

Understanding Pesticide Formulations

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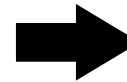
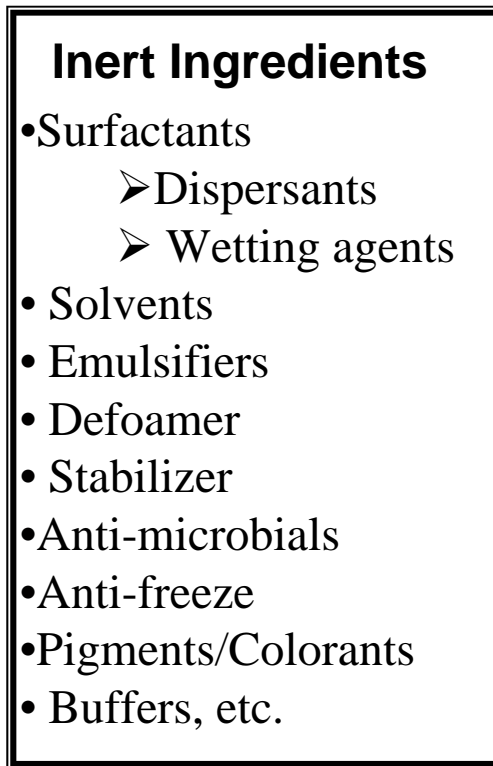
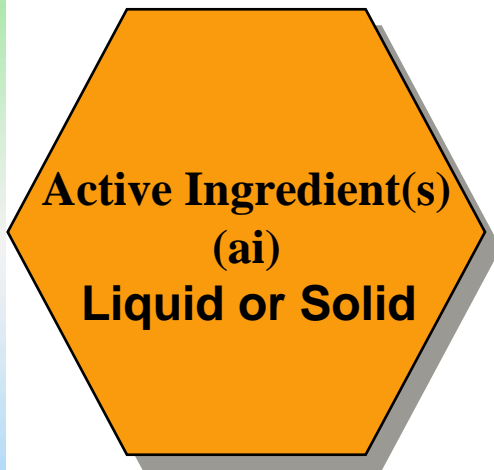
Overview

- ◆ What is a Formulation?
- ◆ Some Basic Formulation “Types” (5 of >60)
- ◆ How/Why do we select a Formulation type?
- ◆ Common additives – what differences they make!

What is a Pesticide Formulation?

- ◆ A homogeneous and stable mixture of active and inert ingredients which make the final product simpler, safer, and more efficacious to apply to a target pest.
- ◆ Even though there are no chemical reactions involved, there are many aspects of chemistry present in a formulation. Some of the chemistry involved is thermodynamics of mixing, phase equilibria, solutions, surface chemistry, colloids, emulsions and suspensions.

Formulation Development



Common Formulation Types

◆ Dry - Sprayable

- ◆ WP – Wettable powders
- ◆ WG or WDG – Water dispersible granule

◆ Liquid Sprayable

- ◆ SL – Soluble Concentrate
- ◆ SC – Suspension Concentrate
- ◆ EC – Emulsifiable Concentrate
- ◆ ME - Microemulsion
- ◆ OD – Oil Dispersion
- ◆ CS – Microencapsulated Particles

◆ Dry – Spreadable Granule

- ◆ GR – Soil applied Granule on inert or fertilizer carrier

Formulation Descriptions

WETTABLE POWDER (WP)

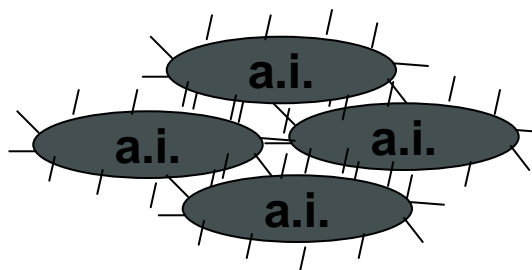
A solid pesticide formulation – micronized to powder form and typically applied as suspended particles after dispersion in water.

Basic Ingredients:

(micronized to ~5 um)

solid active + dispersant (anionic) + wetting agent (anionic/nonionic)

5.0 – 75.0% a.i.



Neg. charged anion dispersant

Characteristics: simple but dusty, difficult to measure, easy to mix into water

Formulation Descriptions

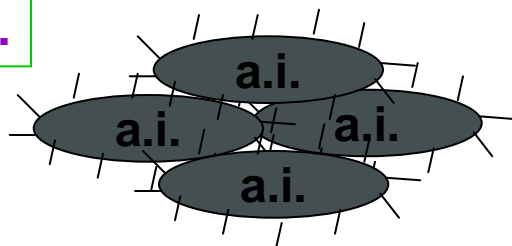
WATER DISPERSIBLE GRANULE (WG)

A pesticide formulation consisting of granules to be applied after disintegration and dispersion in water. The granular product has distinct particles within the range 0.2 to 4 mm. Water dispersible granules can be formed by a) agglomeration, b) spray drying, or c) extrusion techniques.

Micronized to ~5 um

Similar to Wettable powder (extra dispersant) + water → Granule

5.0 – 75.0% a.i.



damp granule is dried
to remove moisture/agglomerate

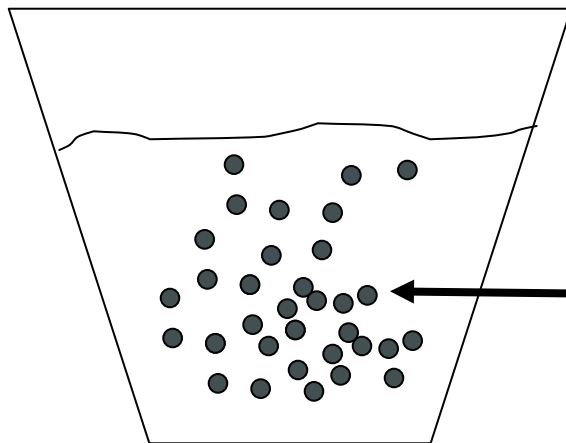
Characteristics: Low dust, simple to measure, more time needed to disperse

Formulation Descriptions

SUSPENSION CONCENTRATE (SC)

A stable suspension of solid pesticide(s) in a fluid usually intended for dilution with water before use. Ideally, the suspension should be stable (i.e. not settle out).

0.1 – 60.0% a.i.

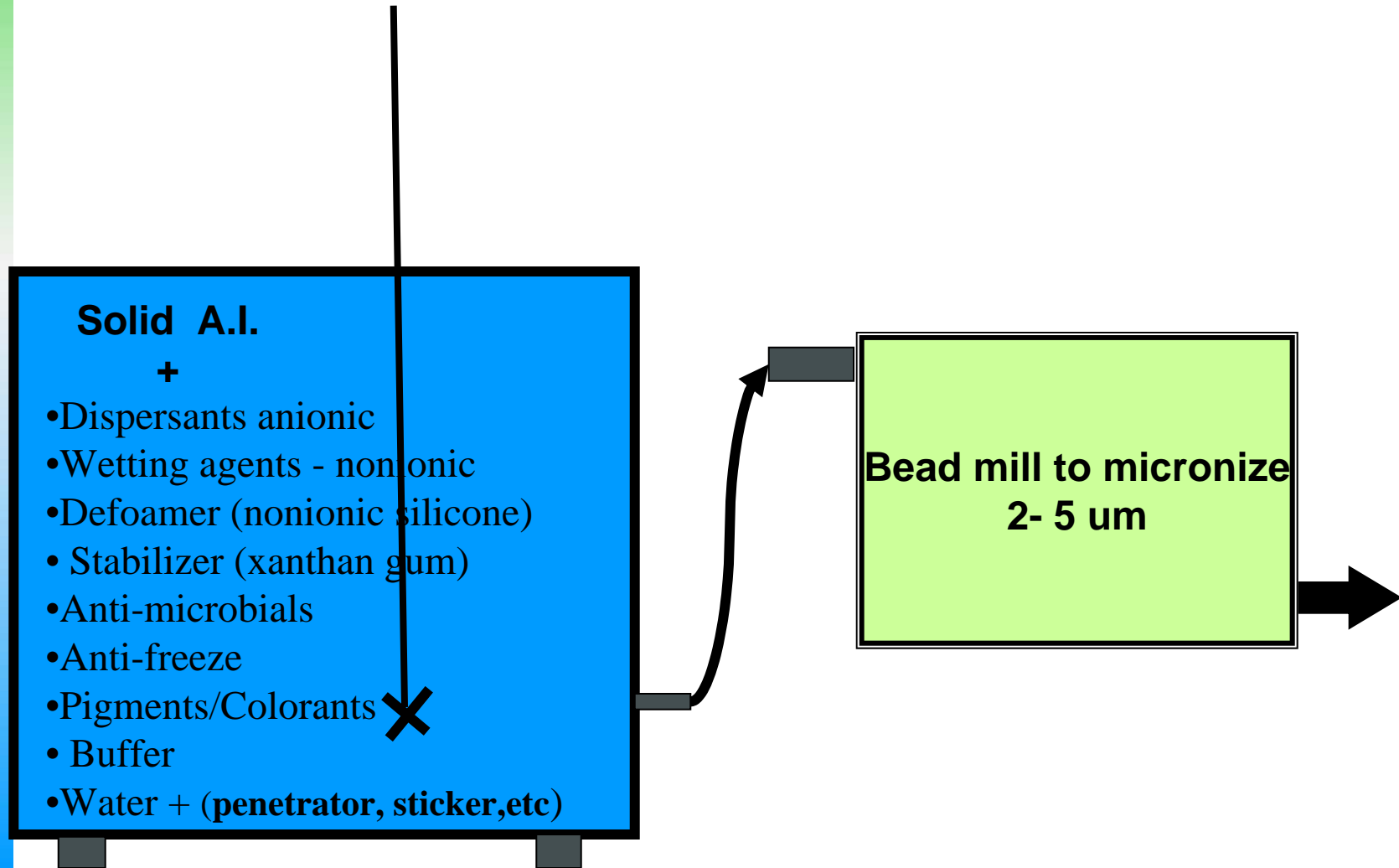


Solid particles (5 μm) suspended in aqueous phase due to anionic/nonionic dispersant – wetting agent with polymeric viscosity stabilizer

Characteristics: A.I. must be water insoluble with friable crystals, Easy to tankmix (very compatible) - A.I. tends to settle out over time.

Formulation Development

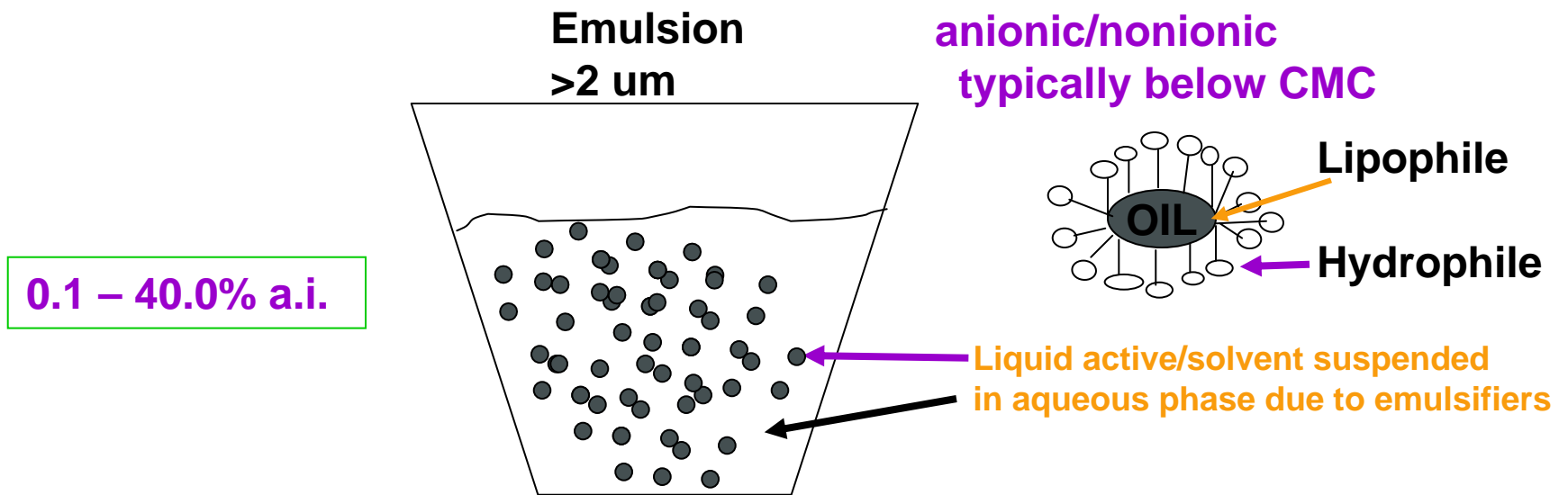
Typical Suspension Concentrate



Formulation Descriptions

EMULSIFIABLE CONCENTRATE (EC)

A solution of a pesticide with emulsifying agents in a water insoluble organic solvent which will form an emulsion when added to water. Complete HLB must be reached to achieve a long term stable formulation.



**Characteristics: A.I. must be solublized in water immiscible solvent (VOCs, Odor)
Correct HLB leads to stable emulsion in water. Solvents may increase toxicity to operator/environment and degrades spray equipment parts, freezing may initiate crystal formation. Often very efficacious if no phyto.**

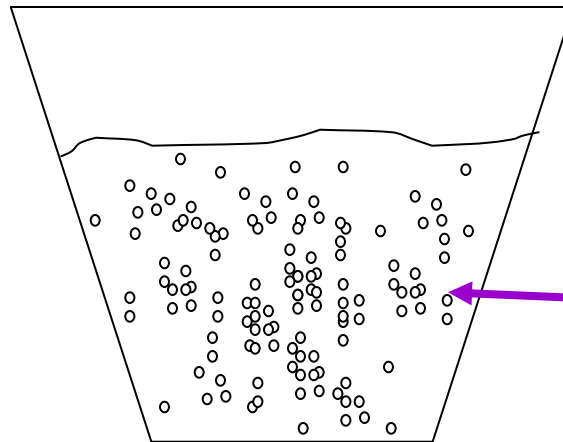
Formulation Descriptions

Micro-emulsion (ME)

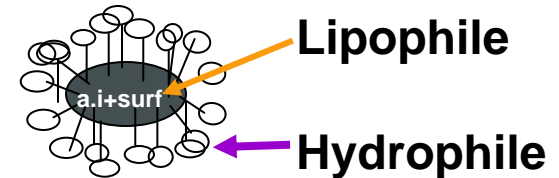
A solution of a pesticide with emulsifying agents in a water insoluble organic solvent which will form an solution/emulsion when added to water. Complete HLB must be reached to achieve a long term stable formulation.

ME – clear in water <1um

0.1 – 5.0% a.i.



Above CMC



Oily active/surfactant "dissolved" or <1um in aqueous phase due to surfactants

**Characteristics: A.I. must be solublized in 'selected' surfactants (toxicity, cost)
Very stable thermodynamically, A.I. type and level limited in ME formulations**

What determines formulation type for an active ingredient?

- ◆ Active Ingredient Characteristics:
 - ◆ Human/environmental toxicity profile (may eliminate WPs or ECs)
 - ◆ Solubility profile in water or other solvents/surfactants (SC, EC, ME)

Market may demand specific requirements

- ◆ (e.g., soil granule for consumer, no VOCs, fertilizer compatibility)

**NOTE RTU formulations are different from their “more concentrated” versions
(Market Demands and Formulation Ingredients – VOC issue?)**

- ◆ Enhanced A.I. Properties
 - ◆ (cuticle penetration, particle size, dislodgability)
- ◆ Product differentiation (WP, SC, SC w/penetrate, WG. GR, GR on Fert, ME)

Residues Left After Application

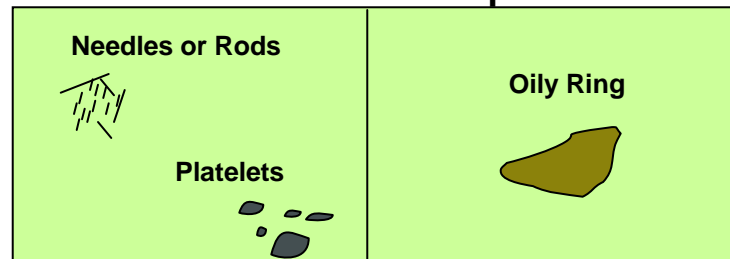
Solid Crystals

Wettable Powder
Water Dispersible Granule
Suspension Concentrate
Oil Dispersions
Some Emulsifiable Concentrates
Some Solutions

Liquid Droplets

Emulsifiable Concentrates
Micro-emulsions
Solutions

Solids



Liquids

The value of Surfactants and Adjuvants



Property of Bayer CropScience

The value of Surfactants and Adjuvants

SC Spray Droplets Run-off without help from surfactants

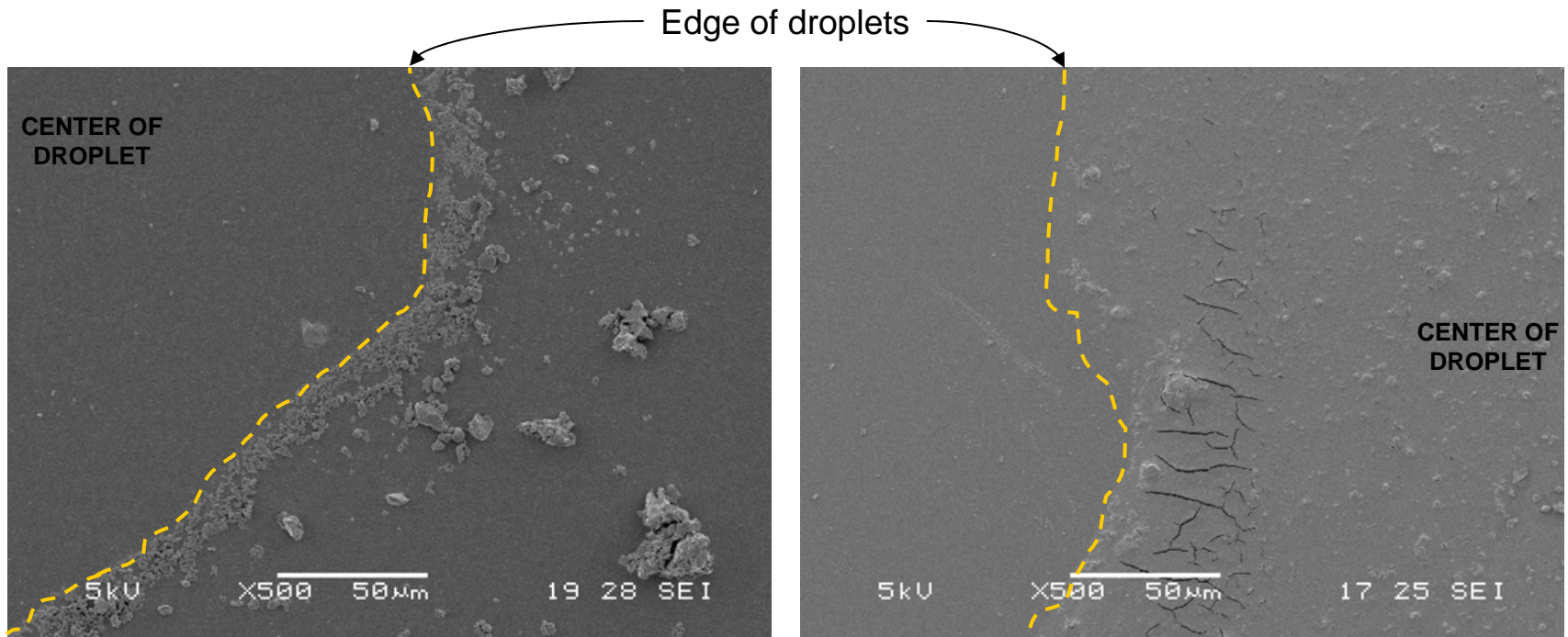


The value of Surfactants and Adjuvants

Droplets stay on surface and don't run off



Character of dried deposits of two SC formulations



With this SC formulation, Al crystals segregate to periphery of droplet, and dry in a classic “coffee ring.”

With this SC formulation, Al crystals are more evenly dispersed and trapped within a complex formed by formulation additives.

Questions?