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# VANDERBILT

## *Presentation*

## An Introduction to Suspension Concentrates

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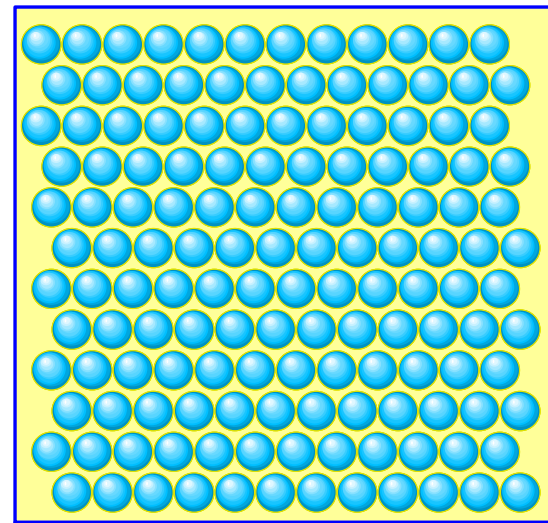
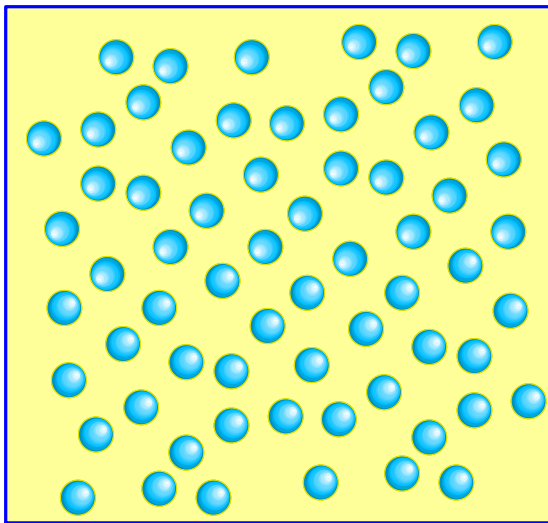
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# An Introduction to

# Suspension Concentrates

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

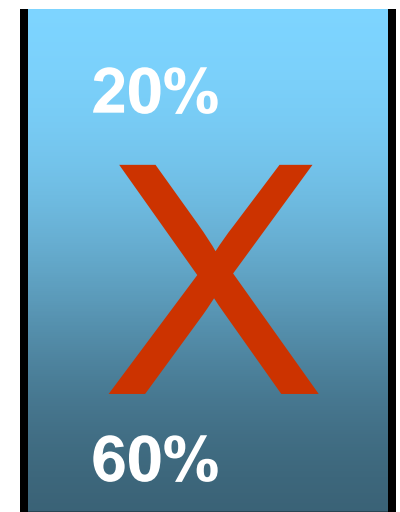
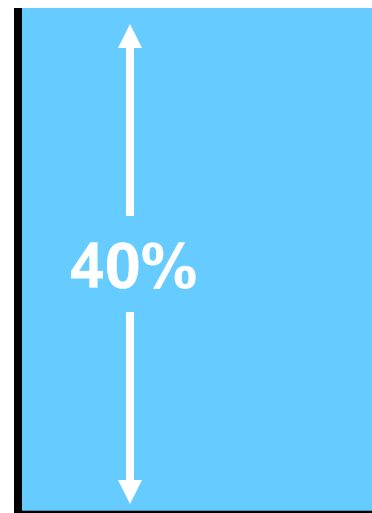


# Suspension Concentrates

## 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.

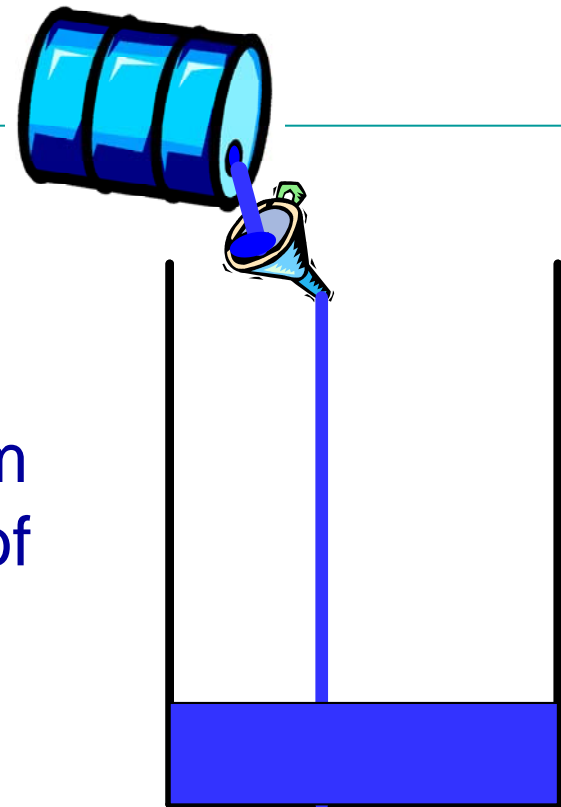


# Suspension Concentrates

## 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.

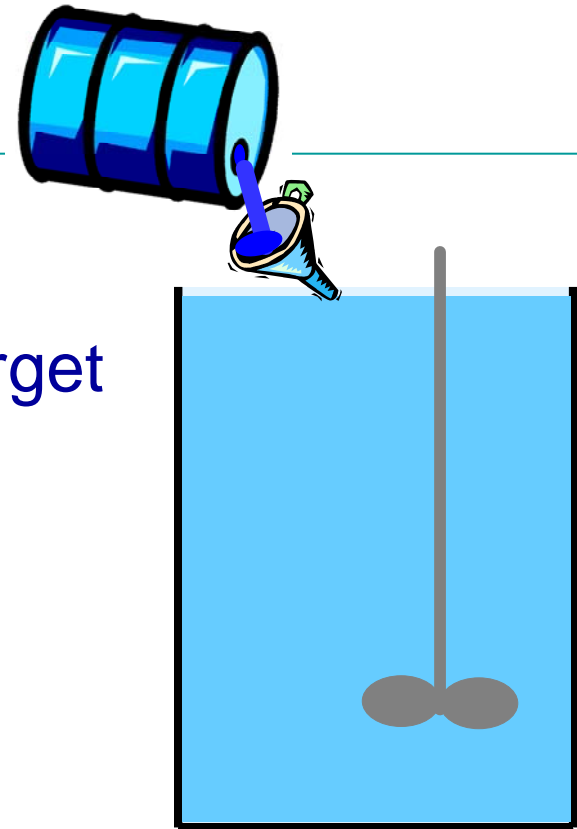


# Suspension Concentrates

## 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:

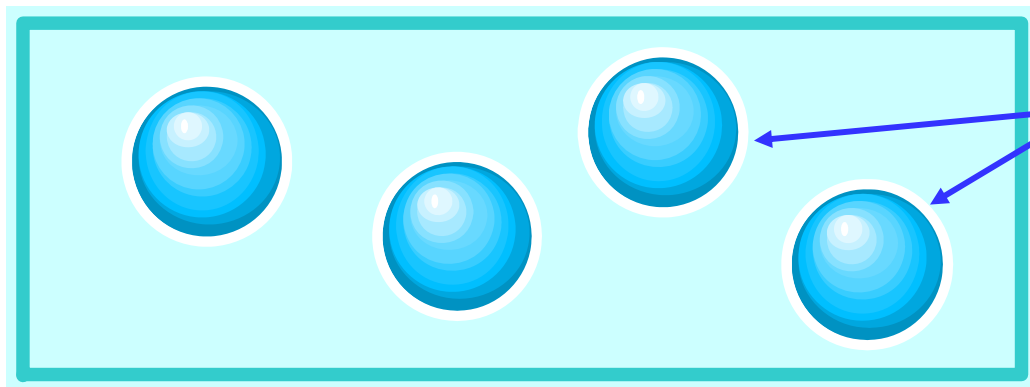
Water

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:

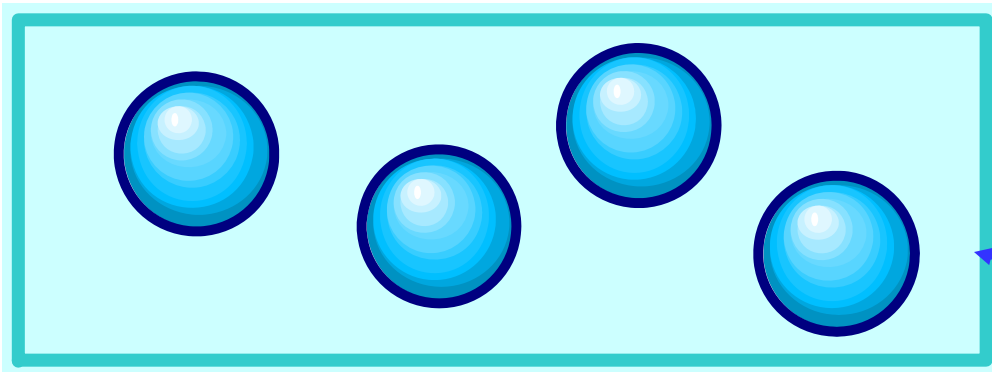
Water

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:

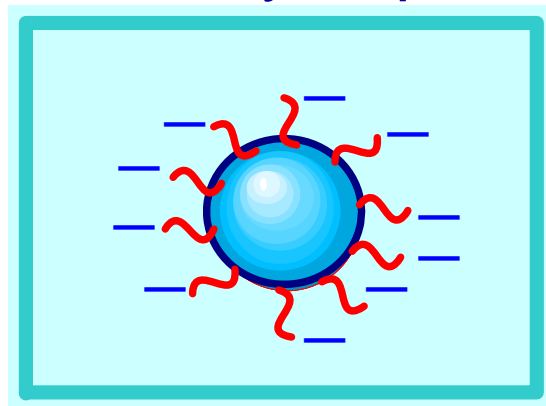
Water

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

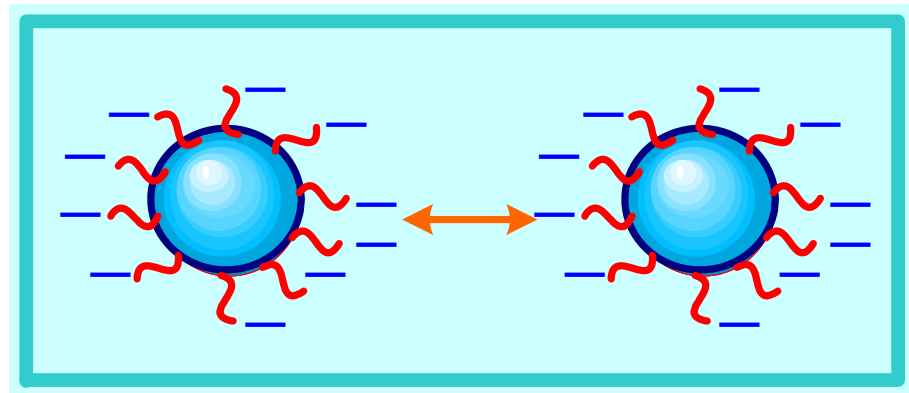
Insoluble Particles (pigment, biocide, etc.)

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**<sup>®</sup>  
Magnesium Aluminum Silicate

**VEEGUM**<sup>®</sup>  
Magnesium Aluminum Silicate

<b>VAN GEL B</b>	The standard economical grade for most suspensions
<b>VAN GEL ES</b>	The most electrolyte tolerant grade
<b>VEEGUM</b>	The standard grade for a wide range of applications
<b>VEEGUM CER</b>	Smectite clay/CMC blend; high efficiency stabilizer

Several additional grades are available to match formulation requirements.

**VANZAN**<sup>®</sup>  
Xanthan Gum

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



## DISPERSING AGENTS

**DARVAN**<sup>®</sup>  
Dispersant

<b>DARVAN 2</b>	Sodium lignosulfonate
<b>DARVAN 670</b>	Sodium polynaphthalenesulfonate
<b>DARVAN 7-N</b>	Sodium polymethacrylate
<b>DARVAN 811</b>	Sodium polyacrylate
<b>DARVAN 821A</b>	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<sup>®</sup> (pictured), ball mill, bead mill, sand mill.

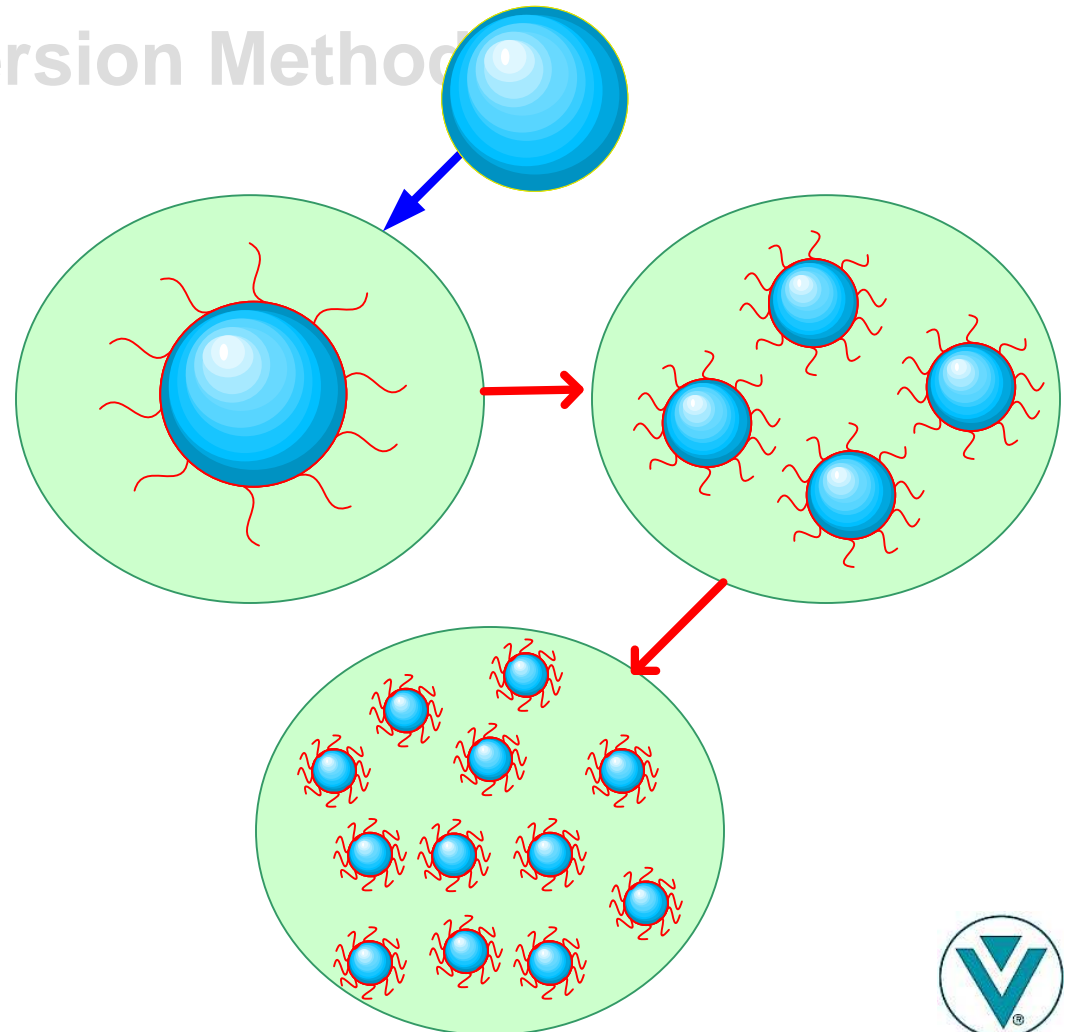


# Making Suspension Concentrates

## 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

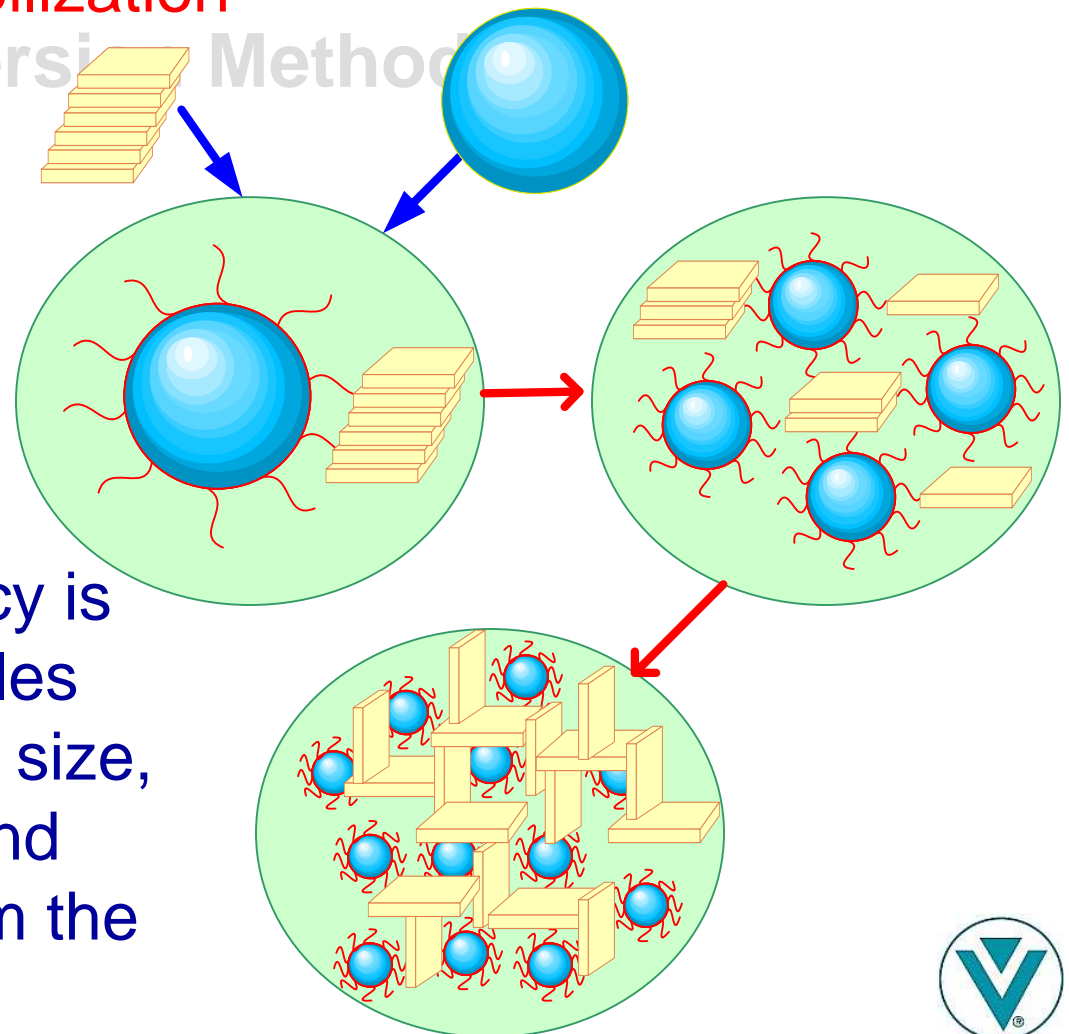
## Wet-Mill Method

### 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



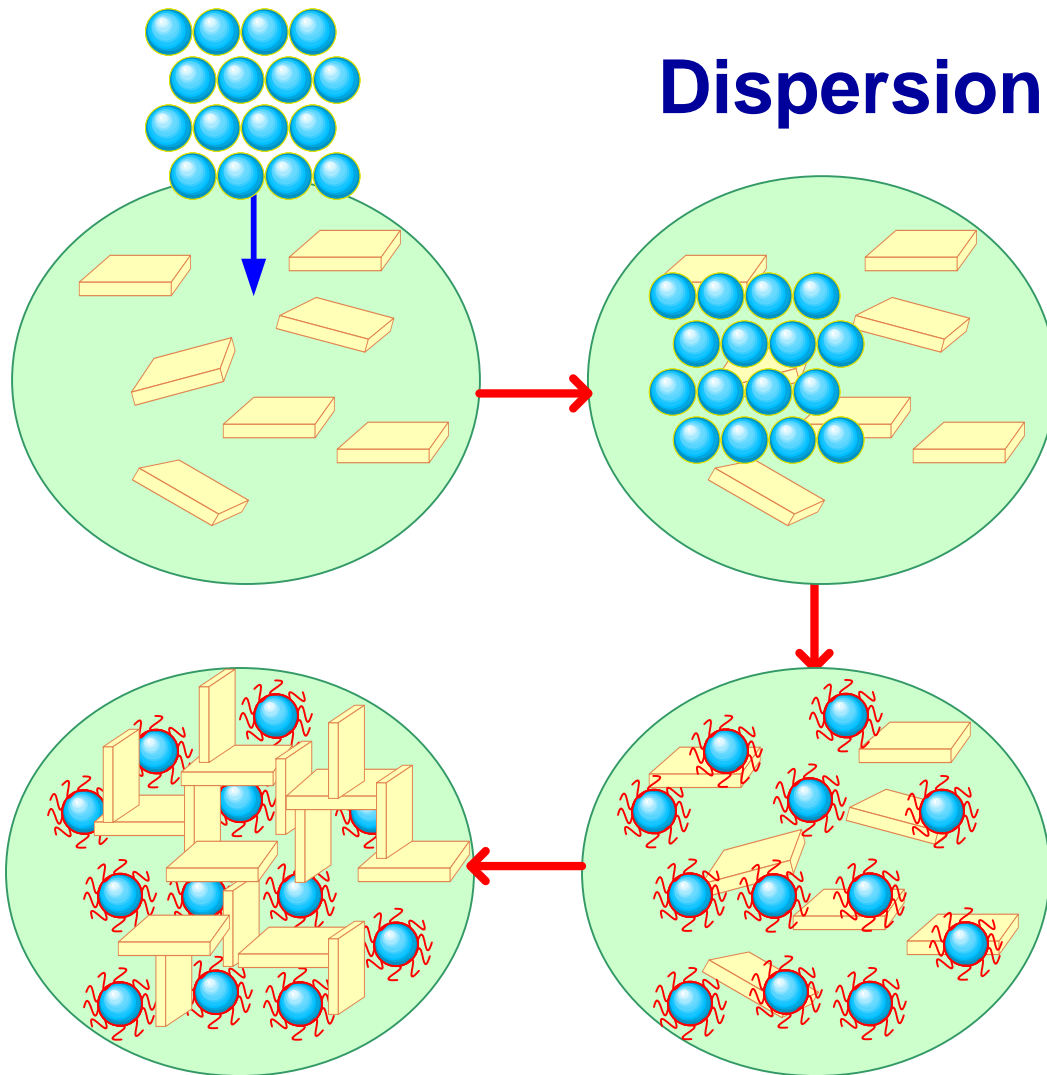
The particles are already at their required particle size. Using a dispersing mixer, the suspension system (e.g., smectite/xanthan gum) is hydrated first.



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



# An Introduction to

# Suspension Concentrates

**VAN GEL**<sup>®</sup>

Magnesium Aluminum Silicate

**VANZAN**<sup>®</sup>

Xanthan Gum

**VEEGUM**<sup>®</sup>

Magnesium Aluminum Silicate

**DARVAN**<sup>®</sup>

Dispersant

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