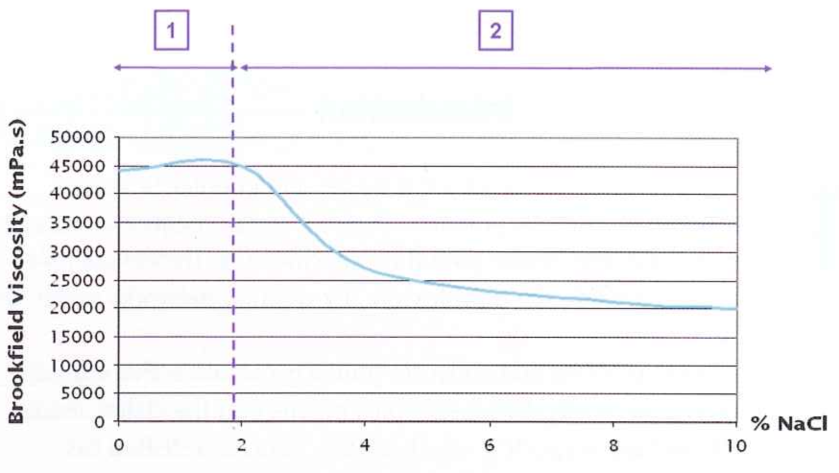

Fig. 2 SepiMAX™ ZEN's mechanism: viscosity versus % NaCl

In pure water, electrostatic repulsions are dominant and disrupt the hydrophobic interactions.

In the first part of the curve, the Na^+ ions block the anion-active charge present; electrostatic repulsions decrease and the size of the microgels also decreases. The loss of viscosity, as a consequence of this decrease in electrostatic repulsion, is compensated by hydrophobic interactions: viscosity is constant over this area.

In the second part of the curve, the Na^+ ions continue their screening process, thus provoking a sharper decrease in electrostatic repulsion and therefore also in the size of the microgels. As such, the hydrophobic interactions partially compensate for the loss of viscosity, due to the decrease in electrostatic repulsion. Nevertheless, it should be noted that we maintain a very good level of viscosity for a quantity of NaCl up to 10%, level not often reached in terms of performances.

It can be also obtain a higher level of viscosity by using 3% of polymer (around 100,000 mPa.s) and continue to benefit from excellent electrolyte resistance **(Fig. 3)**.

It is essential to check that viscosity stability is satisfactory, by adding active ingredients that are frequently used in formulation and that are known for their stress-inducing aspect as they are rich in electrolytes. The results, presented in **Table 1**, show that our polymer resists well when monovalent or divalent active ingredients are added.

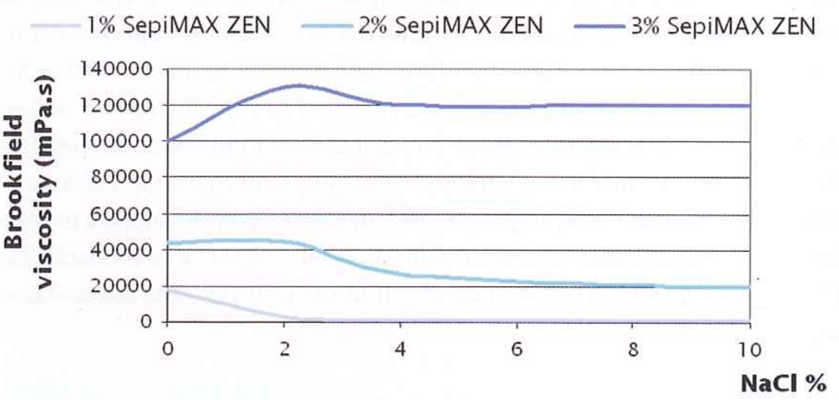

Fig. 3 Performances in aqueous gels with NaCl

Aqueous gels may also be created directly with mineral water, which are often used in products, to obtain gels which are remain transparent and stable over time (**Table 2**).

Active Ingredient	%	pH	Brookfield viscosity LV S3 S6
Aqueous gel	0	5.8	50 000 mPa.s
Glycolic Acid	4.0	3.3	45 000 mPa.s
Magnesium chloride	0.1	5	40 000 mPa.s
SEPICONTROL™ A5 Capryloyl Glycine & Sarcosine & Cinnamomum Zeylanicum Bark Extract	4.0	4.7	52 000 mPa.s
GIVOBIO™ GZn Zinc Gluconate	1.0	5.5	48 000 mPa.s
GIVOBIO™ GZn / GIVOBIO™ GMg Zinc Gluconate / Magnesium Gluconate	1.0/1.0	5.7	47 000 mPa.s
EDTA	0.2	8.5	41 000 mPa.s

Table 1 Performances in aqueous gels with different active ingredients

Mineral Water	Mineral Water Conductivity	Brookfield viscosity LV S3 S6
Demineralized Water	–	65 000 mPa.s
Avène	477 µS/cm	64 000 mPa.s
La Roche Posay	756 µS/cm	62 000 mPa.s
Vichy	7340 µS/cm	69 000 mPa.s
Uriage	13 680 µS/cm	58 000 mPa.s

Table 2 Performances in mineral waters

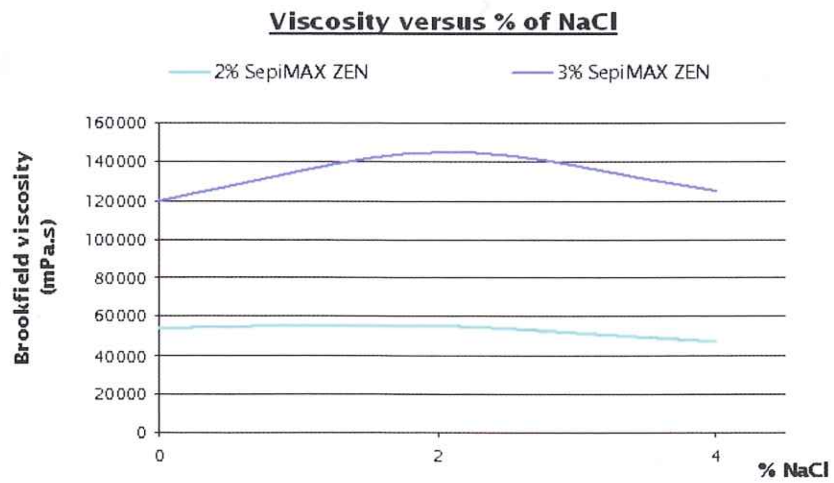

Fig. 4 Performances in cream-gels

Oily Phase Stabilization

SepiMAX™ ZEN stabilizes oily phases easily: for example, 15% of Caprylic/Capric Triglyceride, even with 4% electrolytes. The cream-gels are stable over time and their viscosity remains constant, regardless of the percentage of NaCl added.
Combining 2% of our polymer with 0.5% of natural polymer maintains the polymer's electrolyte resistance properties and allows formulators to make changes to the sensorial aspects of the texture **(Fig. 4)**.
In emulsion **(Table 3)**, it stabilizes 20% of Caprylic/Capric triglyceride combined with MONTANOV™ L (C14-22 Alcohols & C12-20 Alkyl Glucoside), glucolipidic emulsifier and the following active ingredients (added at the end of the process):

- 1% Zinc Gluconate
- 3% Sodium PCA.

Emulsions can also be made with ethoxylated emulsifiers and a synergy is observed between the new polymer and a fatty alcohol (cetearyl alcohol).

MONTANOV™ L	3%	3%	3%
Caprylic/Capric Triglyceride	20%	20%	20%
SepiMAX™ ZEN	1%	1%	1%
Zinc Gluconate	–	1%	–
Sodium PCA	–	–	3%
Viscosity (mPa.s) BROOKFIELD LV S3 S6	84 500	92 500	69 000
Conductivity (µS/cm)	1 360	1 7680	5 300

Table 3 Performances in emulsions with MONTANOV™ L

Ethoxylated emulsifier	2%	2%	2%
Caprylic/Capric Triglyceride	20%	20%	20%
NaCl	2%	2%	2%
Cetearyl Alcohol	–	2%	2%
SepiMAX™ ZEN	1%	–	1%
Viscosity (mPa.s) BROOKFIELD LV S3 S6	8 100	14 000	47 000

Table 4 Performances in emulsions

Cosmetic Applications

The performances of this new polymer provide the formulator with the opportunity to safely develop formulae based on an extensive range of marketing briefs:

- Skincare products presented in gel form (bringing transparency into play), serums that are simply bursting with active ingredients or emulsions boasting a host of claims (anti-aging, anti-acne, plumping, etc.)
- Bodycare products that help slim, revitalize, moisturize, anti aging, etc.,
- SPA-specific products,
- Transparent hair gels offering effective hold,
- Sun-care products,
- Innovative concepts, such as »do it yourself« where the consumer adds her own active ingredients to a neutral cosmetic base that is resistant to all types of active ingredient cocktails.

Conclusion

Seppic, expert in the field of thickening polymers, proposes its innovative polymer, a state-of-the-art polymer, providing solutions for formulators allowing them to push beyond the current limitations in terms of electrolyte resistance.
Thanks to its high associative behaviour, it maintains the viscosity of aqueous gels containing up to 10% NaCl as well as the viscosity of cream-gels and emulsions containing the most stress-inducing active ingredients.
In addition, the aqueous gels obtained are totally transparent (even under acidic pH) and offer a true sensorial revelation.
Overcoming obstacles in formulation, SepiMAX™ ZEN helps formulators remain completely ZEN.

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