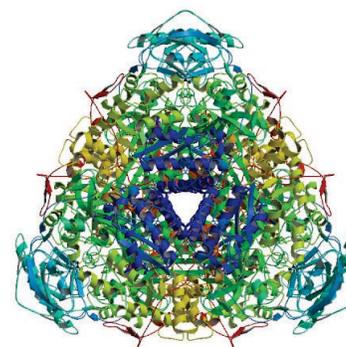
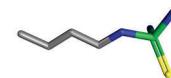
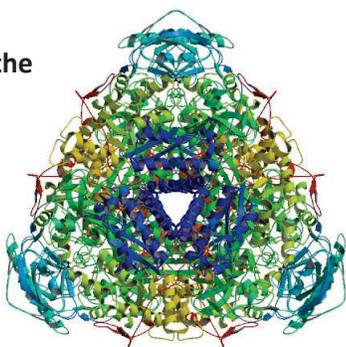


Ammonia volatility from surface/near surface application increases with

Residue

Soil pH

Urea is acted on in the 'keyhole' structure of the urease enzyme



N-(N-Butyl)thiophosphoric triamide

Has same tri-atom configuration as urea

NPPT has same tri-atom structure, but tail has an additional C group.

NBPT (Agrotain and siblings) and NPPT (Limus)

are the only chemistries known to inhibit urease activity for days (usually about 10) (Agrotain Ultra- 26.7% NBPT, use rate 3 qt/t of urea AU density is 8.9 lb/gal [6.7 lb NBPT/T])

Ammonium thiosulfate has measureable short-term activity, but NBPT is much better.

ATS does not directly affect the urease enzyme and is only indirectly inhibiting after interacting with soil-

Thiosulfate reacts rapidly and abiotically with soil, forming tetrathionate and liberating Fe²⁺ and Mn²⁺



Nitrification-

$$\text{NH}_4^+ \xrightarrow{\text{'Slow'}} \text{NO}_2^- \xrightarrow{\text{'Fast'}} \text{NO}_3^-$$

\uparrow
 \nwarrow

Nitrosomonas spp *Nitrobacter spp*

Factors influencing rate of transformation-
Moisture (moist, not saturated)
Temperature- max ~ 80F, min 32F
pH- favored by pH > 7 slowed by pH < 6

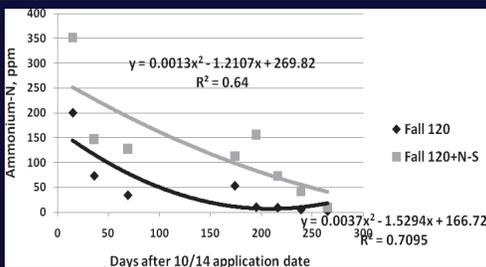
Nitrapyrin-
 2-Chloro-6-(trichloromethyl)pyridine (N-Serve®/Instinct®)



Nitrapyrin mode of action is as a bactericide or at least it greatly decreases bacteria ability to oxidize ammonium.

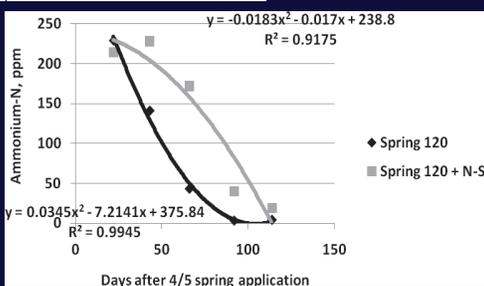
Active at concentrations as low as 1 ppm if the nitrapyrin is available all at once.

From PubChem
<https://pubchem.ncbi.nlm.nih.gov/compound/nitrapyrin#section=3D-Conformer>



**Fall N, Touchton et al., 1978
 N-Serve 24, Illinois**

**Spring N, Touchton et al., 1978
 N-Serve 24, Illinois**



Some studies showed a yield increase with N-Serve, while others showed no yield increase. Yield increases were more a result of weather between application and N uptake rather than performance of the product.

Yield increases over the seven years in Minnesota were 15 bushels per acre more for fall anhydrous ammonia + N-Serve over fall anhydrous ammonia alone, and 27 bushels per acre more for spring anhydrous ammonia compared to fall anhydrous ammonia (Randall et al., 2008).

Inherent issues with N-Serve for ammonia

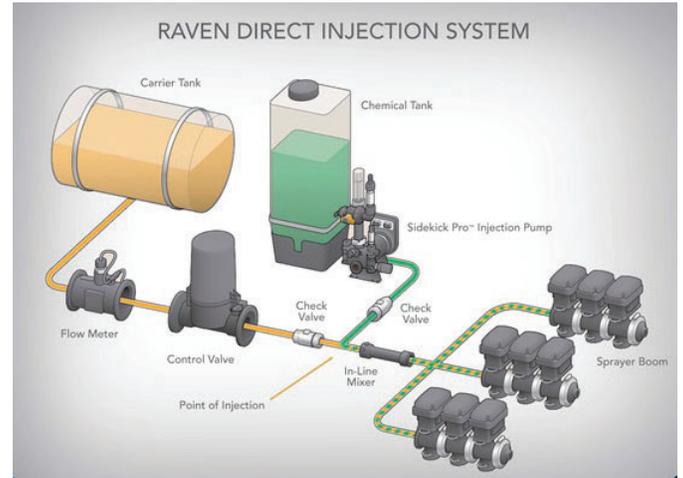
Corrosive-

Replace aluminum float-gauges with stainless steel

Replace normal acme gaskets with BunaN gaskets/Teflon

First time use, be prepared to clean out screens frequently on first tank fill of each tank

Volatility- 2-3 times more than the most volatile incorporated herbicides



Direct injection system (not an endorsement)

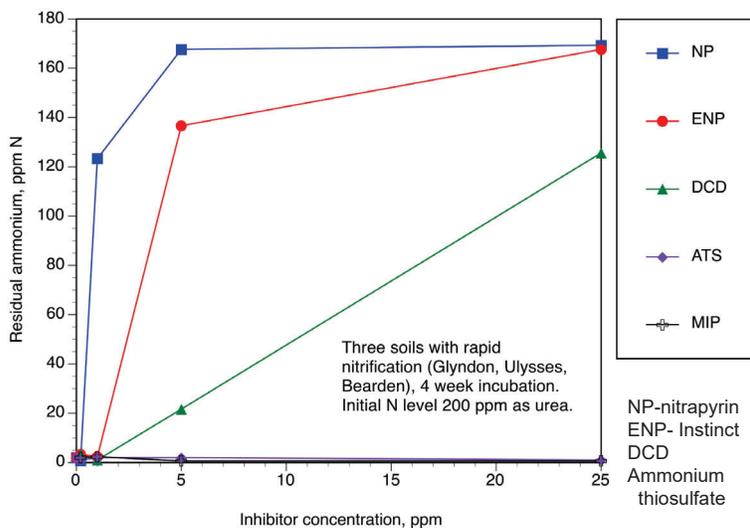
Instinct II® is a new formulation of Nitrpyrin that can be mixed with ammonium fertilizers and can stay on the soil surface without incorporation.

The formulation is microencapsulated nitrpyrin.

That means that nitrpyrin release is slow compared to nitrpyrin for ammonia.

Release rates of Instinct indicated a slow release through the encapsulation, with only 14% released in a 70 day incubation study. (Menelas, 2014, PhD thesis, Purdue).

Speculated that use in the field might be better if soil pH/soil biology acted on the microencapsulation.



Field study, Purdue (Omonode and Vyn, 2013, AJ)

Instinct treated UAN had higher ammonium and lower nitrate than untreated UAN.

Nitrification was significantly reduced. Nitrous oxide emissions were reduced 44%.

Wisconsin 2008-2012

Laboski and Andraski, 2013 Wis Fert and Lime

Soil ammonium levels were higher and soil nitrate levels lower with Instinct than without.

Yield increases documented, as well as sites with no yield differences.

DCD- Dicyandiamide

First developed as a fertilizer (66.7-0-0)

Found that DCD was toxic to plants when DCD was used at rates equivalent to use as a fertilizer

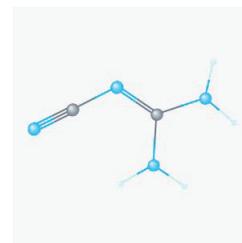
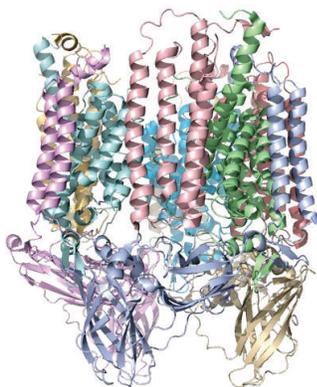


Image from PubChem

<https://pubchem.ncbi.nlm.nih.gov/compound/Dicyandiamide#section=Top>

DCD is bacteriostatic- It interferes with bacteria metabolism, preventing replication. Mode of action proposed is inhibition of ammonia monooxygenase, a key enzyme in nitrification.



Ammonia monooxygenase

http://www.genome.jp/dbget-bin/www_bget?mca:MCA1797+mca:MCA2854

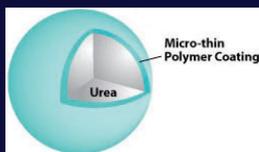
DCD- a nitrification inhibitor

Found in **AgrotainPlus** (Agrotain, Int.)
SuperU (Agrotain, Int.)

Others.....

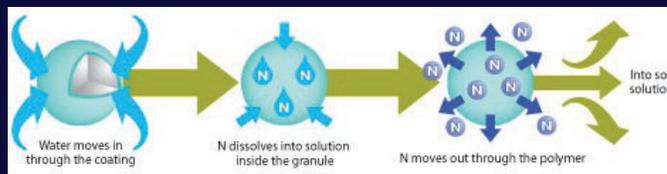
Needs to be added at >1% of total N content of fertilizer needing protection.
Best commercial product is about 1.2%

ESN- Agrium



Images from Agrium ESN website

How ESN works (Agrium website)



Urea in ESN remaining after field burial, Casselton, ND, fall 2013.
Ransom, unpublished data, North Dakota State University.

Date of sampling	Date of burial	
	10/11	10/25
	% urea remaining	
10/25/2013	89 a	na
11/08/2013	84 a	96 a
04/29/2014	55 bc	65 b
05/13/2014	50 c	59 bc
05/27/2014	37 d	45 cd
06/10/2014	na	38 d

Illinois-

4 locations over 12 years, ESN was similar in corn yield to urea + Agrotain, and 3 bu/a higher in yield than urea alone.

In 4 years of no-till, ESN was 21 bu/a better than urea surface-applied.

(Ebelhar et al., 2010)

Minnesota-

3 different ESN application methods- deep band (4 inches), broadcast incorporated fall and spring resulted in similar corn yield to urea using the same methods over a 4-year period.

(Randall and Vetsch, 2009)

Corn grain yield as affected by 80 lb N/acre applied as N source, timing, method of application and additive. Manhattan, KS. Weber and Mengel 2009.

Treatment	Yield, bushels/acre
Control	104
Winter urea	138
Winter ESN	154
Spring urea	165
Spring Urea + Agrotain	169
Spring Urea as SuperU	173
Spring ESN	167
Spring 50% ESN:50% Urea	174
Spring UAN broadcast	148
Spring UAN + Nutrisphere	149
Spring Coulter UAN	162
LSD (0.05)	19

Best fit for ESN-

Spring wheat/Durum- in soil

Corn as a blend in preplant to keep plant healthy until side-dress

Maybe a 4 part urea / 1 part ESN

Enough ESN to carry N into late grain fill season for higher protein.

What about other products where a claim of N activity is made, but there is no mode of action nor is there convincing evidence they they work on N availability at all?

Buyer beware is more important these days than ever-

- Letting Tech reps go
- Development, then maybe research
- Be extremely skeptical

<http://extension.agron.iastate.edu/compendium/index.aspx>

You can find this link at the bottom of my home page

<Dave Franzen NDSU>

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