

# Colloidal Silica Dispersions

## Description

Colloidal silicas are over 99% pure silicon dioxide. The products manufactured by Cabot Corporation (CAB-O-SIL<sup>®</sup>) and Degussa AG (Germany) are made by burning silicon tetrachloride in the presence of water vapor to produce a pure colloidal silicon dioxide (fumed silica) with a particle size range of 10 to 20 nanometers. CAB-O-SIL has been cleared for use in food and drug applications up to specified levels. Some of the many uses of these products are listed below:

Paper Coatings  
Ceramic Binders  
Grease Viscosity Controller  
Textile Treatments  
Pigment Suspending Agent  
Thixotropic Thickener

Film Coatings  
Cosmetic Thickening Agent  
Battery Acid Thickener  
Pharmaceutical Suspending Agent  
Rubber Reinforcement  
Antifoams/Defoamers

The thickening and thixotropic effect of the silica will depend upon the nature of the liquid, the concentration of silica, the types of other additives and the degree of dispersion. Specifically, non-polar liquids (e.g., aliphatic hydrocarbons or mineral oil) require lesser amounts of colloidal silica to produce a given viscosity increase than do polar liquids (e.g., water or alcohol). The thickening effect of the silica particles is due to these particles bonding to each other forming a lattice network. In polar liquids, the particles will hydrogen bond to the molecules of the liquid reducing the desired lattice formation. In all types of liquids, the quantity of silica required can be reduced by the addition of certain additives. The manufacturer of the silica should be consulted for a more detailed description of these phenomena. The final factor is the degree of dispersion. In non-polar liquids, the viscosity continuously increases with increasing shear. In moderately polar liquids, the viscosity increases to a peak and then drops off to a plateau as the shear level is increased. In polar liquids the viscosity decreases, until it reaches a plateau (as the shear level is increased). Note: As for any thixotropic material, only relative viscosity data taken under identical conditions has any significance.

## Equipment and Process

High-shear mixers, colloid mills and homogenizers are all used in the preparation of colloidal silica dispersions. The proper dispersing equipment will depend upon the polarity of the liquid, the nature of any additives and the final viscosity desired.

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In general, polar systems (e.g., aqueous systems) require a homogenizer to produce the energy needed to reach the low-viscosity plateau. Non-polar systems (e.g., greases) can use either a colloid mill or a homogenizer, depending upon the amount of viscosity buildup required. Moderately polar systems (e.g., polyester resin systems) normally use a high-shear mixer to avoid over-shearing the silica and going beyond the maximum viscosity peak. The required pressure rating of the homogenizer will vary according to the exact application but will normally be up to 5000 psi.

### Testing

Viscosity determinations are generally made with a Brookfield viscometer at a low and a high speed to determine the degree of thixotropy. The readings are repeated after 24 hours and 7 days to indicate stability. Again, only relative values measured under identical conditions are relevant. For clear liquids visual examination after shelf-aging for 24 hours to 7 days will frequently show whether the colloidal silica has been completely dispersed. Initially, the dispersion may look uniform and transparent; but if the dispersion is not complete, it will show a gel agglomeration at the bottom of the container on standing.

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