

Integrity C940 &  
C940 HC

Rheology  
Modifier



Integrity Ingredients Corporation

"Where Quality and Service Meet"

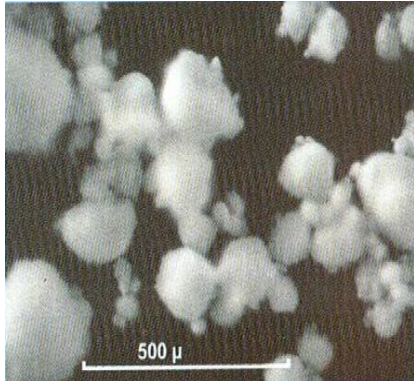
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# INTEGRITY C940 & C940HC

**Integrity C940 & C940HC** are a crosslinked polyacrylic acid. It is supplied in acid-form as a white powder. The typical properties of **Integrity C940 & C940HC** are shown in Table 1.

Table 1: Typical properties of **Integrity C940 & C940HC**

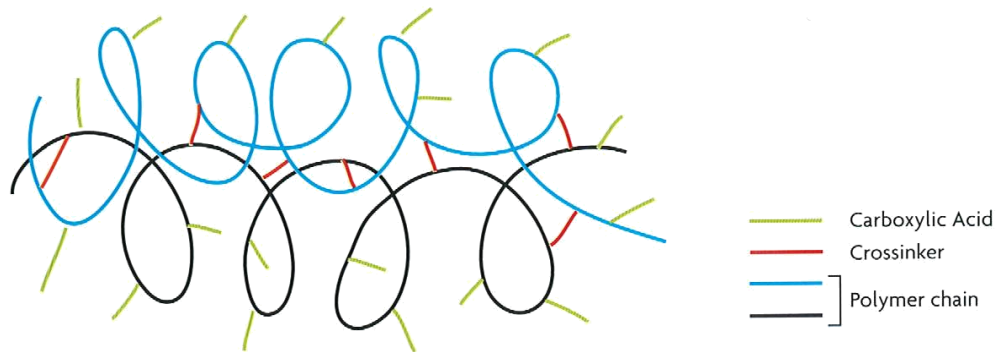


Appearance	White free flowing powder
Odor	Slightly acetic
Loss on Drying	2.0% max
Heavy Metals	10 ppm Max
Viscosity (0.5% solution)	40,000 – 70,000 cps (Brookfield RVT spindle #6, 20 rpm)
pH (0.5% solution)	3 ± 0.5
Clarity % Transmission	Minimum 90% - Integrity C940
Clarity % Transmission	Minimum 96% - Integrity C940HC
Shelf Life	24 months

**Integrity C940 & C940HC** are manufactured via suspension polymerization. The polymeric powder is separated from the polymerization medium, purified and dried to the required specification.

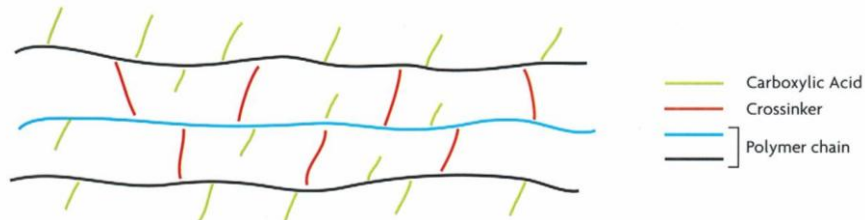
Each particle (about 0.2 micron in diameter with an average agglomerate size of 2-7 microns) is a network structure of polymer chains chemically connected by crosslinks (shown in figure 1).

**Figure 1:** Coiled **Integrity C940 & C940HC**



When in contact with water, hydration starts to uncoil the polymer network of **Integrity C940 & C940HC**. This result in an increase in viscosity of the aqueous dispersion (**Integrity C940 & C940HC** 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 Integrity C940 & C940HC**



### ➤ 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

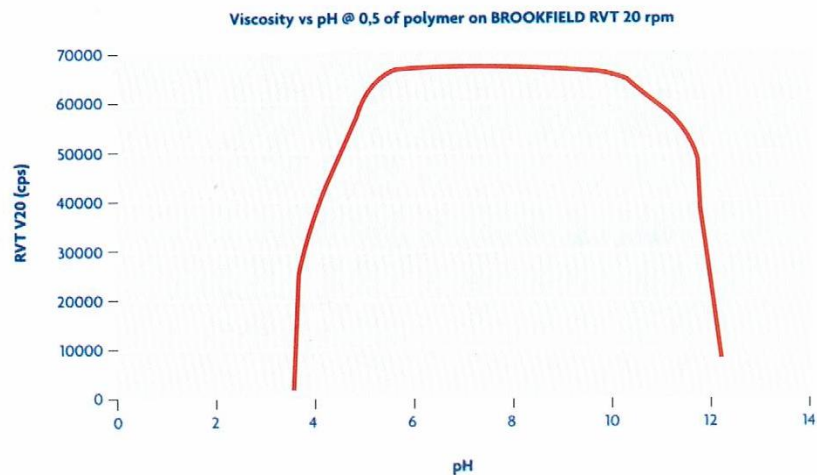
Alcohol Level	Neutralizing agent
0-10%	Hydroxides of sodium, potassium and ammonium
30%	Monoethanolamine
	Triethanolamine
60-80%	Aminomethylpropanol (AMP)
	Triisopropanolamine
	Diisopropanolamine

The same principle holds for thickening organic solvents; an organic amine is recommended. **Integrity C940 & C940HC** 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 Integrity C940 & C940HC

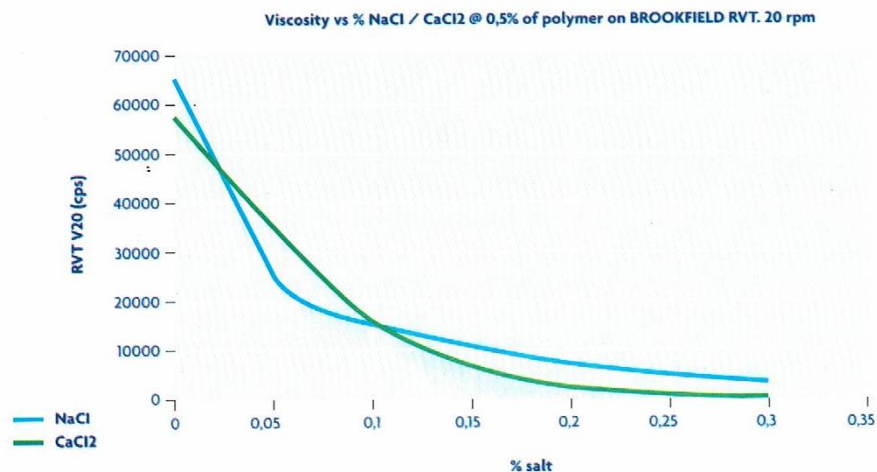
As described above, the viscosity of **Integrity C940 & C940HC** in water (for example) will increase upon neutralization with a base (such as sodium hydroxide). The relationship of the viscosity of a 0.5% aqueous dispersion and pH is depicted in Figure 3. The viscosity of the aqueous dispersion increases as **Integrity C940 & C940HC** are 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



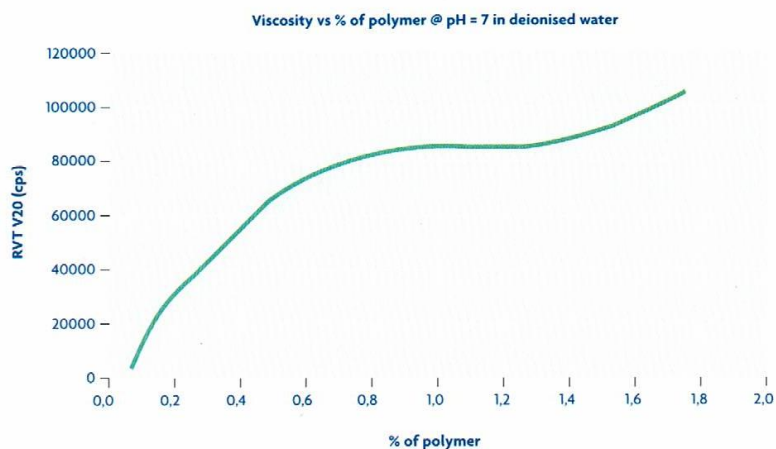
The neutralized version of **Integrity C940 & C940HC** (in form of a salt) are in fact a polyelectrolyte. Therefore, the viscosity of its aqueous dispersion will be susceptible to the presence of electrolytes (e.g. an inorganic salt). The effect of mono- and di-valent salts is depicted in Figure 4. The 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 di-valent ions. In industrial practice, the use of a slight excess of **Integrity C940 & C940HC** 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  
**Integrity C940**  
& **C940HC**  
at pH 7

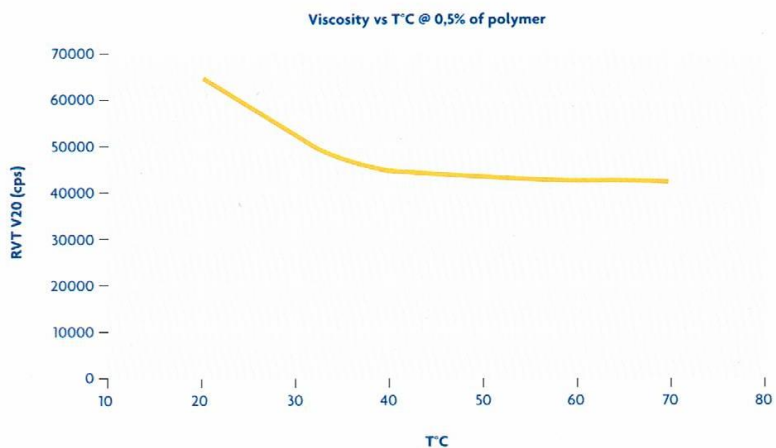


Thickening efficiency increases with increasing concentrations of **Integrity C940 & C940HC** at specific pH (e.g.7) as depicted in Figure 5. Generally, the viscosity of aqueous dispersions will experience a slight reduction at high temperatures (e.g. 60-70° C), as shown in Figure 6.

**Figure 5:**  
Effect of **Integrity C940 & C940HC** Concentration on viscosity at pH 7



**Figure 6:**  
Effect of temperature on viscosity of the 0.5% aqueous dispersion of **Integrity C940 & C940HC** at pH 7



Aqueous dispersions of **Integrity C940 & C940HC** exhibit pseudoplastic behavior (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 **Integrity C940 & C940HC** 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 **Integrity C940 & C940HC** 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:

$$\text{Brookfield yield value} = (\text{Apparent viscosity at 0.5 rpm} - \text{Apparent viscosity at 1 rpm}) / 100$$

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 Integrity C940 & C940HC

**Integrity C940 & C940HC** have a high affinity for water and powder particles hydrate quickly. A device to disperse the **Integrity C940 & C940HC** 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-wetting 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 **Integrity C940 & C940HC** can be achieved within 2 hours. The aqueous dispersion is then ready for subsequent neutralization with a base according to the standard procedure.

The above procedure may also be applied to the preparation of dispersions of **Integrity C940 & C940HC** in solvents. However, **Integrity C940 & C940HC** will generally disperse very well in solvents.

For aqueous-solvent systems, it is recommended to disperse **Integrity C940 & C940HC** in the solvent phase prior to the addition of water (and a base for neutralization) to the medium.

## ➤ Handling, Regulatory and Safety of Integrity C940 & C940HC

**Integrity C940 & C940HC** are 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).

**Integrity C940 & C940HC** are a high molecular weight crosslinked poly(acrylic acid). As with other high molecular weight crosslinked polymers, **Integrity C940 & C940HC** 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.

**Integrity C940 & C940HC** polymers are not biodegradable and do not support the growth of molds. **Integrity C940 & C940HC** polymer (mainly in neutralized salt form) will be removed with the biomass during a normal wastewater treatment. Therefore, **Integrity C940 & C940HC** are not expected to pass through a typical wastewater treatment to the environment.

The INCI name of **Integrity C940 & C940HC** polymer for use in personal care and cosmetic applications is carbomer.

## ➤ Applications of Integrity C940

**Integrity C940 & C940HC** are an effective rheology modifier for many applications in home care, industrial and institutional (HI&I) cleaning industries, personal care/cosmetics and other (e.g. solid fuel gels and alkaline batteries).

It provides 3 basic functions:

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

### 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

### Personal Care / Cosmetics

**The hair care applications include:**

- ✓ Shampoo
- ✓ Hair dye and colors
- ✓ Styling products

**The skin care applications include:**

- ✓ Creams and lotions
- ✓ Sunscreens
- ✓ Body washes

### Miscellaneous

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

## ➤ Integrity Ingredients Corporation Expertise and Services

Customers of Integrity Ingredients Corporation have access to our technical staff with expertise in a wide range of polymer chemistries for solution to their challenges. Integrity Ingredients Corporation's customer service team is dedicated to fast responses, the highest quality standards and on-time delivery requirements.

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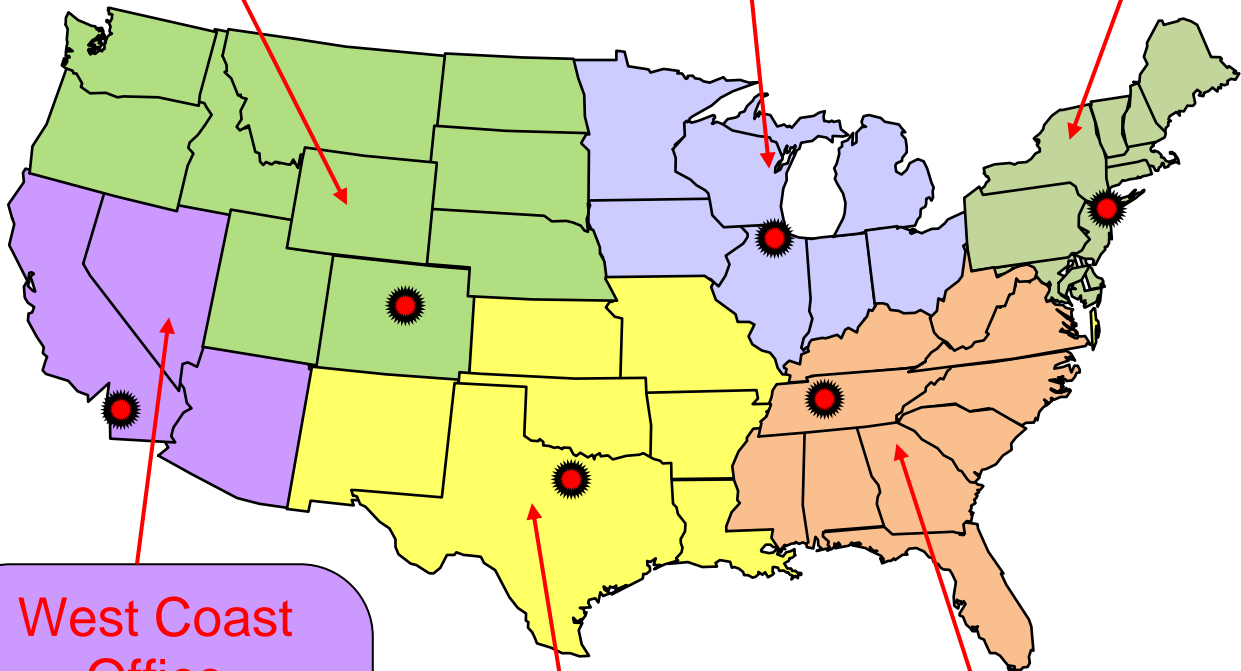
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