21st Century Challenges in Fertilizer Coatings

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Definition:

“Coating” is a surface treatment applied to solid fertilizers

- **Solid**
- **Liquid**
- **Thermoplastic**
- **Curing (polymerizing)**

Goal:

To preserve and enhance the quality of the fertilizer through shipping, storage, handling and application

Note: Coatings cannot “save” a granule with poor integrity

Functions Provided by Coatings:

- *Control **dust** emission*
  - *Or **stabilize** the particle surface*
- *Minimize **caking** (bag set, pile set)*
  - *Or enhance **flow-ability***
- *Minimize **moisture** pickup*
- *Improve **compatibility** in end uses*
- *Enhance **color** and/or **appearance***
- *Modify **nutrient release** characteristics*

Fertilizer Industry Round Table

November 15, 2012

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Samples of Diammonium Phosphate from around the world

Granule properties (quality) are not necessarily the same, even though the chemical grade for all is 18-46-0

Poor process control or excessive production rates can often lead to poor granule quality

The goal is to *preserve* and *enhance* the *quality* of the fertilizer throughout it's life cycle

Factors that contribute to granule quality

Chemical

- Fertilizer type and chemical composition have a large effect on quality
- Impurity levels and type can effect granule quality
- Post granulation reactions (curing processes)
- Crystal formation on granule surfaces (re-crystallization)

Factors that contribute to granule quality

Mechanical

- Method of production
- Type of material handling equipment used
- Number of times the material is handled

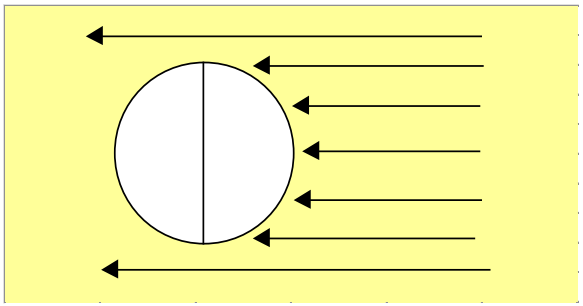
Ambient Conditions

- Storage temperature and humidity
- Type of storage facility
- Bagged or bulk storage

Granule properties that effect fertilizer quality

- ***Shape and Surface Area***
- ***Surface Texture***
- ***Porosity***
- ***Mechanical Stability*** ***(Hardness, both Initial and Over Time)***
- ***Chemical Stability***
- ***Moisture Content***
- ***Critical Relative Humidity***

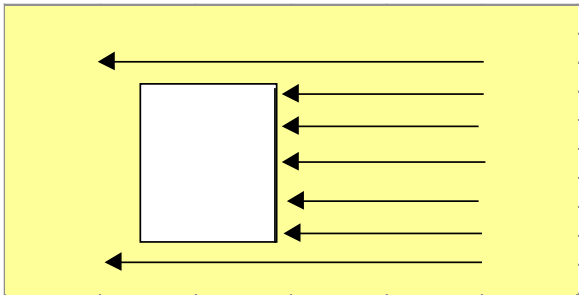
- ## GRANULE SHAPE
  - *Round or Spherical is the desired granule shape. It is the easiest to coat .*
  - *A spherical granule can have 50 percent or more of surface area exposed to a coating medium at one time*



  - *The round granule is the least likely to abrade or chip which creates dust during shipping and handling*

•An Angular granule is typical of compacted products. It is more difficult to coat

•Less than 50 percent of surface area will be exposed to a coating medium at one time



•The Angular granule is more likely to abrade or chip which creates dust during shipping and handling

- ***GRANULE SURFACE AREA***
  - ***Lower surface area requires less coating***
    - Spherical granules have less surface area than angular granules of equal size.
      - Spherical granules will require less coating agent
      - Angular granules will require more coating agent
  - As the ***Size Guide Number*** (SGN) increases, the surface area decreases and dosage also decreases somewhat proportionally.
  - As the ***Uniformity Index*** (UI) increases, the surface area decreases to some degree and dosage also decreases somewhat proportionally.

- ***SURFACE TEXTURE***
  - ***The texture of a granule will effect the ease of coating, the granule surface area and as a result the dosage rates.***
  - ***Smooth Texture:*** *A smooth surface is easier to treat because the coating agent spreads without obstructions. Also the surface area is lower. It will require reduced mixing times and lower dosages rates.*
  - ***Rough Texture:*** *A rough surface is harder to treat because the coating agent will not spread as easily. This result in increased mixing times because spreading is restricted. In addition the surface area is higher which increases dosage rates.*

- ***GRANULE POROSITY***
  - ***Granules with high porosity*** *are typically soft and have a rough surface texture. They are prone to abrasion and dust formation during handling*
  - *A* ***porous granule can absorb coating agents****, although careful coating selection can minimize this problem*
  - ***Absorption*** *will reduce the amount of coating agent on the surface; this limits the long term effectiveness of the coating agent.*
  - *Porous granules normally* ***require increased dosages*** *or* ***multiple coatings*** *to extend the useful life of the coating agent.*

- ***MECHANICAL STABILITY***
  - ***Granule Hardness and/or Toughness*** *enables the particle to withstand abrasive forces encountered during shipping and handling.*

- ***CHEMICAL STABILITY***
  - ***Post granulation reactions or curing processes*** *produced changes that can de-stabilize the fertilizer granule.*

- ***MOISTURE CONTENT***
  - ***High internal moisture levels*** *will drive crystal formation on the particle surface. This can lead to high dust levels and increased tendency to caking*
- ***CRITICAL RELATIVE HUMIDITY***
  - ***Critical Relative Humidity*** *is a measure of how easily and how quickly a fertilizer absorbs moisture from its surroundings. Moisture absorption can destabilize a fertilizer particle.*

The Goal of a Coating is to

To preserve and enhance the quality of the fertilizer through shipping, storage, handling and application

Effective application of a coating can help us to reach this goal.

For this an application system in needed.

Three Parts of Coating Application System

1) **Storage Tank and Feed Delivery System**
   - ⇨ *Maintains product temperature, pressure and inventory*

2) **Application System** *(Spray Nozzles for liquids)*
   - ⇨ *Helps to distribute the coating on the granule surface*

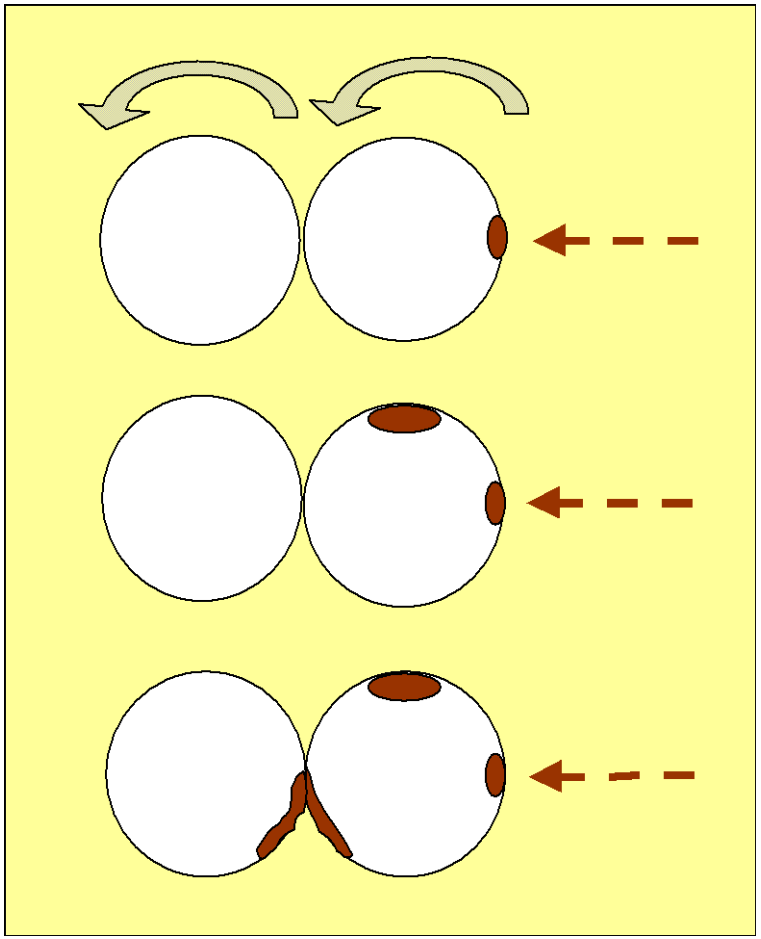
3) **Mixing Equipment**
   - ⇨ *Mixing the fertilizer during coating application helps to maximize coating distribution and effectiveness*

KEYS to OPTIMIZING COATING EFFICIENCY

- *Maximize surface area contact with the coating*
- *Avoid “misting” and “over spay” conditions*
- *Provide sufficient mixing*
- *Avoid mechanical degradation*
- *Match coating used to site specific parameters:*

Why is mixing important ?

- More uniform coverage
- Lower dosage rates
- Better performance



When granules rotate, the coating agent spreads across the granule surface - even to granules that are not contacted by the spray droplets

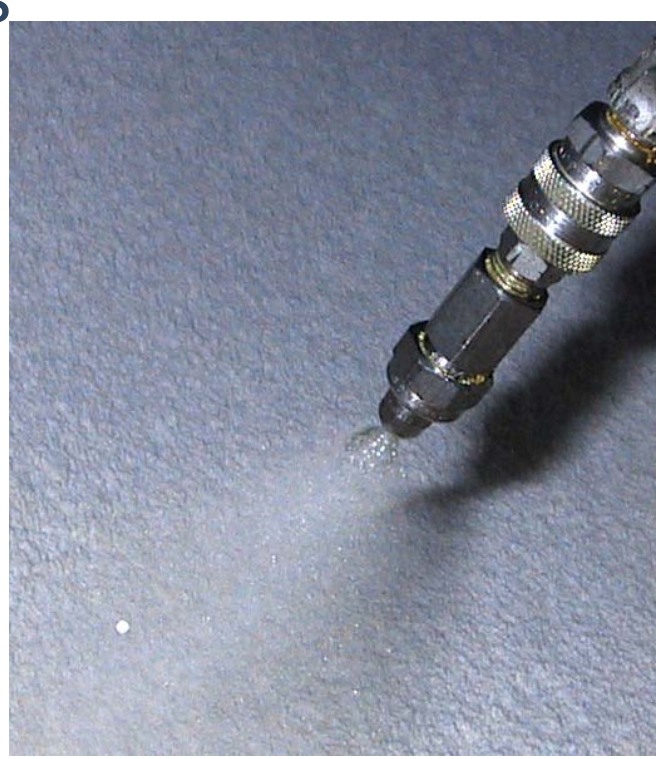
Storage Tank and Feed Delivery Systems (for liquids)

- Storage Tank and Product Lines
  - Heated
  - Insulated
- Pump (style depends on the coating type)
- Flow control system
  - Pressure Control
  - Metering Pumps
  - Mass Flow Meter
  - Ratio Control

Spray Nozzles - Two basic types

1. Hydraulic Type

- Requires consistent line pressures
- Minimizes undesirable “misting” and “over-spray”
- Easy set up and control
- Can be more prone to plugging



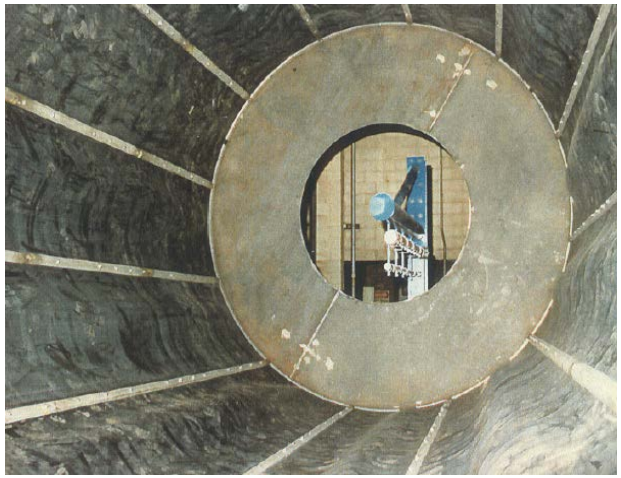
2. Air-atomizing Type

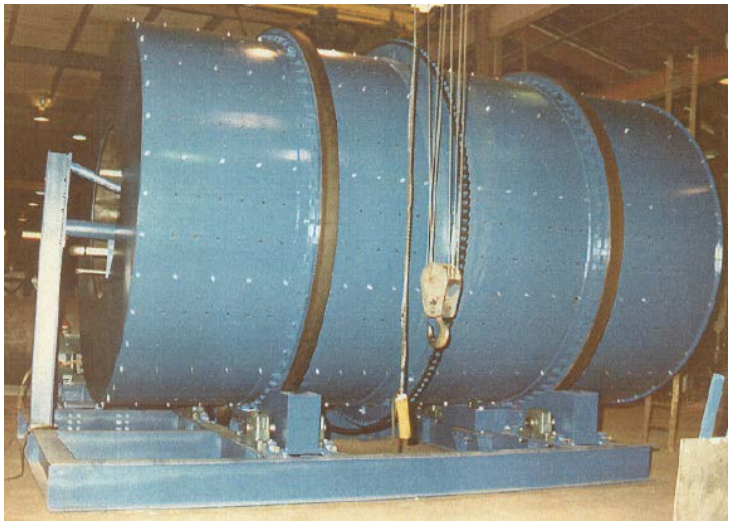
- Uses compressed air and line pressure
- Excellent atomization
- Over atomization creates undesirable “misting” and “over-spray”
  - Coating surfaces other than the fertilizer
  - Carry over into scrubber systems

TYPES of MIXING EQUIPMENT

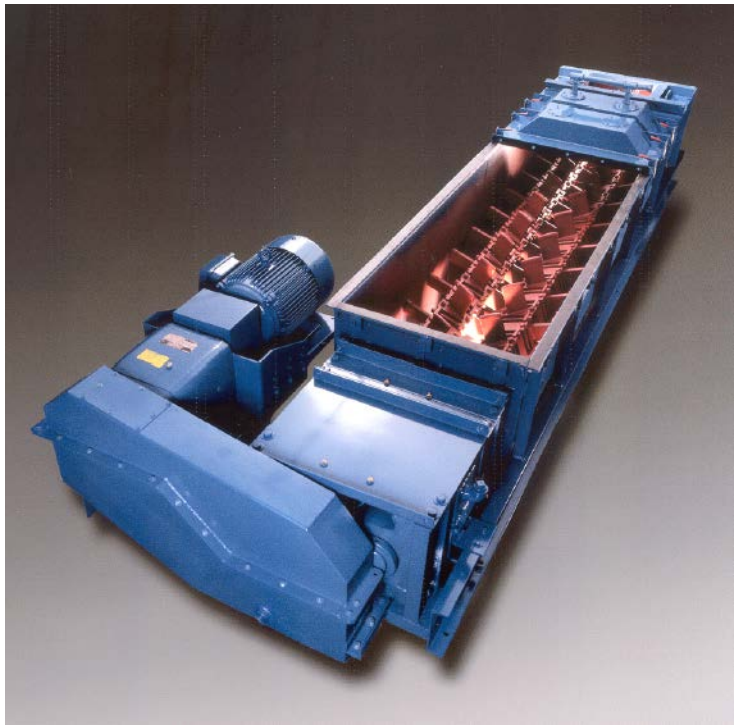
- **Drums** - spray inside drum
- **Blenders (ribbon or paddle)** - spray or inject during blending
- **Screw Conveyors** - spray or inject during blending
  "cut flight" and "live bottom" can be used
- **Transfer Points** - spray at drop points
- **Conveyor Belts** - spray on product surface
  often fixed plows are used to induce mixing
- **Specialized Process Equipment** (Wurster, etc)

- ***COATING DRUMS***
  - *Coating drums are very effective devices*
  - *Excellent mixing*
  - *Minimal product degradation*
  - *Optimal spraying access*
  - *Relatively large devices compared to other systems*
  - *Some elevation loss*





- ***BLENDERS (ribbon or paddle)***
  - *Excellent mixing*
  - *Useful in elevation*
  - *Need to be well designed to be effective*
  - *Minimize product degradation*
  - *Poorly designed mixers are not effective*



"Tender Blender"

- ***Transfer Points***
  - *Provides **marginal mixing**. If sufficient elevation is present, mixing can be improved significantly.*
- ***Screw Conveyors***
  - *Screw conveyors provide **marginal mixing***

  Tend to crush or degrade fertilizer particles when the clearance between the casing and the auger is less than two granule diameters

  "Cut flight" or "live bottoms" can improve mixing somewhat
- ***Conveyor Belts***
  - *This is the **least effective** method due to poor mixing.*

  Some mixing can be introduced with fixed plows.

  High dosage rates to offset poor spreading are often required

What types of coatings can be used ?

Types of Coatings

- **Particulate or Solids (parting agents)**
  - *Clays, talc, etc.*
  - *Improve flow-ability (reduce caking)*
  - *Often large amounts required*
  - *Increase dust levels*

Types of Coatings

- **Liquids (Water Soluble or Water Dispersible)**
  - *Used where solubility is required (solution grades, drip irrigation)*
  - *Ability to control dust control and caking is often limited*
- **Liquids (Water Insoluble)**
  - *Covers a wide range of products from low tech to high tech*
  - *Effectiveness can range from very poor to good*

Types of Coatings

- ***Thermoplastic***
  - *Change from Liquid to a Solid*
  - *Effectiveness can range from poor to good*
  - *Excessively brittle coating can contribute to high dust levels*
  - *Even coating distribution over the surface can be problematic*
- ***Curing or Polymerizing***
  - High Cost
  - Coating and curing process is often complicated and difficult
  - Effective as a Controlled Release coating (with high dosages)

Types of Coatings

- **“Purpose Built” or Engineered Products**
  - Specific to the fertilizer type and production process
  - Specific to the type of application system used
  - Effectively provides long term dust control by reducing the formation of dust and binds loose dust to the granule surface
  - Effectively reduces caking tendencies, may contain anti-caking agents
  - Can provide enhancing hydrophobic qualities to help minimizes moisture absorption and reduce bulk blend interactions
  - Low toxicity and meet environmental, health and safety standards

TRENDS

1) Drive toward fertilizer quality is increasing

Higher fertilizer prices drive demand for higher quality

2) Desire for product differentiation is increasing

- *Increased demand for specialty fertilizers*
  - *Increased use of secondary and micro-nutrients*
  - *Increased use of Controlled-Release*
- *Increased demand for quality coatings*

TRENDS

3) Regulatory and Social pressures continue to drive Health, Safety and Environmental issues

- TSCA (2012 CDR)
- REACH
  - Similar programs likely to follow around the world
- Water Quality and Nutrient Run Off
- ????

RESPONDING to CHALLENGES

- Improve quality as much as possible through production and process changes
- Minimize mechanical degradation through life cycle
- Target nutrient requirements
- Keep abreast of current issues
  - Industry publications
  - Conferences
- Support industry groups

RESPONDING to CHALLENGES

- **Install quality coating application systems to achieve optimum results**
- **Select a "purpose built" or engineered coating**
  - **Matched to your product(s) and process to provide enhanced quality and performance**
  - **Cost-effective**
    - **per ton of product**
    - **recognize the true cost of customer complaints**
  - **Environmentally Acceptable**

SUMMARY

- Coating agents are an integral part of a quality fertilizer
- Coatings improve and preserve fertilizer quality,
  but coatings can't create quality from thin air
- Many common, low cost coatings have definite
  performance limitations and/or EH&S issues
- Select a knowledgeable, capable and reliable Supplier,
  one that can provide help when a challenge arises

THANK YOU