

# How to Prepare Aqueous Dispersions of Carbopol<sup>®\*</sup> Polymers

## Dispersion

Although their application is not limited to aqueous systems, the Carbopol<sup>®</sup> polymers owe much of their exceptional utility to their hydrophilic nature, or affinity for water. A single particle of Carbopol<sup>®</sup> will wet out very rapidly when put in water. Like many other powders, Carbopol<sup>®</sup> polymers tend to form clumps of particles when haphazardly dispersed in polar solvents. The surfaces of these clumps solvate, forming a layer which prevents rapid wetting of the clump interiors. When this happens, total mixing time is governed by the slow diffusion of solvent through this solvated layer to the dry interior. Therefore, formation of lumps must be avoided to prevent excessively long mixing cycles.

## Dry Addition of Carbopol<sup>®</sup> Polymers

The simplest way to achieve complete dispersion of a Carbopol<sup>®</sup> polymer is to take advantage of its small particle size. This advantage is lost if the Carbopol<sup>®</sup> is added too fast. Add the Carbopol<sup>®</sup> slowly and carefully to the dispersion medium while the mix is being stirred rapidly. Any device that will sprinkle the Carbopol<sup>®</sup> powder as discrete particles is useful. For example, something as simple as a coarse sieve containing a few large pebbles is very useful for making large batches. The sieve permits rapid sprinkling and, at the same time, breaks up any loose polymer agglomerates.

See Technical Data Sheet 103 for information on use of the other production scale dispersion techniques for introducing Carbopol<sup>®</sup> polymers into water.

## Agitation

Agitation enhances the rate of Carbopol<sup>®</sup> solvation. In general, higher shear rates disperse Carbopol<sup>®</sup> polymers most rapidly. Extremely high-shear mixers should be carefully employed because they can break down the polymers, resulting in permanent viscosity loss. In some cases, this loss can be as high as 50 percent. Conventional impellers such as propellers or turbines do not impart excessively high shear rates. They can be used to mix mucilages for extended periods with virtually no decrease in polymer efficiency.

Moderate agitation equipment (800-1200 rpm) is most commonly available. Here, the primary consideration is to incorporate Carbopol<sup>®</sup> polymers slowly and carefully so that large, partially-wet agglomerates do not form. Mixers such as the Eppenbach, Barrington or Lightnin' Mixer are well suited for the preparation of Carbopol<sup>®</sup> mucilages.

In cases where the Lightnin' Mixer is employed, the use of two impellers on a common shaft is recommended. The lower impeller should be about 1/4 liquid depth off the bottom, and the top impeller about 1/4 liquid depth below the surface. Position the mixer in the tank so that a vortex of one to one-and-one-half impeller diameters is generated. The top impeller will disperse the Carbopol<sup>®</sup> polymer rapidly before undesirable, half-hydrated, hard-to-disperse lumps can form.

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Use of a variable drive motor is recommended. If the mixer cannot be repositioned to avoid vortexing, the vortex can be minimized by reducing mixer speed during the initial stages of neutralization. As neutralization continues and the mix begins to thicken, a variable drive motor can be run at progressively higher speeds. The increasing viscosity decreases the tendency to vortex formation.

### **Dispersions in Non-Solvents: The Indirect Addition Method**

The recommended method of incorporating Carbopol® polymers is to premix them in a non-solvent. Carbopol® polymers can be easily dispersed, for instance, in the oil phase of emulsions. Many oils and solvents may be used successfully to make readily-pourable 30 percent dispersions of Carbopol® polymers. When such non-solvent dispersions are added to the aqueous phase, which must contain the necessary neutralizing agent, normal thickening occurs.

When dispersing Carbopol® polymer in the oil phase, mix until a smooth, homogenous dispersion is reached.

Using moderate to vigorous agitation (800-1200 rpm), add the oil phase containing Carbopol® polymer to the water phase. The water phase should contain an appropriate neutralizing base.

Continue to mix for 15-20 minutes until the Carbopol® polymer has swelled to produce a smooth emulsion.

### **The Direct Addition Method**

In the presence of some polar oils (aromatic or dicarboxylic acid esters) or molten oils above 60°C, Carbopol® will physically plasticize, hindering stable emulsion formation. In these cases, dispersing Carbopol® polymer directly into the water will result in a smooth, stable emulsion.

Begin by mixing the water with moderate agitation (800-1200 rpm). Very slowly sift the Carbopol® polymer into the vortex. Before adding the dry Carbopol® polymers to the tank, break up any lumps that have formed in the polymer due to static electricity or humid conditions. Continue agitation until a thin, cloudy solution without lumps is attained.

Continue agitation while pouring in the oil phase. Mix until particle size is reduced and a glossy product is obtained. Neutralize with a suitable base.