



Distributed in the Interest
of Product Development

VANDERBILT

Presentation

An Introduction to Suspension Concentrates

R.T. Vanderbilt Company, Inc.

30 Winfield Street, P.O. Box 5150, Norwalk, CT 06856-5150

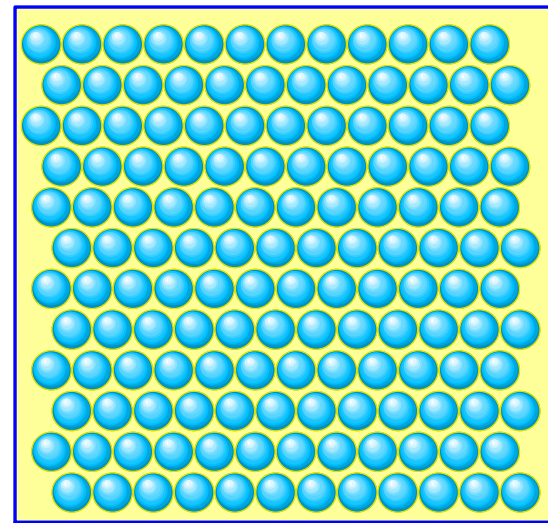
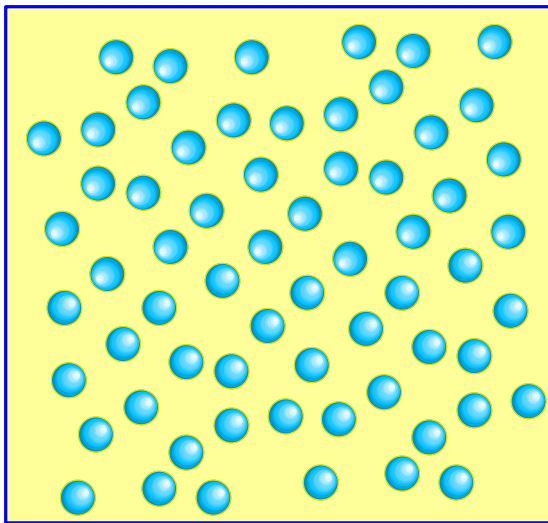
Telephone: (203) 853-1400, Fax: (203) 853-1452, Web Site: www.rtvanderbilt.com

Before using, read, understand and comply with the information and precautions in the Material Safety Data Sheets, label and other product literature. The information presented herein, while not guaranteed, was prepared by technical personnel and, to the best of our knowledge and belief, is true and accurate as of the date hereof. No warranty, representation or guarantee, express or implied, is made regarding accuracy, performance, stability, reliability or use. This information is not intended to be all-inclusive, because the manner and conditions of use, handling, storage and other factors may involve other or additional safety or performance considerations. The user is responsible for determining the suitability of any material for a specific purpose and for adopting such safety precautions as may be required. R.T. Vanderbilt Company, Inc. does not warrant the results to be obtained in using any material, and disclaims all liability with respect to the use, handling or further processing of any such material. No suggestion for use is intended as, and nothing herein shall be construed as, a recommendation to infringe any existing patent, trademark or copyright or to violate any federal, state or local law or regulation.

An Introduction to

Suspension Concentrates

30% to 70% Suspension of Fine Insoluble Particles
Pesticides, Biocides, Chemicals, Abrasives, Pigments

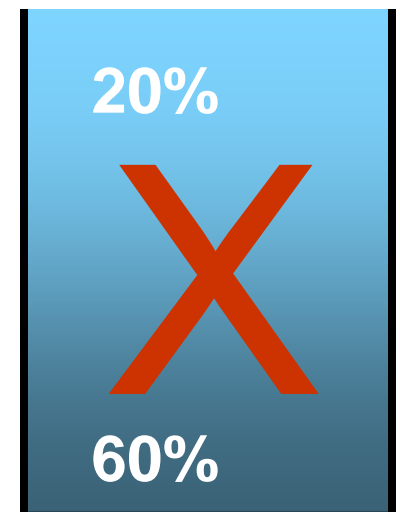
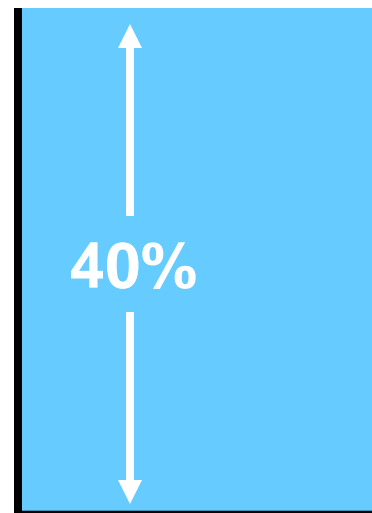


Suspension Concentrates

Formulation Goals:

- **Maximize Suspension Uniformity and Stability**
- Minimize Viscosity / Optimize Fluidity
- Optimize Dilutability

The suspended particles need to be uniformly dispersed throughout the liquid to ensure that the correct “dose” is delivered when a prescribed amount of concentrate is added to water or a target formulation.

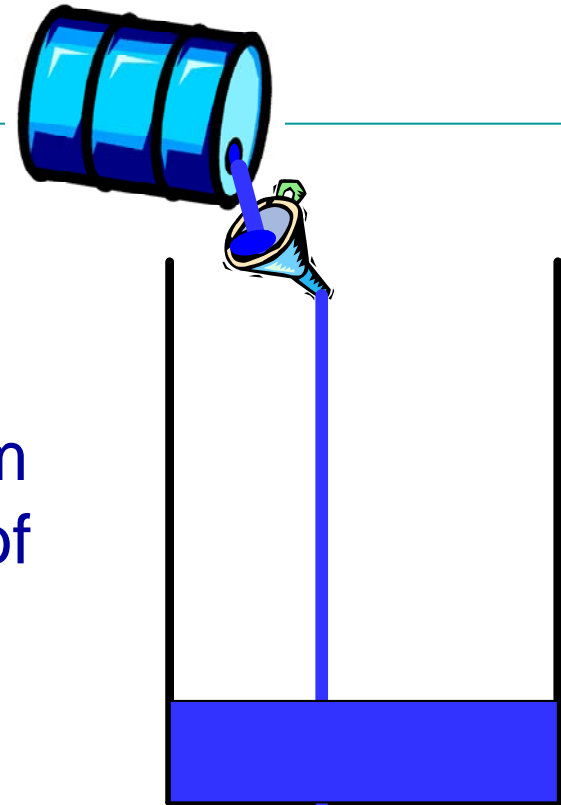


Suspension Concentrates

Formulation Goals:

- Maximize Suspension Uniformity and Stability
- **Minimize Viscosity / Optimize Fluidity**
- Optimize Dilutability

A readily pourable or pumpable concentrate is usually preferred to facilitate addition to the target medium and to ensure maximum evacuation of the concentrate's container.

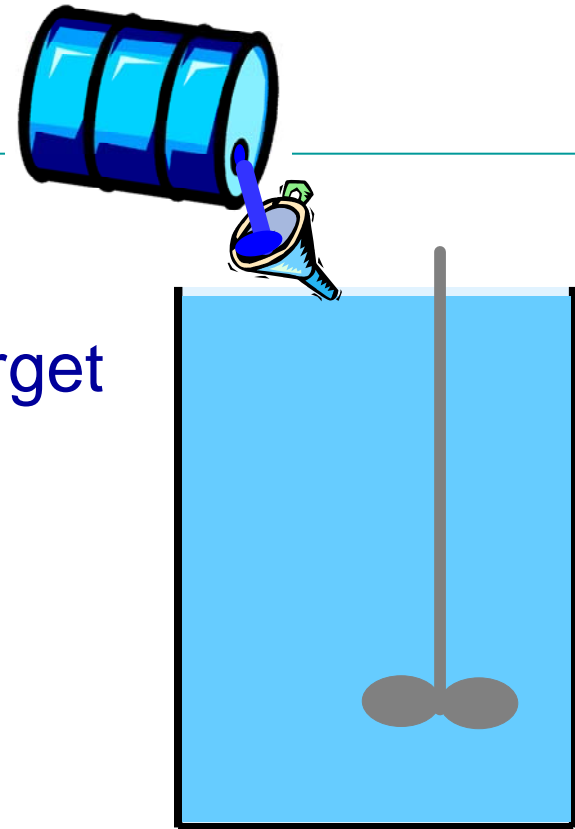


Suspension Concentrates

Formulation Goals:

- Maximize Suspension Uniformity and Stability
- Minimize Viscosity / Optimize Fluidity
- **Optimize Dilutability**

When added to dilution water or a target formulation, the concentrate should disperse evenly and uniformly.



Suspension Concentrates

Basic Ingredients:

Water

Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

Water may be from the local supply or softened to reduce reaction of hardness (Mg, Ca, Fe) with wetting and dispersing agents.



Suspension Concentrates

Basic Ingredients:

Water

Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

There are usually particle size requirements to ensure proper bioactivity, chemical activity, color strength, etc.

If the particles are pre-milled to the required size, they are simply dispersed in the liquid phase. For toxic actives, a coarser size is often used; milling and suspension formation are simultaneous in a media mill.



Suspension Concentrates

Basic Ingredients:

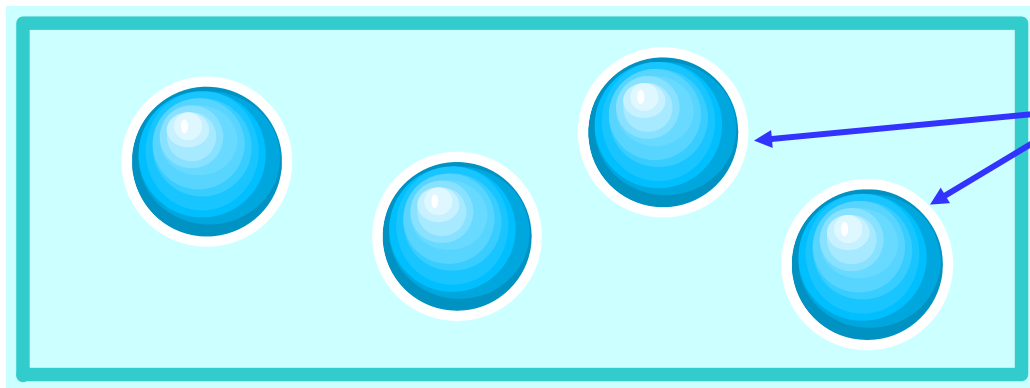
Water

Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

Most fine particles are not easily wet by water because of occluded air and/or natural hydrophobicity. This is a particular problem at high concentrations.



dispersed, but not wet



Suspension Concentrates

Basic Ingredients:

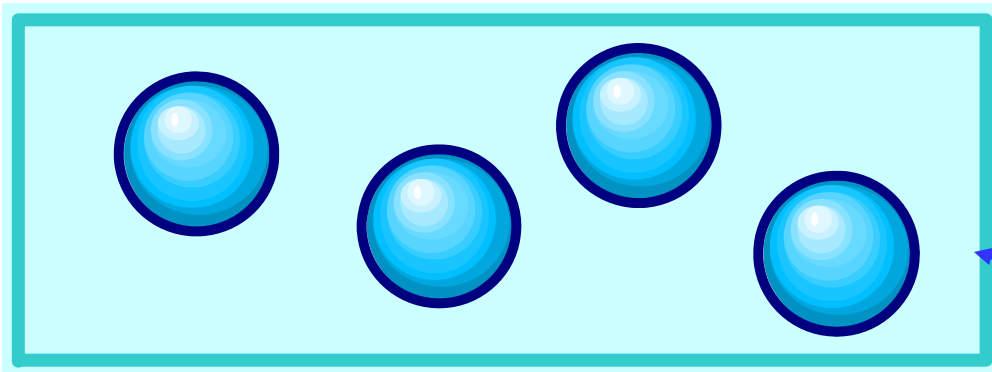
Water

Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

The wetting agent molecule has a portion with an affinity for the particle surface and a portion with an affinity for water. It facilitates intimate contact of the liquid with particle surfaces.



Wetting agents for concentrates are usually nonionic surfactants.

well wet



Suspension Concentrates

Basic Ingredients:

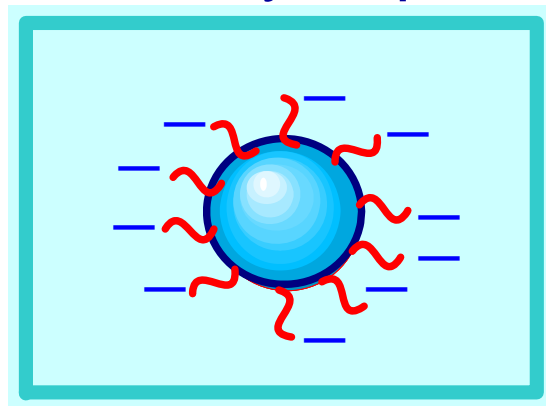
Water

Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

The dispersant keeps the wetted particles separated and mutually repulsed. Most are anionic: one portion has an affinity for the particle, and the hydrophilic anionic group extends into the water.



Suspension Concentrates

Basic Ingredients:

Water

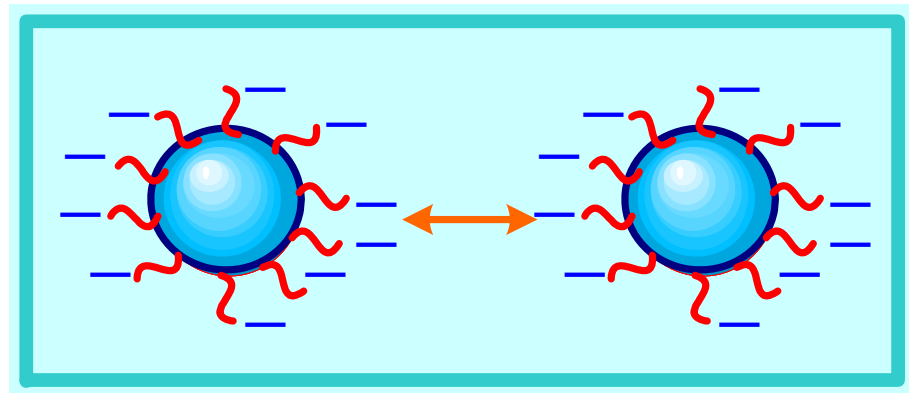
Insoluble Particles (pigment, biocide, etc.)

Wetting Agent

Dispersing Agent

The now negatively charged particles repel each other, so their movement through the liquid (or the liquid past them) is not impeded – viscosity is minimized.

Dispersing agents are generally poor wetting agents, but some wetting agents are also dispersants.



Suspension Concentrates

Often Included Ingredients:

Antifreeze (glycol)

Evaporation Control Additive (glycol)

Preservative

Antifoam

Suspending Agent(s)

A glycol, e.g. propylene glycol, is added to depress the freezing point if the dispersion will be stored or transported in a sub-freezing environment.



Suspension Concentrates

Often Included Ingredients:

Antifreeze (glycol)

Evaporation Control Additive (glycol)

Preservative

Antifoam

Suspending Agent(s)

A glycol is added to retard surface evaporation and skinning if it is likely that the container of concentrate will be left uncovered for extended periods during normal use.



Suspension Concentrates

Often Included Ingredients:

Antifreeze (glycol)

Evaporation Control Additive (glycol)

Preservative

Antifoam

Suspending Agent(s)

A preservative is used when the concentrate's organic ingredients (wetting agent, dispersant, suspending agent) are susceptible to degradation by bacteria or fungi.



Suspension Concentrates

Often Included Ingredients:

Antifreeze (glycol)

Evaporation Control Additive (glycol)

Preservative

Antifoam

Suspending Agent(s)

The surfactants used as wetting agents are often sufficiently surface active to form air bubbles in the concentrate, which suspending agents can make difficult to remove. An antifoam is used to inhibit bubble formation.



Suspension Concentrates

Often Included Ingredients:

Antifreeze (glycol)

Evaporation Control Additive (glycol)

Preservative

Antifoam

Suspending Agent(s)

Some dispersions are made without a suspending agent because the particle size is extremely fine, the concentration is very high, or the viscosity is high.

The rest rely on suspending agents for optimum stability.



Suspending Agent(s)

A suspending agent will impart yield value to the dispersion: the insoluble particles remain separated and suspended. A suspending agent is usually a thickener as well, but not all thickeners are suspending agents.

<u>Suspending Agent</u>	<u>Thickener</u>
Smectite Clay VEEGUM®, VAN GEL® Magnesium Aluminum Silicates	CMC
Xanthan Gum VANZAN® Xanthan Gum	Nonionic Cellulosics
Attapulgate	Polyacrylates
Crosslinked Polyacrylates	

Combinations of suspending agents (smectite + xanthan gum) or suspending agent and thickener (smectite + CMC) are synergistic and can be more effective in balancing suspension stability, fluidity and cost. A synergistic combination can also provide processing advantages.





SUSPENDING AGENTS

VAN GEL[®]
Magnesium Aluminum Silicate

VEEGUM[®]
Magnesium Aluminum Silicate

VAN GEL B	The standard economical grade for most suspensions
VAN GEL ES	The most electrolyte tolerant grade
VEEGUM	The standard grade for a wide range of applications
VEEGUM CER	Smectite clay/CMC blend; high efficiency stabilizer
Several additional grades are available to match formulation requirements.	

VANZAN[®]
Xanthan Gum

VANZAN	The general purpose grade suitable for most applications
VANZAN D	Surface-treated to facilitate dispersion without lumping



DISPERSING AGENTS

DARVAN[®]
Dispersant

DARVAN 2	Sodium lignosulfonate
DARVAN 670	Sodium polynaphthalenesulfonate
DARVAN 7-N	Sodium polymethacrylate
DARVAN 811	Sodium polyacrylate
DARVAN 821A	Ammonium polyacrylate

Several additional grades are available to match formulation requirements.

Making Suspension Concentrates

Wet-Mill Method

Dispersion Method



Making Suspension Concentrates

Wet-Mill Method

Dispersion Method

Water, wetting agent, dispersant, coarse particles and all other ingredients that are not shear degradable are added to a media mill: Attritor[®] (pictured), ball mill, bead mill, sand mill.

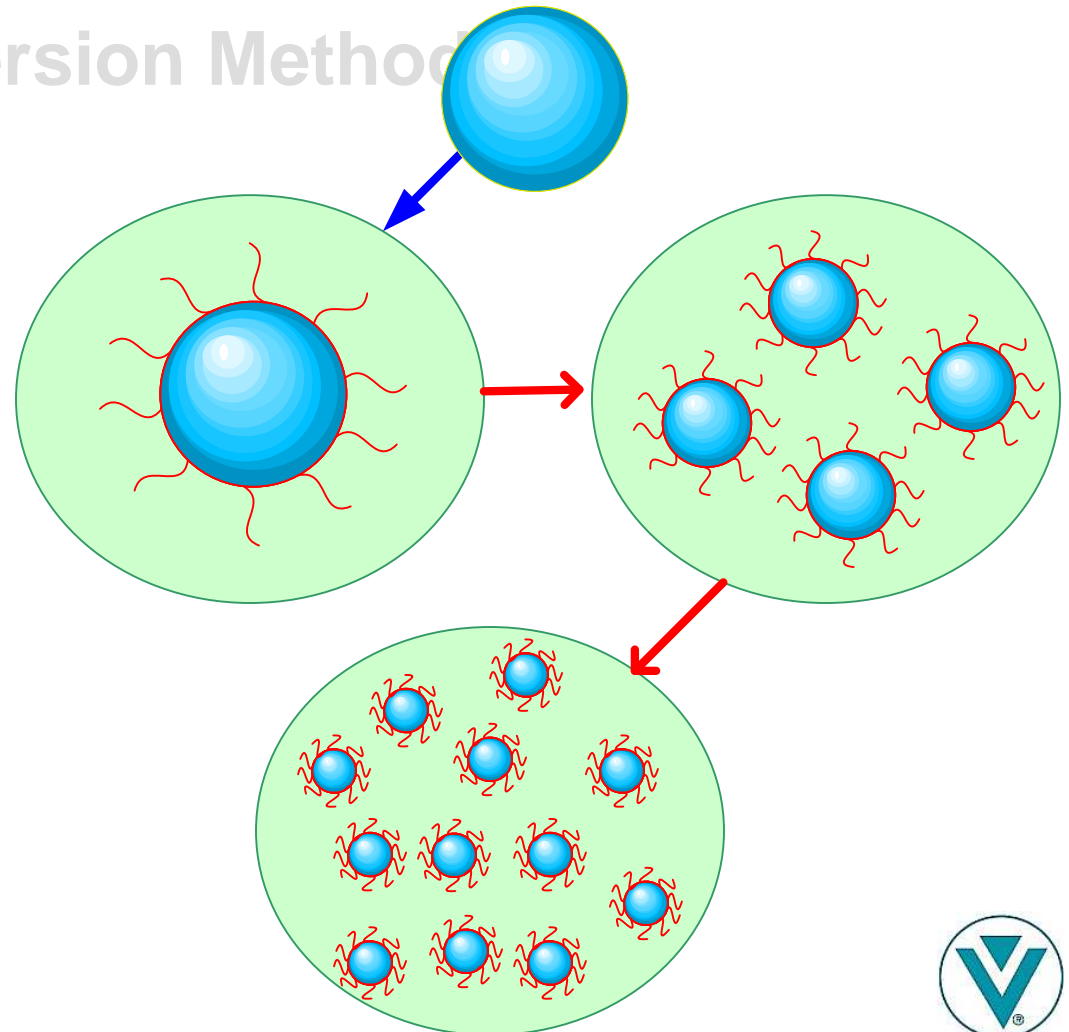


Making Suspension Concentrates

Wet-Mill Method

Dispersion Method

The suspension is formed as the particles are milled to the required size. Shear degradable ingredients, particularly any that will increase viscosity (e.g., xanthan gum) are added at the end of the process with only enough milling to dissolve them.



Making Suspension Concentrates

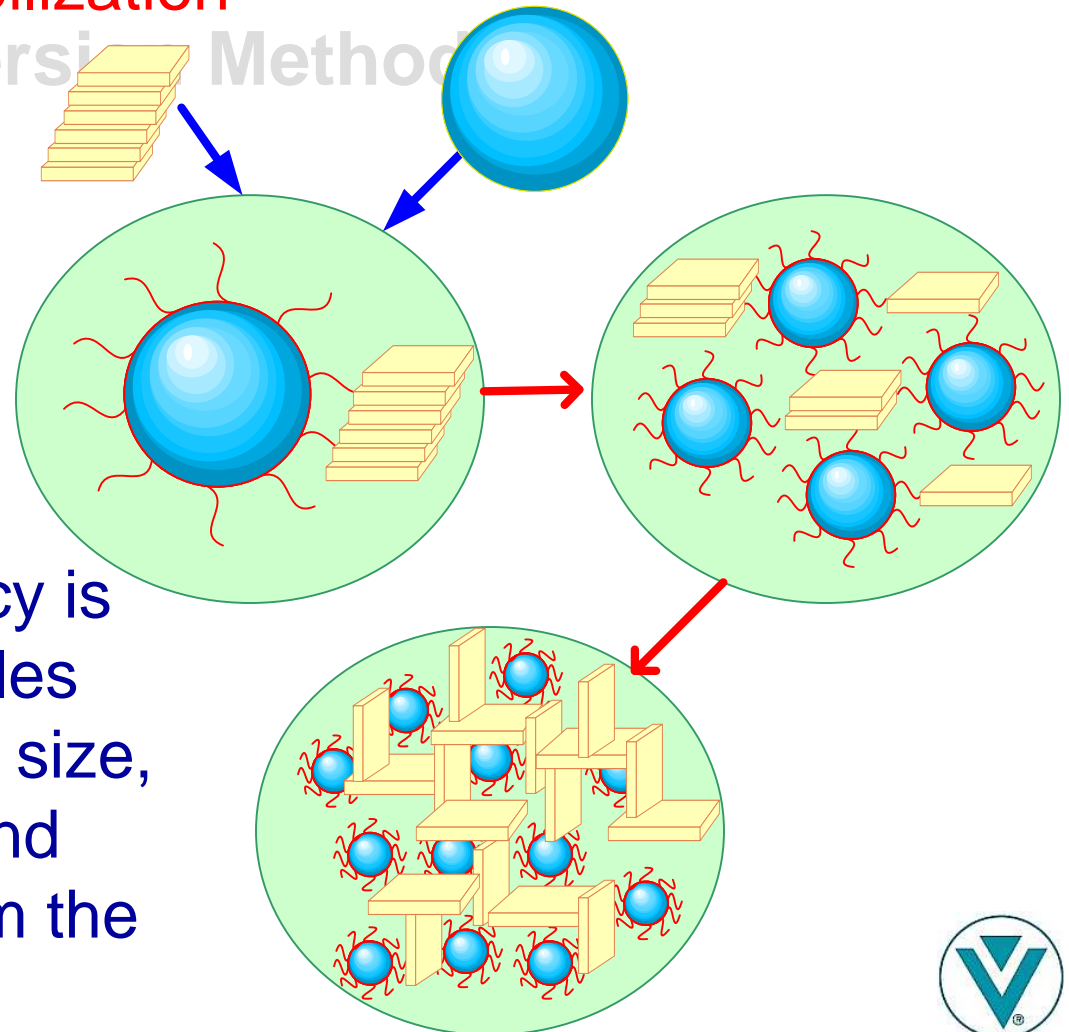
Wet-Mill Method

Smectite/Xanthan Gum Stabilization

Dispersion Method

The smectite is added with all ingredients, except the xanthan gum. While milling, the clay delaminates.

The clay contributes no viscosity, so milling efficiency is maintained. When the particles have been reduced to target size, the xanthan gum is added and interacts with the clay to form the suspension system.



Making Suspension Concentrates

Wet-Mill Method

Dispersion Method



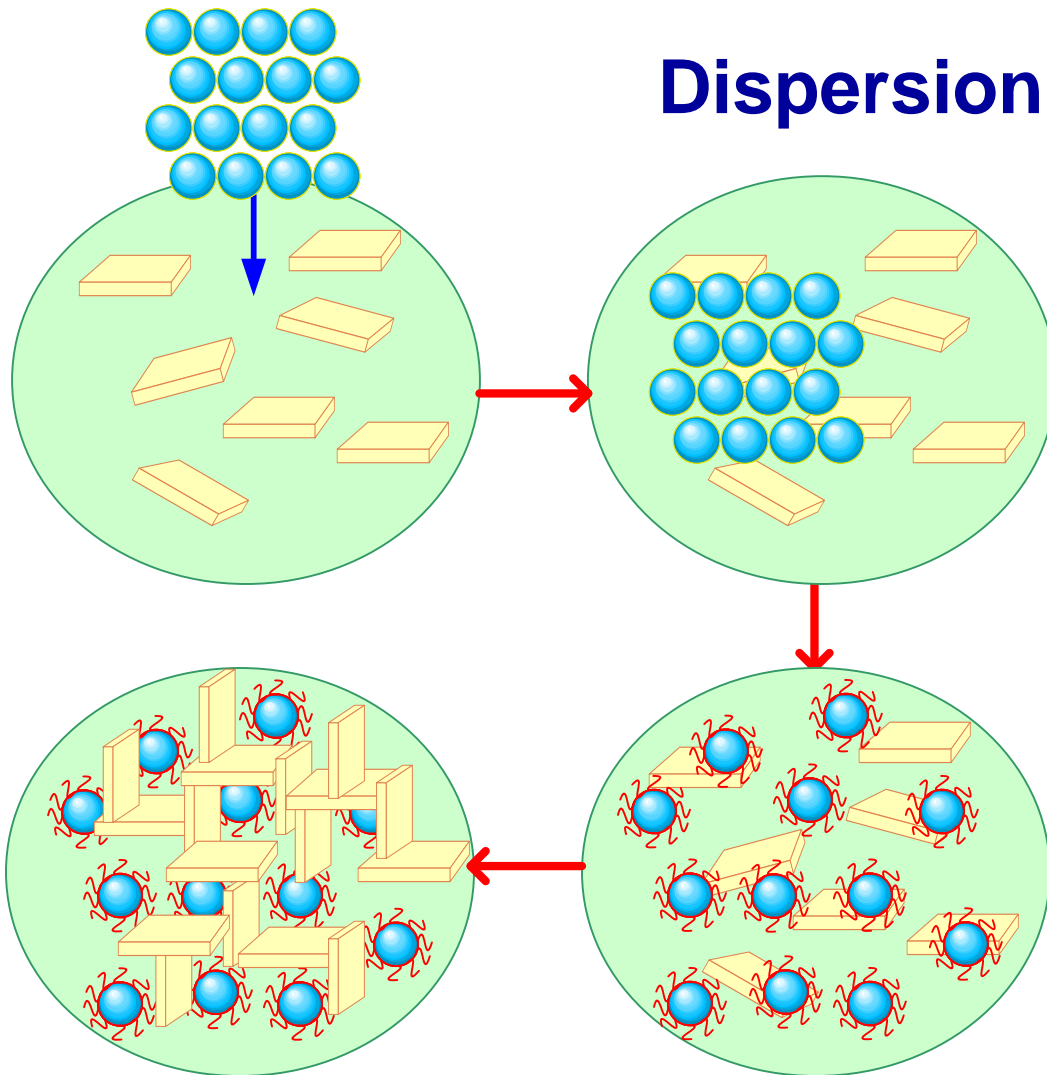
The particles are already at their required particle size. Using a dispersing mixer, the suspension system (e.g., smectite/xanthan gum) is hydrated first.



Making Suspension Concentrates

Wet-Mill Method

Dispersion Method



Then wetting and dispersing agents are added followed by the particles until they are well dispersed. The remaining ingredients are then added

Alternatively, the xanthan gum can be held until the end so that viscosity is minimized while the particles are dispersed.



suspending agent	VAN GEL B[®] magnesium aluminum silicate	0.25
	Water	22.87
dispersant	Na Polynaphthalenesulfonate	2.50
antifreeze	Propylene Glycol	10.00
defoaming wetting agent	Surfynol [®] 104H acetylenic diol	0.05
wetting agent	Triton [®] X114 ethoxylated nonylphenol	0.20
	Preservative	0.20
	Flour Sulfur	64.00
suspending agent	VANZAN[®] xanthan gum	0.03
Example:	Average particle size	2.7 μm
Wet-Milled	Viscosity, 1 day	880
Suspension	Viscosity, 1 month	1010
Concentrate	Viscosity, 3 months	1080
	F/T, 5 cycles	pass



An Introduction to

Suspension Concentrates

VAN GEL[®]

Magnesium Aluminum Silicate

VANZAN[®]

Xanthan Gum

VEEGUM[®]

Magnesium Aluminum Silicate

DARVAN[®]

Dispersant

VAN GEL, VANZAN, VEEGUM and DARVAN are registered trademarks of R.T. Vanderbilt Company, Inc.

Attritor is a registered trademark of Union Process Company

Surfynol is a registered trademark of Air Products and Chemicals

Triton is a registered trademark of Union Carbide Chemicals & Plastics Technology Corporation



**For additional information regarding our high quality minerals and chemicals,
please visit our website:**

www.rtvanderbilt.com

- Technical data sheets
- MSDS information
- Sample requests
- Specifications
- Product brochures
- Articles
- Presentations
- Reports