Fertilizer Development: The Early Years to Today

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Fertilizer Development
The Early Years - Today

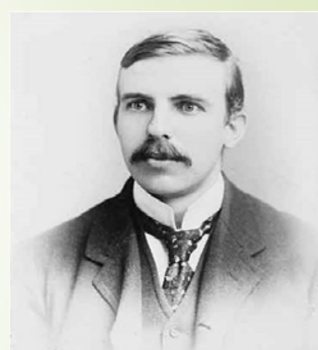
- Timeline of the development of fertilizer
- Why we use controlled-release fertilizer
- Review of controlled-release fertilizer

16th and 17th Centuries

- Manure was found to increase crop yield so the manure was dried and loaded onto ships to be used in other parts of the world.
- As the ships took on water, the manure got wet and started to produce methane gas
- Methane gas and lanterns = EXPLOSION
- Thus, all manure blocks were marked as Ship High In Transit

1772- Nitrogen Discovered

- Scottish physician, chemist and botanist Daniel Rutherford is credited for the discovery of nitrogen.
- Thru a series of experiments handed to him by his mentor and teacher Joseph Black working with "Noxious Air, Fire Air, and Foul Air"
- Isolated nitrogen, one of the most abundant elements in the atmosphere. Nitrogen is an inert gas and forms many inorganic compounds used as fertilizer and noxious gases.
- Nitrogen is a precursor of ammonia (NH_3) which is one of the main commercial compounds.

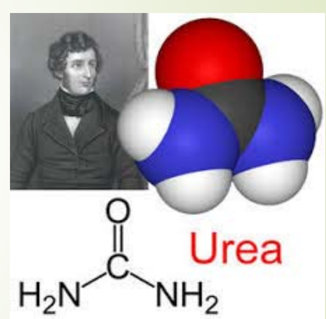


1804- Nitrogen found to be essential for plant growth

- Nicolas-Theodore de Saussure. A Swiss chemist and plant physiologist who was a major pioneer in the study of photosynthesis. He discover that Nitrogen was an essential nutrient for plant growth.
- Born into a wealthy family of accomplished natural scientist, including his father, grandfather, and uncle.
- He discovered that nitrogen is vital because it is a major component in chlorophyll.
- Chlorophyll is the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide.

1828- Synthetic Urea was created

- Urea was found in human urine in 1773 by H.M. Roelle.
- Friedrich Wöhler synthesized Urea in 1828.
- This was the first organic compound to be synthesized from inorganic starting materials.
- It was an accident. Wöhler was attempting to synthesize ammonium cyanate by treating silver cyanate with ammonium chloride.
- The result was a white crystalline material which proved to be identical to urea found in urine.
- Urea is produced commercially by reacting carbon dioxide with anhydrous ammonia under high pressure and high temps. (140 million tons)

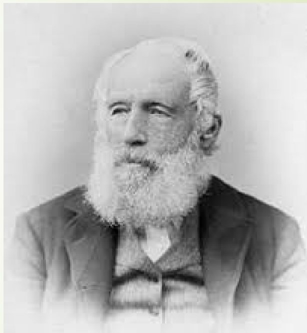


Early uses of Urea

- Pharmaceutical - Urea and malonic acid form barbiturates. Discovered in 1864 by Adolf Bayer.
- Resin - Melamine is formed by dehydration of urea. Used in adhesives, laminates and various coatings.
- Agriculture - Used as a Nitrogen fertilizer.

1842- First patented fertilizer

- Sir John Bennet Lawes creates the first commercial fertilizer by treating phosphates with sulfuric acid.
- Created single super phosphate.
- English entrepreneur that experimented with manure and its affect on plant growth in pots and field crops.
- Founded the Rothamsted Experiment Station, the oldest ag research station in the world.
- Studied the effects of different fertilizers on potted plants and field grown crops as well as plant nutrition and how it relates to animal feed quality.



1884- UF first synthesized

- Urea formaldehyde first synthesized by Dr. Holzer in 1884.
- 1919- Hanns John of Prague, Czechoslovakia, patented the first UF resin.

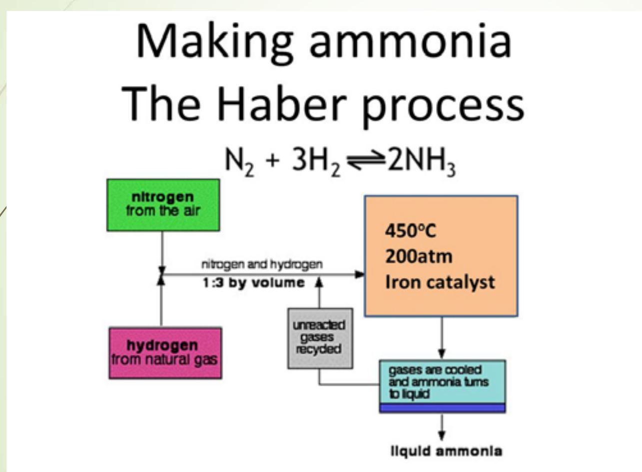
Urea Formaldehyde and its many uses in addition to fertilizer

- Laminates
- Textiles
- Wrinkle resistant fabric
- Cotton blends
- Rayon
- Bonding agent for particle board, fiber board, and plywood

Early 1900's
Two major advances

- 1910- Haber process is invented. This process produces ammonia (NH_3).
- Founded by German chemist Fritz Haber and Carl Bosch
- The process was purchased by German company BASF
- Mainly used for fertilizer, but during World War I it was used for German explosives

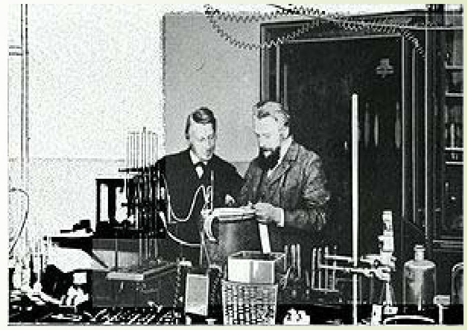
Haber Process



- This process is an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia.
- The process converts atmospheric nitrogen (N_2) to ammonia (NH_3) by a reaction with hydrogen (H_2) using a metal catalyst under high temps and pressure,

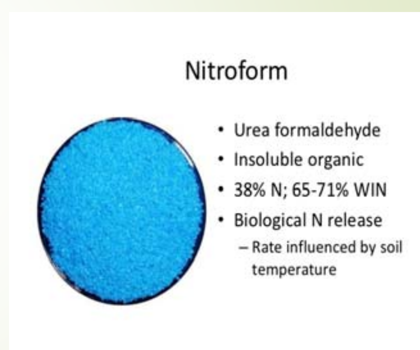
Early 1900's

- Wilhelm Ostwald invents a process which produces nitric acid (HNO_3).
- The ammonia created in the Haber process was converted into nitric acid.
- Without the Haber process we would not have commercially available ammonium nitrate or urea.



1955- Nitroform Urea Formaldehyde offered for sale

- Nitroform became commercially available in 1955 with many additional short chain methylene urea products following.
- In 1956 Auburn University conducted a study on loblolly pine seedling.
- The study conclude that one application of UF 38-0-0 (632 lbs. per acre, 240 lbs. of N) resulted in seedling heights equivalent to those receiving 8 separate applications of straight ammonium nitrate 34-0-0 (1,141 lbs. per acre, 388 lbs. of N).
- First true slow release fertilizer.



Controlled Release Fertilizers

Controlled Release Fertilizer

Timeline continued

- 1960- Archer Daniels Midland Corp creates OSMOCOTE.
- 1991- Pursell Technologies-Perfects and Commercializes POLYON.
- The color green included in the patent.
- Mid 90's Haifa begins selling Multicote in the US.
- Today multiple technologies available from multiple companies.

POLYON, Osmocote, Nutricote, Multicote, Florikote, and Gal-xe.

OSMOCOTE STORY

- Mid 1960s- Archer Daniels Midland Corp. - Creates OSMOCOTE it proves to be too expensive for cereal crops.
- Shortly after the OSMOCOTE know-how was sold to Sutter Hill who formed Sierra Chemical.
- Early1970s - Sierra is sold off to private investors. Robert Severns becomes president of this new private company (Sierra).
- New processes and procedures are created to make a better more consistent product. Marketing into high value crops is the direction.
- Late 1980s - Sierra Chemical is sold to W.R. Grace and become Grace-Sierra.
- 1994 - Grace Sierra is sold to The Scott's Miracle-Gro Co.
- 2011- ICL (Israel Chemicals Ltd) purchases Scott's Professional.

1970's- Sulfur Coated Urea is created

- 1968-1978: Tennessee Valley Authority-TVA Creates a technology that sprays sulfur and a layer of sealant onto urea.
- 1975- CIL (Now Agrium)
- 1980- Lesco (Now Turf care Supply)
- 1982- Scott's Co.
- 1985- Pursell Technologies

- 1990-2007: Owned by Pursell Technologies
- 2007-2014: Owned by Agrium Advanced Technologies
- 2014-Present: Owned by Koch Agronomics

- THE POLYON MARKETPLACE

HARRELL'S- Exclusive Formulator and sales and marketing arm for POLYON east of the Rockies- Mid 90's-2014

SIMPLOT- Exclusive with POLYON west of the Rockies (APEX Brand)

POLYON TODAY

- Formulated and marketed exclusively by HARRELL'S coast to coast since 2014.
- ANYTHING POLYON GREEN is now formulated, manufactured and marketed in the HARRELL'S Brand.
- Distribution agreement with Marion Ag Service in PNW.
- 2014- Simplot parts ways with POLYON and begins making APEX with Gal-xe

IMPACT OF CRFs
Why we should use them

- BEST MANAGEMENT PRACTICE #98 (BMP #98): Controlled Release Fertilizers should be used and applied at manufacturers recommended rates. Reapplication should occur only when substrate solution nutrient status is below desired level for your specific crop.
- Very efficient use of nutrients. Nutrients release over a specific time frame. Many times matching the demand from the crop.
- Reduced nutrient leaching and run-off due to gradual release of nutrients into the growing substrate.
- Reduces volatilization of ammonia (NH_3), only small portions being released.

IMPACT OF CRFs
Why we should use them

- Reduces soluble salt injury.
- Reduces potential contamination of surface water and nearby waterways.
- Increases irrigation efficiency. (Not “feeding” when raining).

IMPACT Continued
Why we use CRFs

- They simply work!! Multiple studies show that a plant grown with CRF produces equal sized plants to those grown with soluble feed and with greater efficiency.
- Reduce labor and energy use- in certain operations the time it takes to continually mix soluble fertilizer is considerable.
- With CRFs it’s one and done.
- Extended shelf life at the retailer level.

What are Controlled-release Fertilizers?

AAPFCO Definition:

- Fertilizers containing a plant nutrient in a form which either (a) delays it's availability for plant uptake and use after application, or (b) which is available to the plant significantly longer than a reference 'rapidly available nutrient fertilizer' such as ammonium nitrate or urea, ammonium phosphate or potassium chloride.
  AAPFCO, 1995

Slow-release Fertilizers vs. Controlled-release Fertilizers

- SRF Release Mechanisms ARE NOT Controlled
- SRFs Have "Unavailable" Nutrients
- SRFs are LESS "Efficient" than CRFs

Slow-release Fertilizers

SRFs	Products
Natural Organics	Milorganite
Synthetic Organics	IBDU, Nitroform
Sulfur Coated	Poly S, Trikote

SRFs Vs. CRFs

- SRF Release Mechanisms ARE NOT Controlled
  - Hydrolysis - (IBDU) Water, particle sizes
  - Mineralization - (Nitroform) Microbial activity, soil temperature, moisture level, oxygen
  - Catastrophic (SCU) - coating breakdown, nutrients dissolve

CRFs

- Conventional water-soluble fertilizer materials (substrates) are given a protective coating or encapsulation (water insoluble, semipermeable or impermeable with pores) that controls water penetration and the rate of nutrient dissolution and nutrient release.

Factors that Play a Role in CRFs Performance

- Coating
- Moisture
- Temperature
- Substrate
- Nursery Manager

Coating

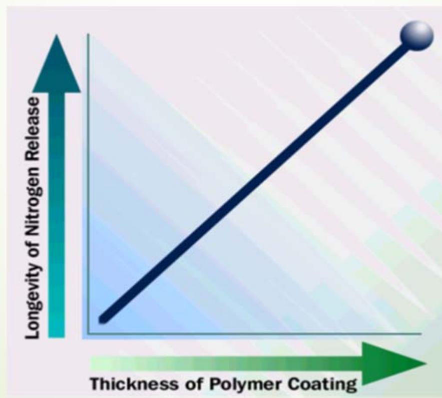
- The Coating is the "CONTROL" in CRFs
- MUST maintain coating integrity
- Coating Porosity

Coating Porosity

- Relates to the openness of the resin or polymer coating and the ability for water/nutrients to move through it.
- Can be "manipulated"

Coating

- Release is a function of coating thickness for most coated products.



Factors that Play a Role in CRF Performance

- Coating
- Moisture

Activation is dependent on moisture but much lower then the wilting point.

Moisture

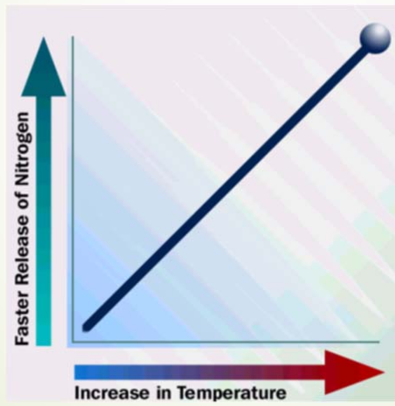
- Activates the CRF release mechanisms
- Initiated by soil moisture and/or water
- Saturation process

Factors that Play a Role in CRFs Performance

- Coating
- Moisture
- Temperature

Direct correlation between temperature and nutrient release

Polyon and Temperature



Temperature

- Product longevities are based on release data at a “specific” temperature
- 70 F= Osmocote, Multicote, Florikote, Gal-xe
- 77 F= Nutricote
- 86 F= POLYON

Factors that Play a Role in CRFs Performance

- Coating
- Moisture
- Temperature
- Substrate

Substrate

- Prill vs. Granule
- Shape (angular/round)
- Surface Smoothness
- Particle Size
- Water Solubility (NPK)

Factors that Play a Role in CRF Performance

- Coating
- Moisture
- Temperature
- Substrate
- Nursery Managers

Nursery Managers

- Product Choice
  - Proper Selection
  - Proper Rate
  - Proper Application
  - Proper Displacement

Nursery Managers

- Growing Media Concerns
  - Bark
  - Peat
  - Native Soils
  - Sand
  - Other Amendments?

Nursery Managers

- Irrigation Concerns
  - Type
  - Water Source
  - Water Quality
  - Frequency
  - Salts Monitoring

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