PHYSICAL STABILITY OF AGROCHEMICAL FORMULATIONS

From Suspension to Emulsion

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Dr. Martin Viertelhaus is Research Scientist Crystalline Materials and Polymorphism at BASF SE, Ludwigshafen, Germany.

His expertise is in the field of solid state development and physicochemical characterization of active ingredients: e.g. agrochemical, pharmaceutical and performance chemicals. During his professional career, he worked for pharmaceutical and chemical companies as well as for a service provider.

This webinar is being recorded and will be made available.

The audience is muted and send the questions to info@crystallizationsystems.com.

This webinar will last 45 minutes.
TECHNOBIS CRYSTALLIZATION SYSTEMS

- Privately owned company
- 50 employees
- Located in Alkmaar, The Netherlands
- Leader in 3 major markets: Pharma, Agro and Fine Chemicals

Portfolio

- 3 products for: formulation, process optimization and crystallization related research
**Products**

**Discover**
- Early stage salt, polymorph screening
- Single crystal growth

**Screen**
- Solubility, MSZW
- Phase diagrams
- Selecting solvents
- Polymorphs, Salt and Co-crystals screening

**Optimize**
- Form control
- Habit control
- Particle size
- Process optimization
- Formulation

**Working volume:**
- **0.06 – 0.1 ml**
  - 32 reactors
- **0.5 – 1 ml**
  - 16 reactors
- **2.5 – 5 ml**
  - 8 reactors
Physical Stability of Agrochemical Formulations
From Suspension to Emulsion

Dr. Martin Viertelhaus
Overview

- solid state properties
- agrochemicals and their formulations
- two active ingredients …
- … plus formulants
- re-crystallization
Solid State Properties

- Solid state properties depend on the crystal form.
- Knowledge about (meta)stable solid forms of active ingredients (AIs) is important for:
  - production
  - formulation
  - storage
  - application
Formulation and Solid State of Active Ingredient
Agrochemicals

■ indications
  ► fungicides (F)
  ► herbicides (H)
  ► insecticides (I)

■ product application
  ► formulated concentrate
  ► dilution in water
    (compatibility with water)
  ► application to fields
Agrochemical Formulation

- formulation development
  - high active loading
  - low viscosity (liquid)
  - easy to dissolve/disperse (solid)
- storage stability
  - 2 years at ambient temperature
  - 2 weeks @ 54°C (accelerated)
- application stability
- robustness in biological tests
Formulation Stability

- production
  - mixing
  - properties
  - viscosity

- storage
  - sedimentation, re-suspension
  - agglomeration, crystallization

- dilution and application
  - mixing
  - crystal growth

crystalline active on leaf surface
Agrochemical Formulation

- 63 different classifications of formulations
- active is
  - solid in solid mixture
  - suspended in liquid
  - dissolved in water or solvent
- solid state properties of active of interest
  - in formulation
  - after dilution
  - during application
  - on the plant

### int. code | description
--- | ---
EC | emulsifiable concentrate
SL | soluble concentrate
DC | dispersible concentrate
SC | suspension concentrate
SE | suspo-emulsion
OD | dispersion in oil
EW | emulsion, oil in water
ME | micro-emulsion
CS | capsule suspension
WG | water dispersible granule
WP | wettable powder

CropLife International, Technical Monograph n°2
the majority of agrochemical formulations include more than one active ingredient

up to four actives ingredients

less resistance building

broader application window

cooperative effects

stronger curative effect
Two Active Ingredients

- 2 solid actives:
  - pre-formulation

- active 1 + active 2
- mixture of AIs
- eutectic melt
- co-crystal
Active I – Active II Eutectic

- melting points of separate actives above 80°C
- mixed actives: eutectic melting at 62.6°C
Suspension Stability Experiment

- pre-formulation or final formulation
- further reduction of “melting point“
  conversion point from suspension to emulsion
- mixture of active ingredients and solvents/blank formulations
  - stirring
  - temperature rise
  - pictures

Photos taken with Crystalline PV
Active I – Active II
Formulation Development

- Al I : Al II (g/g)
- Crystalline PV: T ramp 20°C/h, bottom stirred

**solvent A**

![Images of solvent A at different temperatures](image)

**solvent B**

![Images of solvent B at different temperatures](image)

Photos taken with Crystalline PV
Final Formulation

- solids: eutectic melting at 62.6°C

- eutectic melting temperature reduced to
  - 59°C in solvent A
  - 55°C in solvent B

- formulation physically not stable
  agglomeration, sedimentation

- decision:
  no suspension concentrate
Two Active Ingredients plus Liquid Formulants

- Active 1 + Active 2
- Mixture of AIs
- Liquid plus solid (e.g. eutectic + excess solid)
- Eutectic melt
- Co-crystal

- Active 1 + Active 2 + Formulants
- Mixture of AIs in formulation (SC)
- Liquid plus solid (excess solid active)
- Solution
- Emulsion
- Co-crystal in liquid formulation (SC)
Re-Crystallization

- temperature cycling to enhance the chance to crystallize
- crystal size
- crystal morphology
- individual experiments and temperature programs

experiment: Crystalline PV, T ramp -7.5°C/h, bottom stirred

Photos taken with Crystalline PV
Physical Stability of Agro Formulations

- investigation regarding
  - solid state properties of actives
  - model formulations
  - final formulation

- can explain observation
  - of farmers/users
  - in final formulation

- can avoid running for the wrong formulation type

- dissolution
  - re-crystallization
  - phase transformation
Acknowledgement

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Ludwigshafen
QUESTIONS?

• Any follow up questions or other enquiries: info@crystallizationsystems.com

• Participants will be sent details of how to access a recording of this webinar

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