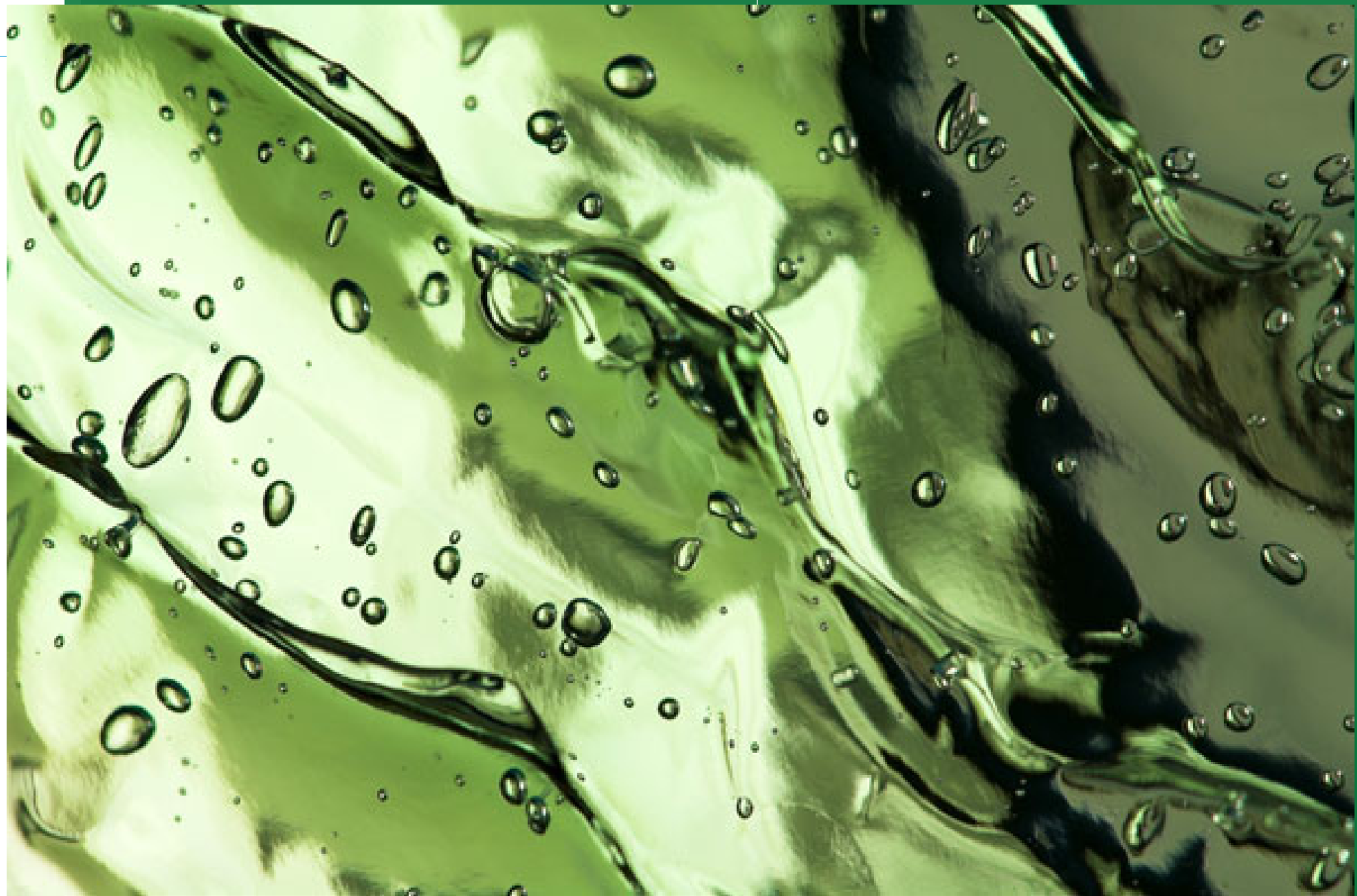

EDGEL 47

Rheology modifier

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The information in this brochure is provided in good faith. To our knowledge it reflects the truth.

EDGEL 47

EDGEL 47 ;

- Is a crosslinked polyacrylic acid . It is supplied in acid-form as a white powder. The typical properties of **EDGEL 47** are shown in Table 1.

- 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).

Table 1: Typical properties of EDGEL 47

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

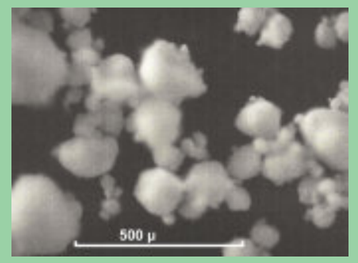


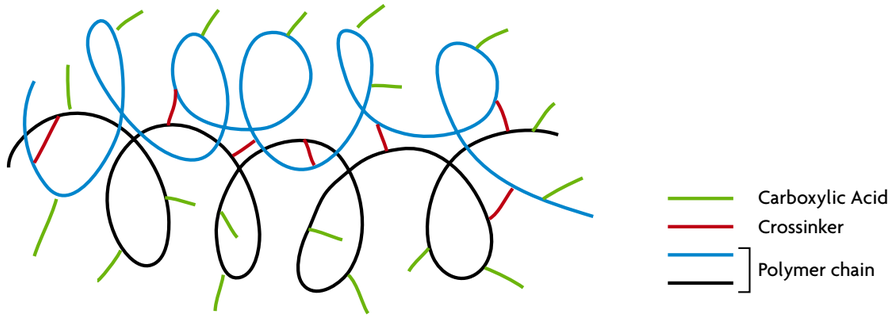
Table 2: Examples of neutralizing agent with the amount of an alcohol in a medium

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. EDGEL 47 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.

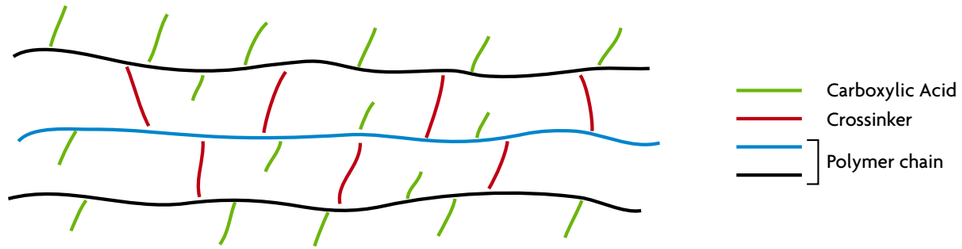
Rheology Modifier

Figure 1: Coiled EDGEL 47



When in contact with water, hydration starts to uncoil the polymer network of EDGEL 47. This results in an increase in viscosity of the aqueous dispersion (EDGEL 47 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).

Figure 2: Uncoiled EDGEL 47



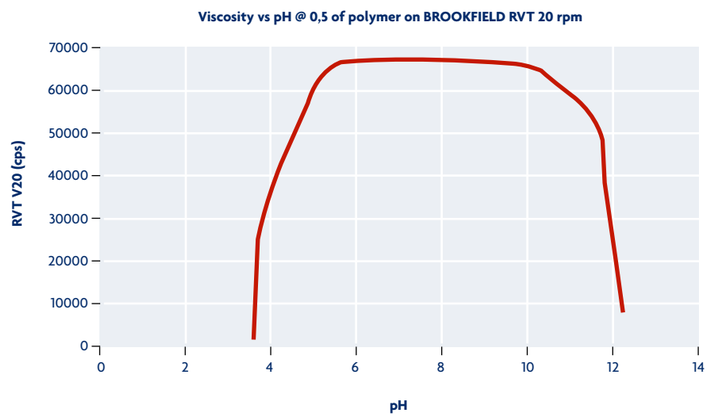
SELECTION OF A NEUTRALIZING AGENT

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).

GENERAL PROPERTIES OF THE AQUEOUS DISPERSION OF EDGEL 47

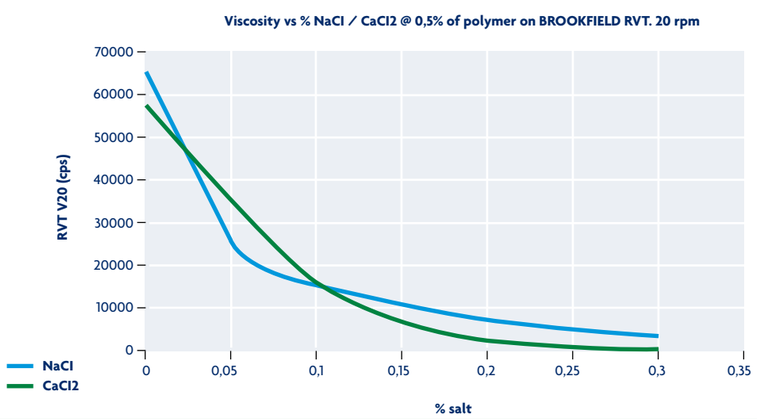
As described above, the viscosity of EDGEL 47 in water (for example) will increase upon neutralization with a base (such as sodium hydroxide). The relationship of viscosity of an 0.5% aqueous dispersion and pH is depicted in Figure 3. The viscosity of the aqueous dispersion increases as EDGEL 47 is neutralized, 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 EDGEL 47 (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 EDGEL 47 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 EDGEL 47 at pH 7



Thickening efficiency increases with increasing concentrations of EDGEL 47 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 EDGEL 47 concentration on viscosity at pH 7

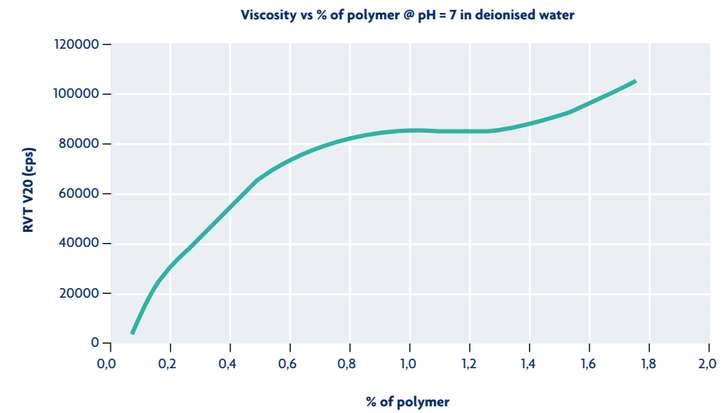
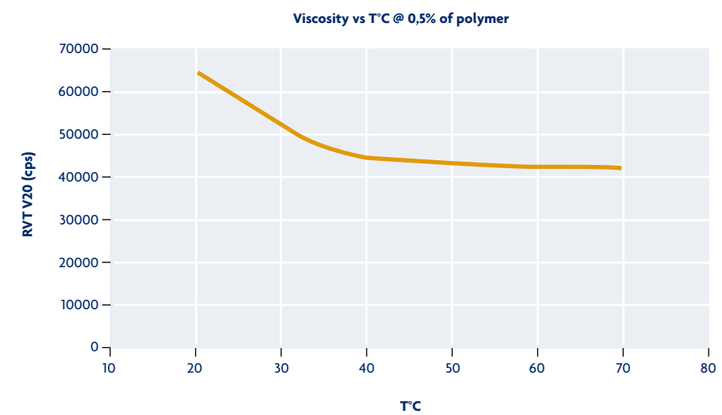


Figure 6: Effect of temperature on viscosity of the 0.5% aqueous dispersion of EDGEL 47 at pH 7



Aqueous dispersions of EDGEL 47 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 EDGEL 47 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 EDGEL 47 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.

HOW TO PREPARE AN AQUEOUS DISPERSION OF EDGEL 47

EDGEL 47 has a high affinity for water and powder particles hydrate very quickly. A device to disperse the EDGEL 47 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 EDGEL 47 can be achieved within two hours. The aqueous dispersion is then ready for subsequent neu-tralization with a base according to the standard procedure.

Foaming can occur in the preparation of aqueous dispersions of EDGEL 47 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 EDGEL 47 in solvents. However, EDGEL 47 will generally disperse very well in solvents.

For aqueous-solvent systems, it is recommended to disperse EDGEL 47 in the solvent phase prior to the addition of water (and a base for neutralization) to the medium.

HANDLING, REGULATORY AND SAFETY OF EDGEL 47

EDGEL 47 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).

EDGEL 47 is a high molecular weight crosslinked poly(acrylic acid). As with other high molecular weight crosslinked polymers, EDGEL 47 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.

EDGEL 47 polymer is not biodegradable and does not support the growth of molds. EDGEL 47 polymer (mainly in neutralized salt form) will be removed with the biomass during a normal wastewater treatment. Therefore, EDGEL 47 is not expected to pass through a typical wastewater treatment to the environment.

EDGEL 47 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 EDGEL 47 polymer for use in personal care and cosmetic applications is carbomer.

APPLICATIONS OF EDGEL 47

EDGEL 47 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

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