

Structure[®] 2020 Polymer

Polymer thickener for alcohol-based hand sanitizers

INCI name: Acrylates Crosspolymer-6

Key benefits

- Effective thickening of ethanol and 2-propanol based hand sanitizers
- Structure 2020 is a low viscosity, white liquid emulsion of 30% actives - easily pumpable
- Thickener product is non-hazardous and carries no warning label
- Product mixes easily into the target alcohol
- Liquid emulsion thickener allows quicker formulation than when using solids typically used, avoiding lengthy hydration and high shear preparation methods
- The emulsion viscosifies and clears upon the addition of alkaline neutralizing agents (such as TEA or AMP) - the resulting viscosified alcohol is water white
- Formulated product rheology matches that of market leading technologies
- Formulated systems are both viscous and elastic – air bubbles can be held inside the gel
- Typical dosage 3-5% active in 70% ethanol. Similar dosage also viscosifies 2-propanol solutions
- Formulated gel provides good viscous pump dispenser action, spreads easily on hands, providing a luxurious handfeel with rubbing. It dries quickly leaving hands feeling soft
- Patent pending

Clear thickened gels from liquid emulsion polymers

Structure 2020 is a high molecular weight alkali-swellable polyacrylate emulsion polymer product. It is sold as a stable white, milk-like emulsion in water (figure 1). Alkali swellable emulsions are activated upon addition of an alkaline neutralizing agent, which causes the emulsion to break (become clear) and viscosify (figure 2). Structure 2020 acts as an excellent thickener for ethanol and 2-propanol solutions typically used for hand sanitizing applications. Clear solutions are a desirable consumer property.

Figure 3 shows clarity data for Structure 2020 solutions in both ethanol and 2-propanol compared with the market leading clear formula.

Figure 1. Structure 2020 emulsion polymer as sold

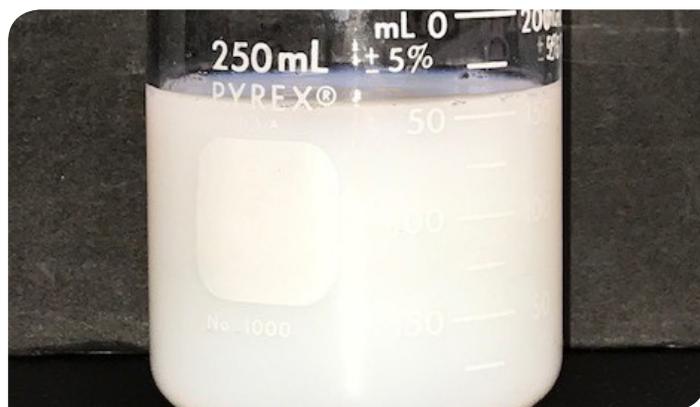


Figure 2. Clear hand sanitizer gel formulated with Structure 2020 – 16.6% Structure 2020 (5% total active) in 70% ethanol



Figure 3. Clarity of formulated hand sanitizer gels using 5% total active Structure 2020 using ethanol and 2-propanol, compared with the market leader

Formulated hand sanitizer gel	Clarity (NTU)
70% ethanol with Structure 2020	7.5
70% 2-propanol with Structure 2020	11
Leading commercial brand	5.3

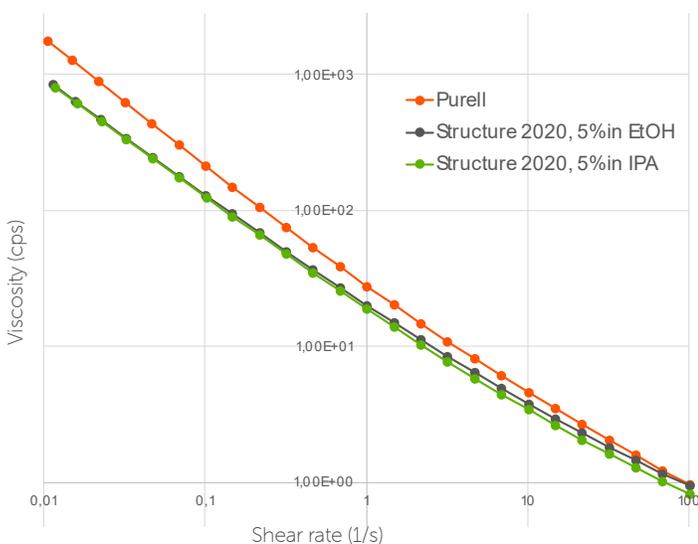
It has been observed that the use of higher alcohol concentrations than 70% may lead to higher turbidity when using Structure 2020 in the final gel.

Rheology of formulated hand sanitizers using Structure 2020

The flow characteristics of a hand sanitizer over a variety of shear conditions are an important component of the consumer experience with a clear alcohol-based hand sanitizers. This includes high shear environments such as during pump dispensing and hand rubbing, to low shear environments, such as shelf appearance and initial texture post dispersing. Structure 2020 is developed to follow very similar rheological properties to the leading 70% ethanol-based hand sanitizers on the market today as shown in figure 4. This rheological behavior should mean that Structure 2020 formulated hand sanitizers meet customer expectations when formulated and applied.

Determination of the preferred rheology of the finished sanitizing gel rheology depends upon the customer expectation, alcohol selected and concentration of the alcohol in the final formulation. Our studies show that suitable gels can be created in concentrations between 3 and 5% active. As Structure 2020 is 30% active, this means a dose range of between 10 and 16.6% as sold product.

Figure 4. Anton Paar measurement of the 16.6% Structure 2020 formulation in ethanol (grey line), in 2-propanol (red line) when compared with the leading consumer product (black line)



Ease of thickener formulation

Most gelled hand sanitizers today use high molecular weight powder polymer thickeners during production. These powders are difficult to disperse and take a long time to hydrate, leading to elongated batch times requiring specialty equipment. Structure 2020 is a 30% active liquid emulsion polymer, meaning it requires no specialty production equipment. It can be easily pumped into mixing tanks and vessels, and quickly disperses into ethanol/2-propanol without the need for extreme shear. Because it is a lower activity liquid, a larger volume is required to provide thickening. Care should be taken to include the 70% water included in the product when calculating the formulation requirements (see below for framework formulations).

Method of alcohol-based hand sanitizer gel preparation

Please follow all appropriate safety measures when dealing with hand sanitizer production. Although Structure 2020 has no hazard label or warnings, the main alcohol component in the hand sanitizer and the finished product formulations are flammable.

- Charge the chosen alcohol and any desired glycerine to the preparation vessel and stir
- Charge the desired amount of Structure 2020 to the dose tank adding any additional make up water to the Structure 2020 emulsion rather than to the alcohol charge
- Note that Structure 2020 contains 70% water, and this water should be used when calculating the desired alcohol concentration of the finished hand sanitizer gel
- Charge the diluted Structure 2020 into the alcohol, mixing well until the solution is homogenous
 - Note that the emulsion may appear to flocculate during the initial charge, but this dissipates with stirring
- Add the chosen alkaline neutralizing agent - triethanolamine (TEA) or aminomethyl propanol (AMP) - see below guidance on the amounts to be added
 - Formulation pH should be brought above pH 7
 - Note that ionic neutralizing agents (i.e. NaOH) are not suitable for this system
- The addition of the neutralizing agent will cause the emulsion to break (removing the milky appearance) and cause the solution to viscosify
 - Caution should be taken to minimize air entrainment if bubbles are not desired in the end formulation
- Continue stirring until homogenous
- Dispense and pack

For other components required in the formulation, a best practice guideline is to add more-hydrophobic ingredients into the alcohol charge, and more hydrophilic components in with Structure 2020. It is advised to avoid formulating electrolytes into the system due to impacts on gel rheology, and drying effect on the hands.

Neutralizing agent dosing guidance

To initiate viscosification of Structure 2020, an alkaline neutralizing agent needs to be added to the alcohol solution containing the dilute emulsion. The acid number of the Structure 2020 emulsion is 1.26×10^{-3} mol COOH/g.

To achieve pH 7.1-7.5 in the finished gel, the following guideline dosage should be used for two recommended organic neutralizing agents:

Per gram of Structure 2020 added, 0.38g of 50% aminomethyl propanol (50% AMP) should be added

Per gram of Structure 2020 added, 0.32g of triethanolamine (TEA) should be added

Framework formulations

To prepare effective hand sanitizers from ethanol or 2-propanol, the following formulations are provided for guidance, giving the viscosity, pH and clear appearance as described below. Modification of some of the ingredient's concentrations will modify the properties of the gel. So too, addition of other ingredients that might be included in the formulation i.e. perfume, color etc.

Ethanol based hand sanitizer – 5% active Structure 2020

Ethanol	70%
Glycerol	0.5%
Structure 2020	16.6% (5% total active)
Water	11%
Aminomethyl propanol	1.9% (50% solution)
Resulting viscosity (Brookfield Sp 5, 20 RPM, 20°C)	6400 cps
Resulting pH	7.5
Resulting appearance	clear

2-Propanol based hand sanitizer

2-Propanol	70%
Glycerol	0.5%
Structure 2020	16.6% (5% total active)
Water	11%
Aminomethyl propanol	1.9% (50% solution)
Resulting viscosity (Brookfield Sp 5, 20 RPM, 20°C)	5600 cps
Resulting pH	7.4
Resulting appearance	clear

The amount of Structure 2020 can be varied to meet desired properties.

Physical properties of Structure 2020

Structure 2020 is an emulsion polymer. It is not stable to freeze/thaw cycles and must be maintained above freezing prior to use. Please consult the material safety data sheet for guidance and handling.

Product specifications

Specification	Parameter Limits
Solids	29-31%
pH	2.2-3
Viscosity (cP)	10,000-15,000 (pH 9.0, NaOH, 25°C, 10 rpm), 2.5% (dry)

Other typical data (not specifications)

Chemical and physical data	Typical Value
Appearance	white Emulsion at 20°C
Density	8.82 lbs/US gal. at 25°C
Specific Gravity	1.06 g/cc at 25°C
Viscosity	<200 cps at 25°C



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