Lubrizol

TECHNICAL DATA SHEET

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Neutralizing Carbopol®* and Pemulen™* Polymers in Aqueous and Hydroalcoholic Systems

Effect of pH on Viscosity

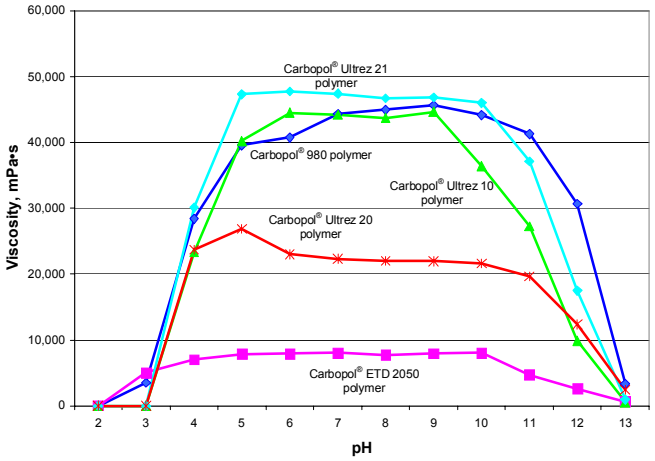
Carbopol® and Pemulen™ polymers must be neutralized in order to achieve maximum viscosity. Unneutralized dispersions have an approximate pH range of 2.5-3.5 depending on the polymer concentration. The unneutralized dispersions have very low viscosities, especially Carbopol® ETD and Carbopol® Ultrez polymers. Once a neutralizer is added to the dispersion, thickening gradually occurs as shown in Figure 1. Optimum viscosity is typically achieved at a pH of 6.5-7.5. As demonstrated by the graph, high viscosities can be achieved in pH ranges of 5.0-9.0.

A frequently asked question is "What pH is correct for my finished product?" The answer is that the best pH of the system should be determined by the performance desired for the particular application. The final pH should be consistent with desired functional attributes of the targeted application.

The viscosity of Carbopol® and Pemulen™ polymers will begin to decrease at pH of 9.0 and higher. This is caused by the dampening of the electrostatic repulsion caused by the presence of excess electrolytes. It is possible to achieve high viscosity systems at pH values below 5 and above 9, but the use level of the Carbopol® and Pemulen™ polymer must be increased to obtain these higher viscosity levels.

Figure 1

Carbopol® Polymers Viscosity vs. pH (0.5 wt% TS Concentration)



Viscosity Results: Brookfield RVT, 20 rpm @ 25°C

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For further information, please visit www.pharma.lubrizol.com

Figure 2

Schematic Depicting Molecule of Carbopol® Polymer in Coiled State

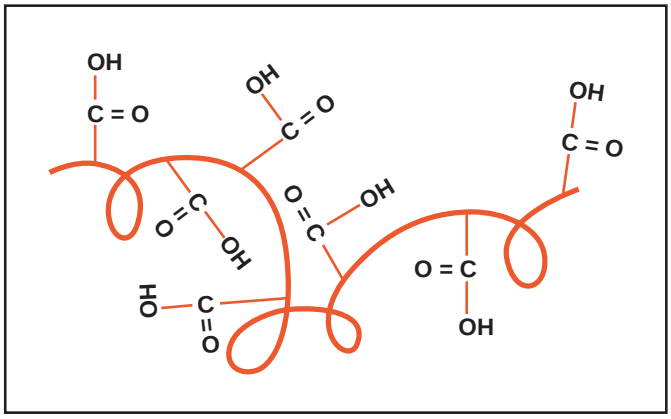
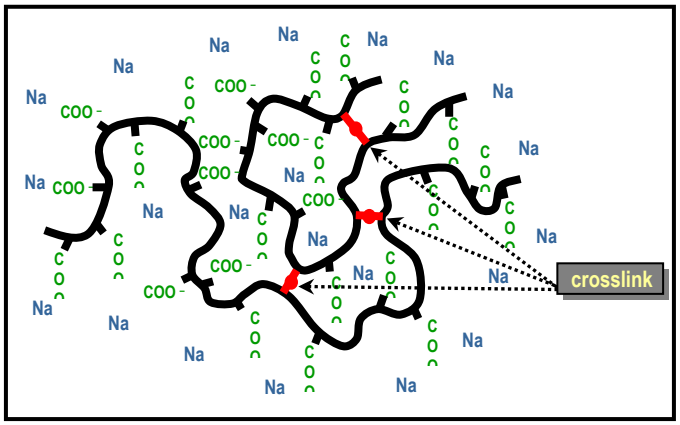


Figure 3

Diagram Depicting Molecule of Carbopol® Polymer in Uncoiled Neutralized State



Thickening Mechanism

Carbopol® and Pemulen™ polymers as supplied are dry, tightly coiled acidic molecules. Once dispersed in water, the molecules begin to hydrate and partially uncoil. The most common way to achieve maximum thickening from Carbopol® and Pemulen™ polymers is by converting the acidic Carbopol® or Pemulen™ polymer to a salt. This is easily achieved by neutralizing the Carbopol® or Pemulen™ polymer with a common base such as sodium hydroxide (NaOH) or triethanolamine (TEA).

Figure 4

Neutralization Ratio Chart

Trade Name	CTFA Name	Manufacturer	Neutralization Ratio Base/ Carbopol® Polymer
NaOH (18%)	Sodium Hydroxide		2.3/1.0
Ammonia (28%)	Ammonium Hydroxide		0.7/1.0
KOH (18%)	Potassium Hydroxide		2.7/1.0
L-Arginine	Arginine	Ajinomoto	4.5/1.0
AMP® Ultra PC2000	Aminomethyl Propanol	Dow	0.9/1.0
Neutrol® TE	Tetrahydro-xypropyl Ethylenediamine	BASF	2.3/1.0
TEA (99%)	Triethanolamine		1.5/1.0
Tris Amino® (40%)*	Tromethamine	Dow	3.3/1.0
Ethomeen® C-25	PEG-15 Cocamine	Akzo	6.2/1.0
Diisopropanol-amine	Diisopropanol-amine	Dow	1.2/1.0
Triisopropanol-amine	Triisopropanol-amine	Dow	1.5/1.0

***NOTE**: The 40% solution should be made from Tris Amino crystals from the manufacturer. Do not use the pre-dispersed solution from the manufacturer as it contains many impurities.

Common Neutralizers

Figure 4 lists the most common neutralizers used, the manufacturers of these neutralizers, and the appropriate ratio to use (as compared to one part of Carbopol® or Pemulen™ polymers) to achieve exact neutralization at a pH of 7.0. The chart is based on Carbopol® Ultrez 10 polymer, but is applicable to all Carbopol® and Pemulen™ polymers because they all have the same equivalent weight of 76 ± 4.

Figure 5
Recommended Neutralizers for Hydroalcoholic Systems

Up to % Alcohol	Neutralizer
60%	Triethanolamine
60%	Tris Amino
80%	AMP® Ultra PC2000
90%	Neutrol TE
90%	Triisopropanolamine

Hydroalcoholic Thickening

Ethanol and isopropanol can be thickened with Carbopol® polymers. The critical factor is choosing the correct neutralizer based on the amount of alcohol that is to be gelled. If the wrong neutralizer is used, the salt of the Carbopol® polymer will precipitate out because it is no longer soluble in the hydroalcoholic blend. Figure 5 gives recommended neutralizers for various alcohol levels.

For a complete guide to making Hand Sanitizing gels, refer to TDS-255: "Formulating Hand Sanitizing Gels with Carbopol® Polymers".