TECHNICAL DATA SHEET

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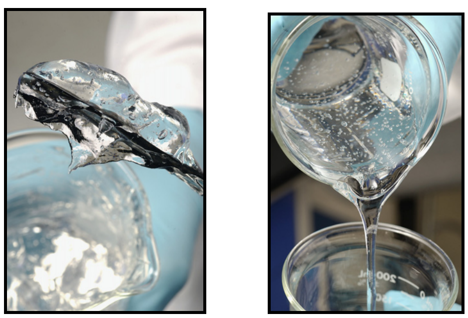
Viscosity of Carbopol®* Polymers in Aqueous Systems

Introduction

Carbopol® polymers can be used to develop semisolid and oral liquid formulations with a wide range of flow and rheological properties (Figure 1). The polymers are highly efficient thickeners, suspending agents and stabilizers at low usage levels (0.1 - 3.0 wt%).

Figure 1: Flow Properties of Carbopol® Polymers, Neutralized Dispersions



Polymer Crosslink Density:	High/Medium	Low
Flow Property:	Short	Long (Pourable)

All Carbopol® polymers are high molecular weight, crosslinked polyacrylic acid polymers. The main differences among the polymers are the crosslinker type and density and solvent used to synthesize the polymer. A description of the polymers featured in this document is shown in Tables 1A and 1B. Please refer to Bulletin 1- *Polymers for Pharmaceutical Applications* for a complete list of polymers.

Table 1A: Carbopol® Polymers Overview

Carbopol® Polymer	Recommended Applications	Polymerization Solvent	Polymer Type	Crosslink Density	Aqueous Gel Viscosity
971P NF	Oral / Topical	Ethyl Acetate	Homopolymer	Low	Low
974P NF	Oral / Topical	Ethyl Acetate	Homopolymer	Medium	Medium - high
980 NF	Topical	Cosolvent[1]	Homopolymer	High	Very high
5984 EP	Topical	Cosolvent	Homopolymer	Medium	Medium - high
ETD 2020 NF	Topical	Cosolvent	Interpolymer	Medium	Medium - high
Ultrez 10 NF	Topical	Cosolvent	Interpolymer	High	Very high

[1] Cosolvent is a mixture of ethyl acetate and cyclohexane.

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Table 1B: Compendial Status of Polymers

Product Trade Name	United States USP/NF*	Europe (Ph. Eur.)	Japan (JPE)[1]
Carbopol® 971P NF Polymer	Carbomer Homopolymer Type A	Carbomers	Carboxyvinyl Polymer
Carbopol® 974P NF Polymer	Carbomer Homopolymer Type B	Carbomers	Carboxyvinyl Polymer
Carbopol® 980 NF Polymer	Carbomer Homopolymer Type C	Carbomers	Carboxyvinyl Polymer
Carbopol® 5984 EP Polymer	Carbomer Homopolymer Type B	Carbomers	Carboxyvinyl Polymer
Carbopol® ETD 2020 NF Polymer	Carbomer Interpolymer Type B	---	---
Carbopol® Ultrez 10 NF Polymer	Carbomer Interpolymer Type A	---	---

* USP/NF after 2006

Brookfield Viscosity of Carbopol® Polymer Dispersions

Carbopol® polymers must be neutralized in order to achieve maximum viscosity. Once a neutralizer is added to the dispersion, thickening gradually occurs. Maximum viscosity is typically achieved at a pH of 6.0 - 7.0.

The viscosity of Carbopol® polymers will begin to decrease at a pH of 9.0 and higher. This is caused by the presence of excess electrolytes which affect the electrostatic repulsion of the ionized carboxylic groups. In order to obtain high viscosity at pH values below 5 and above 9, an increased concentration of Carbopol® polymer is recommended. Additionally, use of a low concentration of polymer at low pH values should be avoided in an effort to achieve a robust formulation.

Brookfield viscosity measurements were obtained for aqueous dispersions of several Carbopol® polymers at concentrations of 0.2 - 2.0 wt. %. The general behavior of each polymer is shown in Figures 2 - 7 based on the data for one lot of each polymer. The dispersions were tested as prepared (conventionally represented as pH 3.0) or after neutralization with sodium hydroxide solution to pH 4.0 - 7.0. An increase in polymer concentration results in an increase in viscosity. In general, a pH plateau is achieved more readily with higher concentrations of Carbopol® polymers.

Figure 2: Effect of pH and Concentration on the Viscosity of Carbopol® 971P NF Polymer Dispersion

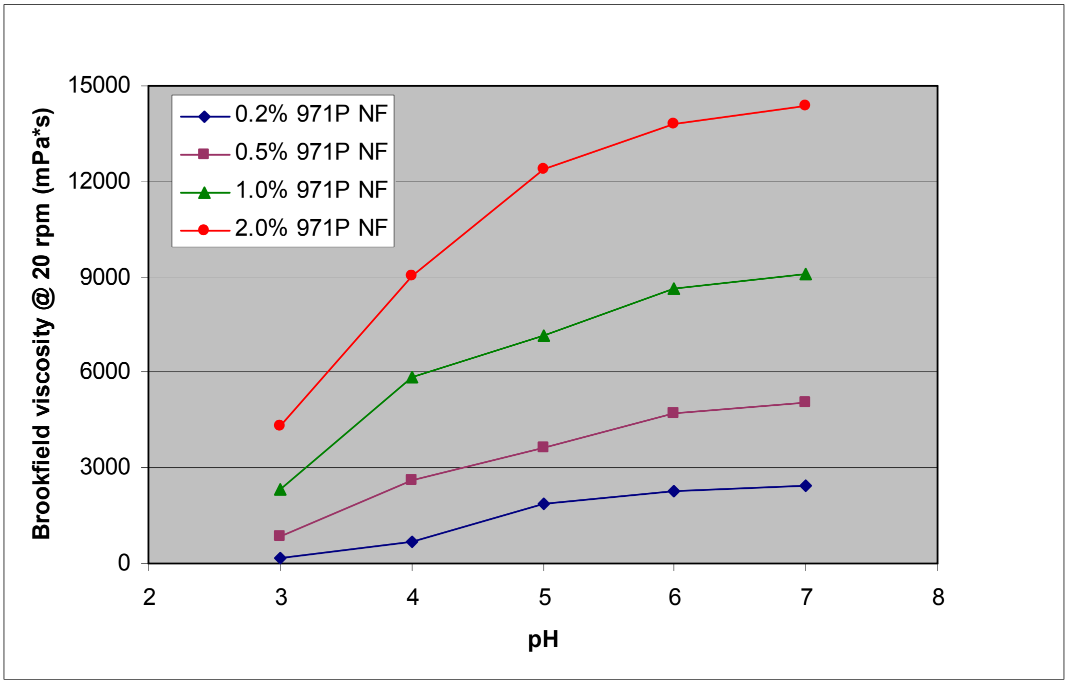


Figure 3: Effect of pH and Concentration on the Viscosity of Carbopol® 974P NF Polymer Dispersion

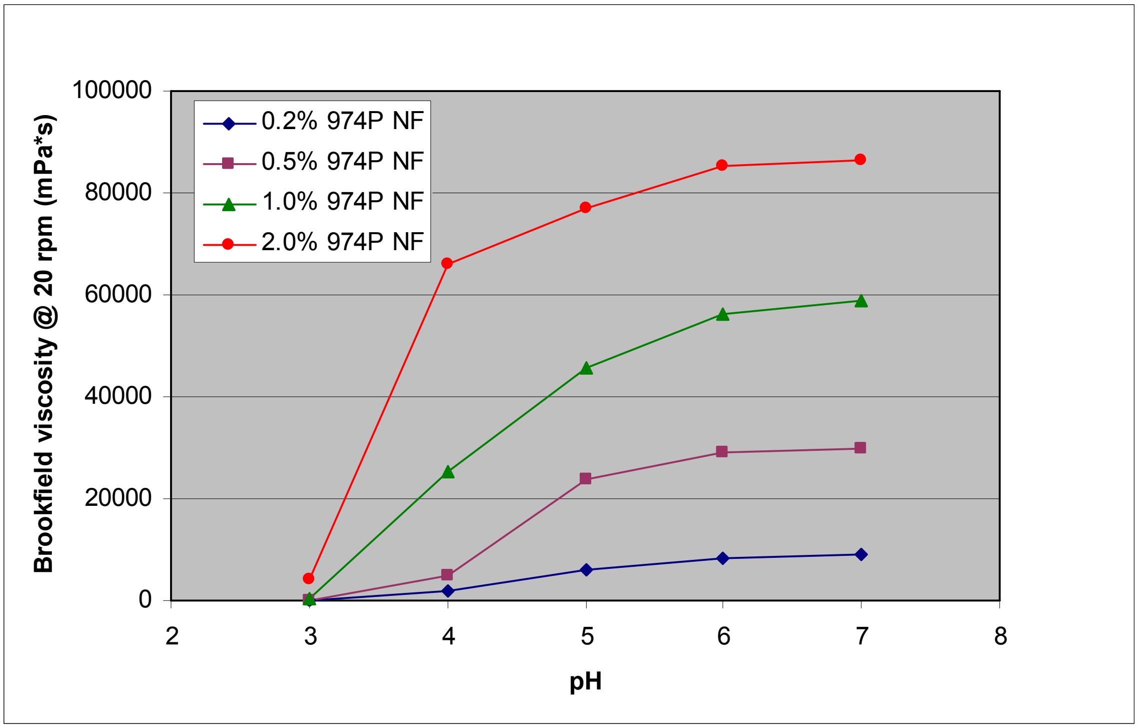


Figure 4: Effect of pH and Concentration on the Viscosity of Carbopol® 980 NF Polymer Dispersion

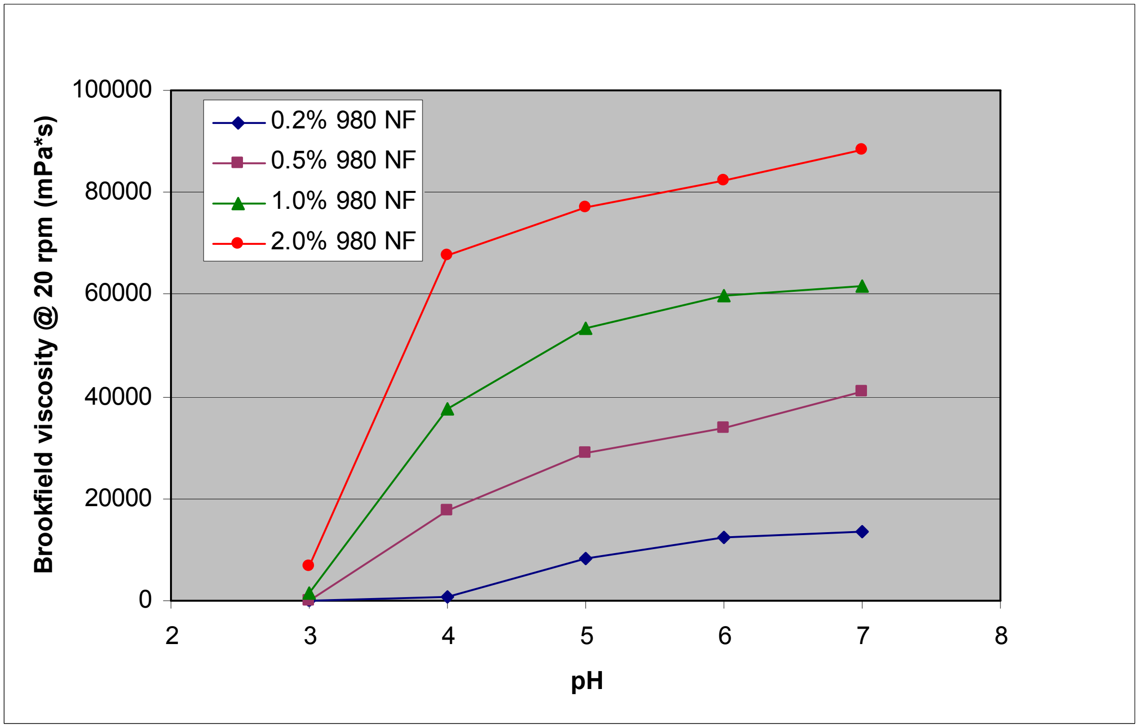


Figure 5: Effect of pH and Concentration on the Viscosity of Carbopol® 5984 EP Polymer Dispersion

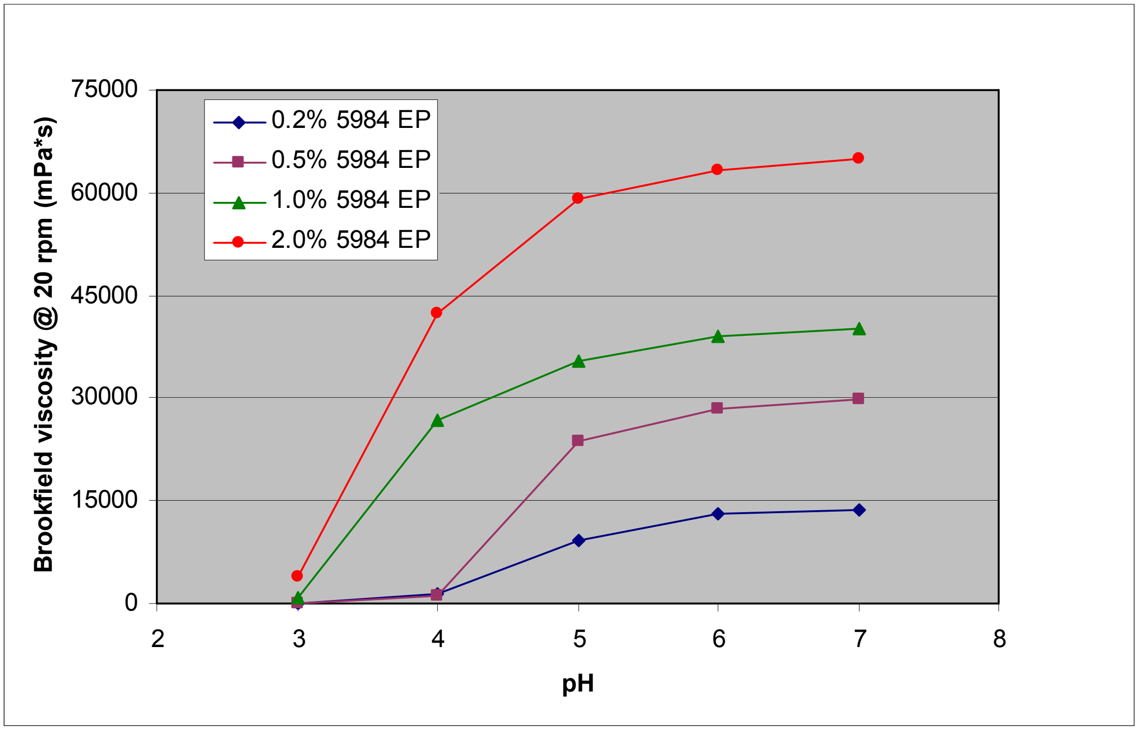


Figure 6: Effect of pH and Concentration on the Viscosity of Carbopol® ETD 2020 NF Polymer Dispersion

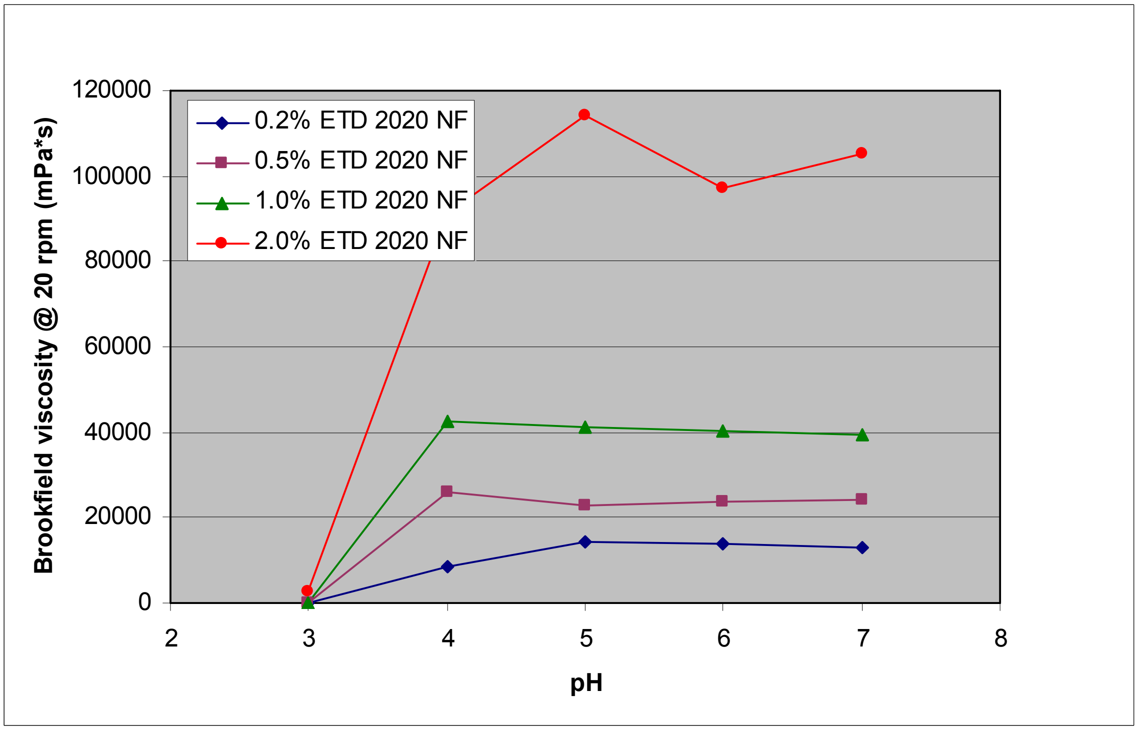
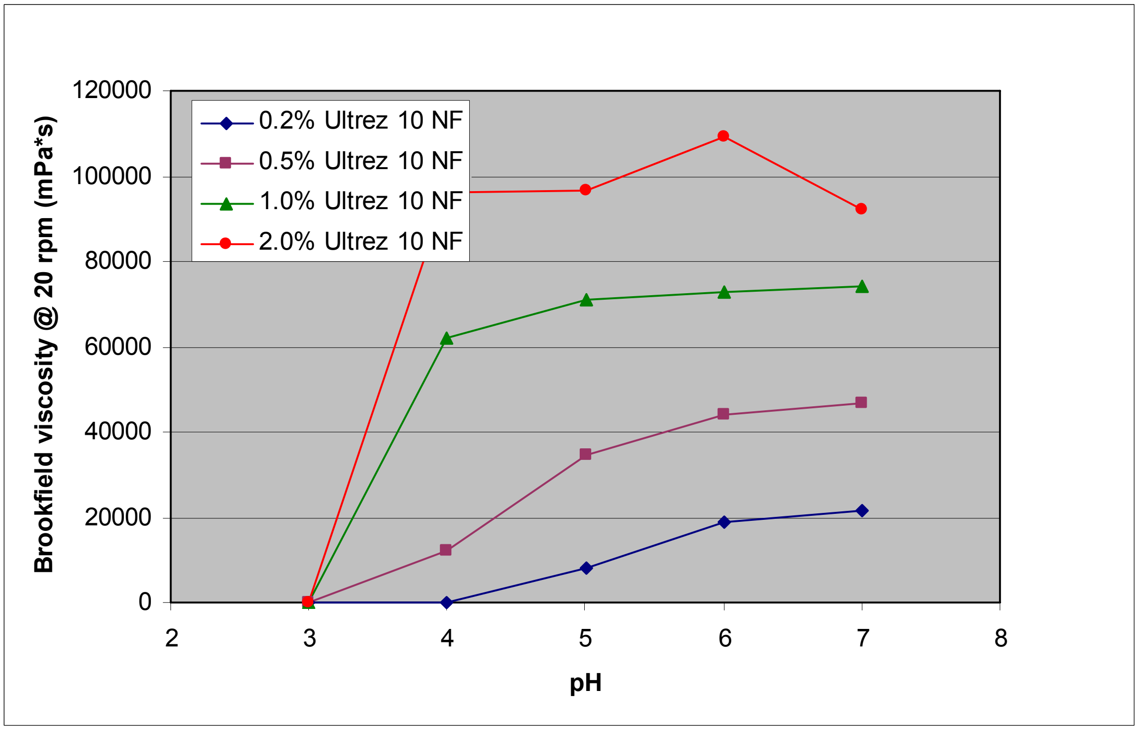
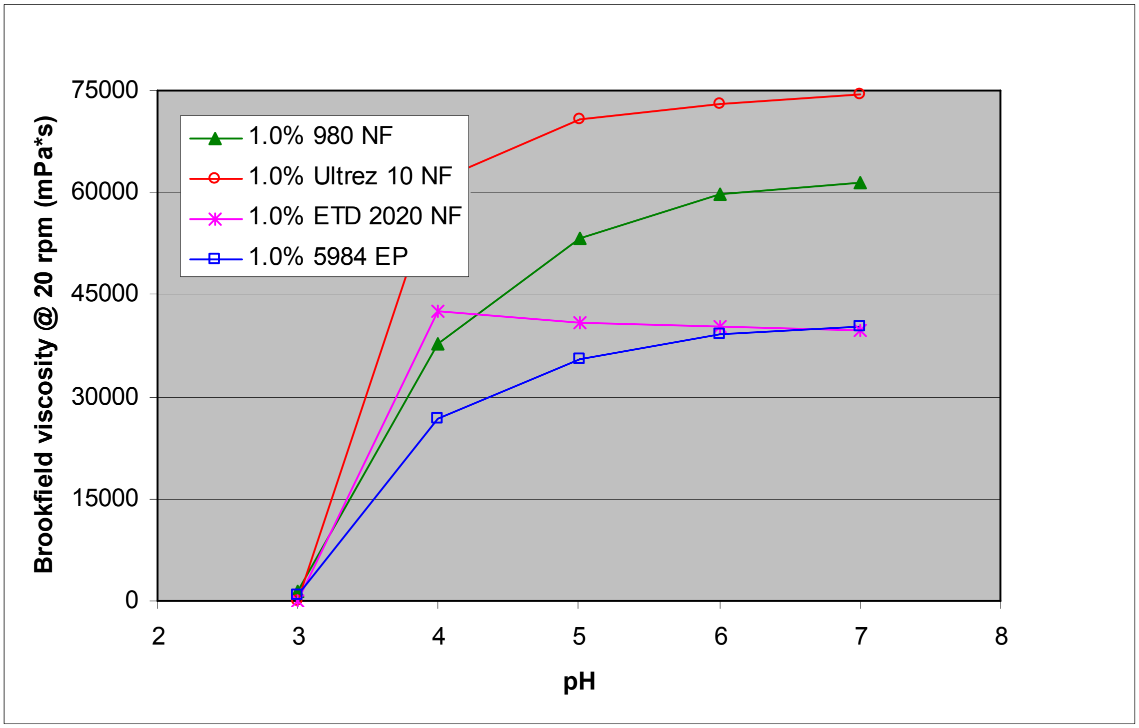


Figure 7: Effect of pH and Concentration on the Viscosity of Carbopol® Ultrez 10 NF Polymer Dispersion



A comparison of the viscosity of 1.0 wt. % aqueous dispersions of several topical grades of Carbopol® polymers is shown in Figure 8.

Figure 8: Effect of Polymer Type on the Viscosity of 1.0% Dispersions – Topical Products



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