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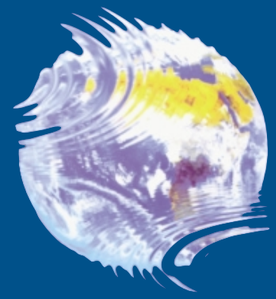
SNF FLOERGER®

GUTENBERG ON LINE REGIONS - Tel. 04 77 42 35 00 / 03 - 2003

FLOGEL™ 700

Rheology modifier



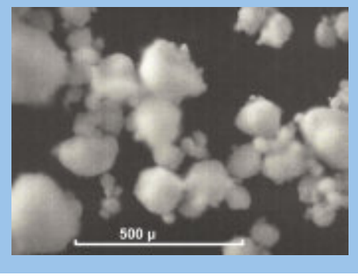
SNF FLOERGER®

FLOGEL™ 700

FLOGEL™ 700 is a crosslinked polyacrylic acid . It is supplied in acid-form as a white powder. The typical properties of **FLOGEL™ 700** are shown in Table 1.

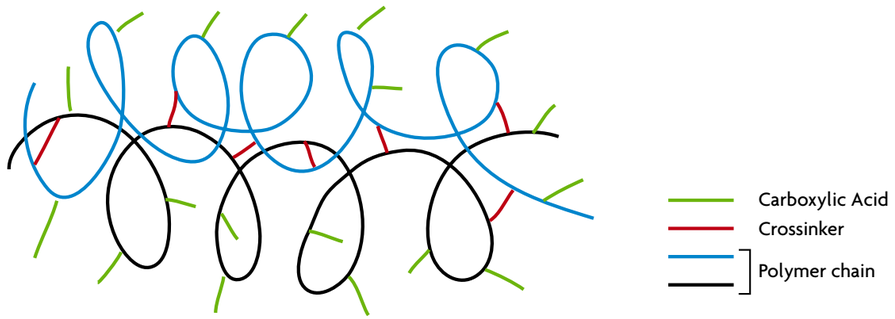
Table 1: Typical properties of FLOGEL 700™

Appearance	fine white powder
Odor	mildly acetic
Particle size	5 microns
Bulk density	0.25 g/cc
Active content	> 97%
Viscosity of	
0.2% aqueous dispersion	20,000-30,000 cps
0.5% aqueous dispersion	40,000-65,000 cps
	(RV, #6, 20 rpm, 25°C)
pH of 0.5% aqueous dispersion	3.0
Shelf-life stability	24 months



FLOGEL™ 700 is manufactured via suspension polymerization. The polymeric powder is separated from the polymerization medium, purified, and dried to the required specifications.
Each particle (about 0.2 micron in diameter with an average agglomerate size of 2-7 microns) is a network structure of polymer chains chemically connected by crosslinks (shown in Figure 1).

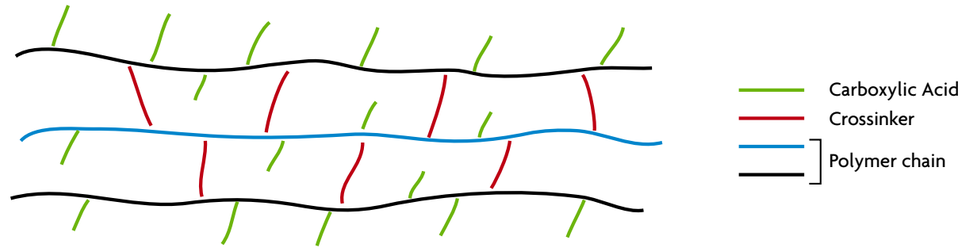
Figure 1: Coiled FLOGEL™ 700



When in contact with water, hydration starts to uncoil the polymer network of **FLOGEL™ 700**. This results in an increase in viscosity of the aqueous dispersion (**FLOGEL™ 700** polymer is not soluble in water but becomes swollen in water). To achieve full viscosity, it is necessary to complete the uncoiling of the polymer chain network. Complete uncoiling is achieved by neutralizing the carboxylic acid groups with a base (an alkali or amine); the resulting anionic charge on the polymer chain creates repulsive forces that rapidly uncoil the network to an extended structure, therefore attaining maximum thickening efficiency (Figure 2).

Rheology Modifier

Figure 2: Uncoiled FLOGEL™ 700



SELECTION OF A NEUTRALIZING AGENT

There are many types of bases (i.e. neutralizing agents) available commercially. Hydroxides of sodium, potassium and ammonium are the most common inorganic bases for use in an aqueous system. For hydroalcoholic systems, the choice of a neutralizing agent depends on the hydrophilicity of the medium to be thickened (i.e. hydrophilicity decreases with increasing the amount of alcohol in the medium). The hydrophilicity of the neutralizing agent chosen will decrease with increasing amount of alcohol in the medium (examples shown in Table 2).

Table 2: Examples of neutralizing agent with the amount of an alcohol in a medium

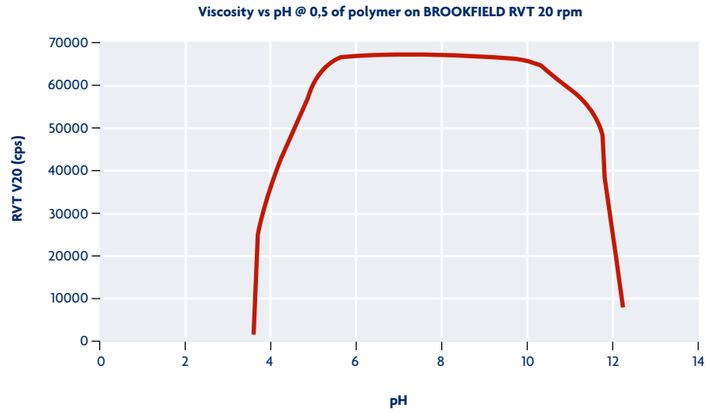
Alcohol Level	Neutralizing agent
0-10%	Hydroxides of sodium, potassium and ammonium
30%	Monoethanolamine
	Triethanolamine
60-80%	Aminomethylpropanol (AMP)
	Triisopropanolamine
	Diisopropanolamine
	Triethylamine
	Triamylamine
90-100%	Fatty amine *(e.g. Ethomeen C-25)*

The same principle holds for thickening organic solvents; an organic amine is recommended. **FLOGEL™ 700** can be used to thicken a variety of polyhydroxy solvents (such as diols, triols and polyols) without a neutralizing agent since the thickening mechanism is hydrogen bonding. In many cases, the use of dual neutralizing agents (inorganic and organic) can be useful for an emulsion system.

GENERAL PROPERTIES OF THE AQUEOUS DISPERSION OF FLOGEL™ 700

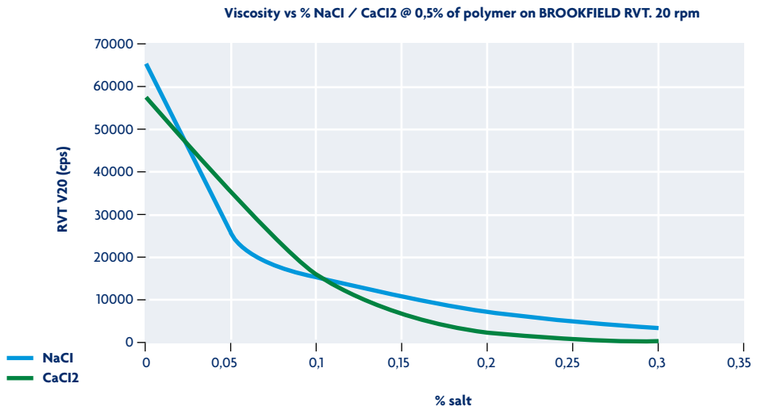
As described above, the viscosity of **FLOGEL™ 700** in water (for example) will increase upon neutralization with a base (such as sodium hydroxide). The relationship of viscosity of an 0.5% aqueous dispersion and pH is depicted in Figure 3. The viscosity of the aqueous dispersion increases as **FLOGEL™ 700** is neutralized, then dispersion viscosity is constant over a range of pH, normally 5-10 (i.e. a flat plateau as shown in Figure 3). With further addition of base (i.e. pH >12), the viscosity of the aqueous dispersion decreases drastically. This effect is due to the presence of excessive ions. Therefore, care must be taken to avoid overshooting the pH in order to maintain the maximum thickening efficiency.

Figure 3: **Effect of pH on viscosity of 0.5% aqueous dispersion**



The neutralized version of **FLOGEL™ 700** (in form of a salt) is in fact a polyelectrolyte. Therefore, the viscosity of its aqueous dispersion will be susceptible to the presence of electrolytes (e.g. an inorganic salt). The effect of mono- and di-valent salts is depicted in Figure 4. The viscosity drops more dramatically for di-valent ions (e.g. calcium chloride) than mono-valent ions (e.g. sodium chloride). Solid precipitation can also occur with of di-valent ions. In industrial practice, the use of a slight excess of **FLOGEL™ 700** or a chelating agent such as EDTA, or both, can overcome the presence of inorganic salts to maintain the thickening efficiency.

Figure 4: **Effect of a salt on the viscosity of the 0.5% aqueous Dispersion of FLOGEL™ 700 at pH 7**



Thickening efficiency increases with increasing concentrations of **FLOGEL™ 700** at specific pH (e.g. 7), as depicted in Figure 5. Generally, the viscosity of aqueous dispersions will experience a slight reduction at high temperatures (e.g. 60-70° C), as shown in Figure 6.

Figure 5: **Effect of FLOGEL™ 700 concentration on viscosity at pH 7**

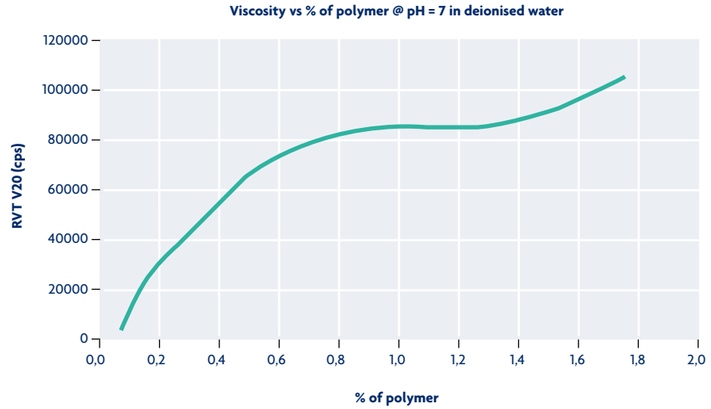
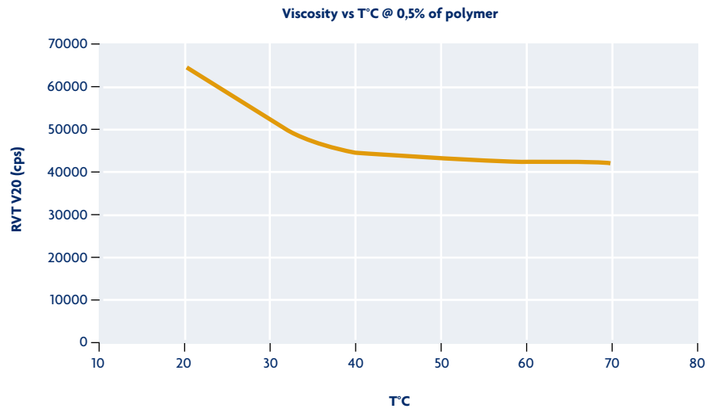


Figure 6: **Effect of temperature on viscosity of the 0.5% aqueous dispersion of FLOGEL™ 700 at pH 7**



Aqueous dispersions of **FLOGEL™ 700** exhibit pseudoplastic behaviour (i.e. the dispersion has a high apparent viscosity at rest but low viscosity under shear stress). Under normal conditions, the dispersion reverts back to its apparent high viscosity when the shear force is removed. This unique rheological property of **FLOGEL™ 700** provides many benefits for various applications such as cling when applied to a vertical surface and non-splashing when poured out from a container.

Yield value is the minimum amount of shear force required to cause a material to flow. Neutralized aqueous dispersions of **FLOGEL™ 700** exhibit a high yield value that is significant for many applications such as imparting stability to suspensions, emulsions, and vertical cling (as mentioned above). The yield value can be approximated with the Brookfield RVT Viscometer by the following equation:

Brookfield yield Value= (Apparent viscosity at 0.5 rpm - Apparent viscosity at 1 rpm)/100

The yield value and the viscosity of aqueous dispersions are the two important factors for providing stability for an emulsion and stability of suspending solid insoluble particles in a medium.

FLOGEL™ 700 Rheology Modifier

HOW TO PREPARE AN AQUEOUS DISPERSION OF FLOGEL™ 700

FLOGEL™ 700 has a high affinity for water and powder particles hydrate very quickly. A device to disperse the **FLOGEL™ 700** powder into water slowly and evenly is required to achieve homogeneous dispersions. Care must be taken to avoid clumps of partially hydrated particles and larger surface-wetted agglomerated particles, which require a long time to disperse (swollen fish-eye particles will be present with insufficient agitation time). Constant agitation is required (a speed of 800-1200 rpm is recommended) while the polymer powder is dispersed. Under proper addition conditions, a homogeneous dispersion (lump free) of **FLOGEL™ 700** can be achieved within two hours. The aqueous dispersion is then ready for subsequent neutralization with a base according to the standard procedure.

Foaming can occur in the preparation of aqueous dispersions of **FLOGEL™ 700**. The foam can be eliminated in many cases by the addition of a small amount of a strong mineral acid (e.g. hydrochloric or phosphoric acid).

The above procedure may also be applied to the preparation of dispersions of **FLOGEL™ 700** in solvents. However, **FLOGEL™ 700** will generally disperse very well in solvents.

For aqueous-solvent systems, it is recommended to disperse **FLOGEL™ 700** in the solvent phase prior to the addition of water (and a base for neutralization) to the medium.

HANDLING, REGULATORY AND SAFETY OF FLOGEL™ 700

FLOGEL™ 700 is supplied in 20 kg cardboard boxes. The polymer is a hygroscopic, fine powder. The containers should be kept tightly sealed to avoid absorption of moisture during storage. Proper industrial precautions must be taken to control dust when handling a chemical in powder form. Further information is provided on the material safety data sheet (MSDS).

FLOGEL™ 700 is a high molecular weight crosslinked poly(acrylic acid). As with other high molecular weight crosslinked polymers, **FLOGEL™ 700** demonstrates low toxicity and low irritation (skin and eye) potentials based on their chemical and physical properties. It also exhibits a low degree of aquatic toxicity.

FLOGEL™ 700 polymer is not biodegradable and does not support the growth of molds. **FLOGEL™ 700** polymer (mainly in neutralized salt form) will be removed with the biomass during a normal wastewater treatment. Therefore, **FLOGEL™ 700** is not expected to pass through a typical wastewater treatment to the environment.

FLOGEL™ 700 polymer is listed in the chemical inventories of the following countries:

- **USA TSCA**
- **European Economic Community EINECS**
- **Canada DSL**
- **Japan MITI**
- **Australia AICS**
- **Korea KICS**

The CTFA/INCI name of **FLOGEL™ 700** polymer for use in personal care and cosmetic applications is carbomer.

APPLICATIONS OF FLOGEL™ 700

FLOGEL™ 700 is an effective rheology modifier for many applications in home care, industrial and institutional (HI&I) cleaning industries, personal care/cosmetics, and others (e.g. solid fuel gels and alkaline batteries). It provides three basic functions:

- Thickening over a wide range of viscosities and imparting desired flow properties
- Stabilizing solid particles in suspension
- Stabilizing an emulsion

a) Home, Industrial and Institutional (HI&I)

Examples of the HI&I applications are:

- Hard surface cleaners
- Dish washing (e.g. automatic dish washing liquid gels.)
- Hand cleaners (e.g. heavy duty hand cleaners and hydroalcoholic hand sanitizing gels)
- Fabric care
- Auto care
- Deicing fluids

b) Personal-care cosmetic applications

The hair care applications include:

- Shampoo
- Hair dye and colors
- Styling products

The skin care applications include:

- Creams and lotions
- Suncreens
- Body washes

c) Miscellaneous

- Solid fuel gels (e.g. gelled ethanol/methanol for cooking and as a fire starter)
- Alkaline batteries

SNF TECHNICAL EXPERTISE AND SERVICES

Customers of SNF have access to our technical staff with expertise in a wide range of polymer chemistries for solutions to their challenges. SNF's customer service team is dedicated to fast responses, the highest quality standards, and on-time delivery requirements. In addition, SNF has sales offices in countries worldwide to meet our customers' demands on a global basis.