
FLUID FORMULATION 102
And
Other Stuff !!
FLUID FERTILIZER FOUNDATION
Louisville, KY
Dec. 8-9, 2015
Jim May, J. May Equipment

You Ever Hear This?

"It Settled Out In The Tanker !!!"

"The Applicator Can't Apply It !!!"

"The Storage Tank Is Full Of Crystals and Plugged Up !!!

Tanks, Tankers and Applicators Do Not Cause Product Problems

The Product Was Bad When It Came Out Of The Mix System

PROBABLE CAUSE

FORMULATION and/or SEQUENCE

MECHANICAL LIMITATIONS

Don’t try vast projects with half vast equipment !!!

RAW MATERIALS

PEOPLE

WHAT'S IN A DEFINITION?

DEFINITION: Hot Mix

Blending ingredients which cause a reaction.

Usually involves Anhydrous Ammonia or Aqua Ammonia Plus a Phosphate.

generates heat by reaction.

DEFINITION: Cold Mix

- Blending ingredients with no detectable reaction. Does not involve Anhydrous Ammonia or Aqua Ammonia reactions.

  Does not generate heat by reaction.

COLD MIX

- Combining all liquid ingredients
- Clear liquids or suspensions
- Combining liquid and dry ingredients
- Primary, Secondary and micronutrients

COLD MIX

- Hot water or steam makes the mix hot….It is still a “cold blend”
- Outside heat sources do not qualify as a “hot mix”
- Only reaction heat, typically NH3 and low pH phosphate, is a hot mix.. Others are cold mixes!!

COLD MIX !!!

DO NOT USE A "LITTLE BIT" OF AMMONIA TO GET A LITTLE HEAT!!!

Hot Mix

- Heat Generated By Reaction
- Typically Involves Anhydrous Ammonia or Aqua Ammonia
- Both React With Low pH Phosphate Sources To Generate Heat
- Maintaining 1 to 3 Ammonia Nitrogen to P_2O_5 Can Control Heat

Hot Mix

Main Reactive Ingredients

Anhydrous Ammonia, 82-0-0

+1750 BTU per Pound

Aqua Ammonia, 24-0-0

+1400 BUT per Pound Of NH3

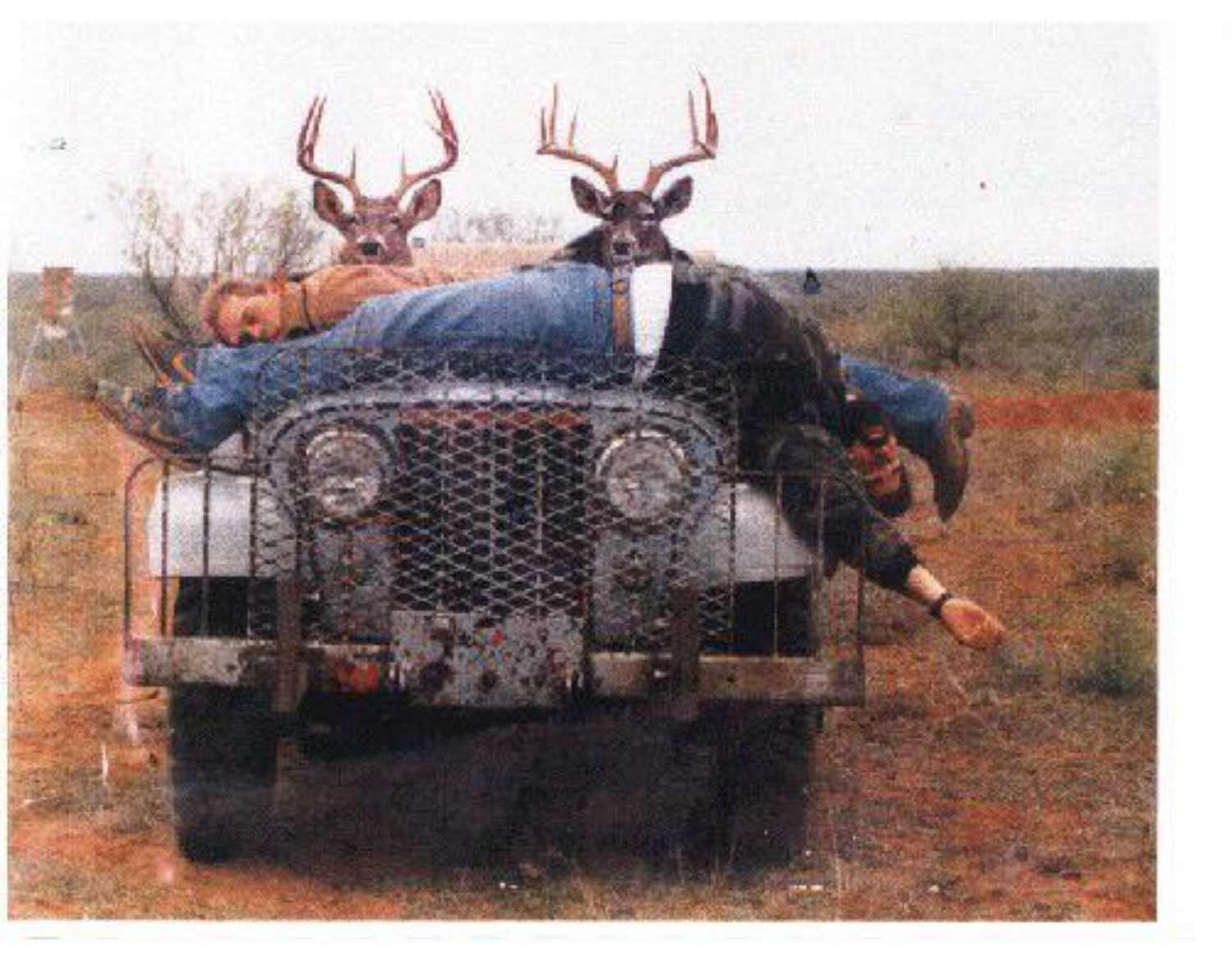
Phosphoric Acid

+ 100 BTU per Pound

Hot Mix

- Typical Heat Of Reaction
- MAP & Ammonia (Anhydrous or Aqua Ammonia)
- Phosphoric Acid & Ammonia
- (Anhydrous or Aqua Ammonia)
- DAP, Phosphoric Acid & Ammonia
- (Anhydrous or Aqua Ammonia)
- DAP Will NOT Breakdown Without Acid and Ammonia
- NEVER Ammoniate 10-34-0 !!!

GET THINGS IN ORDER



JUST A LITTLE …
"COMMON SENSE" *BLENDING*

- Micronutrients are usually small amounts. Add immediately after the water, especially dry materials.
- ** Just the opposite with hot mixes, add last*
- *All liquids, <u>Clear,</u>* sequence is less important. Add large ingredient amounts first. Small amounts may not completely clear the ingredient manifold.
- Reserve some water for flushing

COMMON SENSE CONTINUED

- *All liquids, Suspension,* sequence is important. Add suspension base grades after water. Add additional clay, if needed, before nitrogen solution.
- Low "P" from 10-30-0, additional clay may not be necessary if good quality 10-30-0
- "P" particles are so small that they can be sparged to limit settling. Apply very soon!

MO' COMMON SENSE

- DO NOT make high potash base grades for storage !!!
- THEY DO NOT STORE WELL
- Add to the operators mix hours
  Double mix time
- Limit some formulas, low analysis
- Add as a dry,
  62% high concentration

LIQUID / DRY BLENDS

- Clear liquids with potash, add the potash as soon as possible.
- Watch liquid to dry ratio, make sure it will pump.
- Quick in with potash…. The agitator, pump impeller and fluid velocity are helping dissolve during the mixing cycle
- As additional liquid enters the final dissolving takes place

JUST SOME RANDOM POINTS, LIQUID / DRY BLENDS

- In clear liquids add dry materials that create an endothermic reaction in order of highest minus BTU first
- Example:

Ammonium Nitrate,	< 145 (1st)
Urea	< 110 (2nd)
Ammonium Sulfate	< 100 (3rd)
Potash	< 100 (3rd)

All as soon as possible into liquid

RANDOM POINTS, LIQUID / DRY BLENDS

- Add additional clay before Nitrogen Solution.
- Dry clay it will not gel properly in the presence of Nitrogen Solution
- Liquid clay will "clabber" when added to high Nitrogen Solution. Difficult to break up lumps.

SUSPENSION COLD BLEND POINTS

- High Potash Suspensions. Water, Phosphate base grade then Add Clay , other ingredients if any, potash last
- Once it is not “chocolate syrup in vanilla ice cream” ripple, pump it out.
- Gel clay before adding potash.
- It does not matter how much potash dissolves. This is a suspension.
- Stop over mixing, pump it out..

SOME MORE POINTS

- HIGH NITROGEN GRADES, Nitrogen comes from phosphate,10-34-0 or 10-30-0
- Also as supplemental Nitrogen from, 32-0-0, 28-0-0 or 12-0-0-26
- Rule of Thumb: 50% of supplemental Nitrogen requirement can be from Urea

UREA SOLUTION

- **50% UREA SOLUTION TEMPERATURE CALCULATION**
- 50% Urea solution has a S.O.T. (Salt Out Temperature) of 56 Deg. F.
- **Typical Calculation:** 50% Solution, 1,000 Pounds Water
- 1,000 Pounds Urea
- 2,000 Pounds Total
-
- Urea = -110 BTU per pound (-110 x 1,000 pounds = 110,000 negative BTU's
-

UREA SOLUTION

The Minimum Hot Water Temperature to Achieve Total Dissolution of the Urea.

110,000 BTU ÷ (1,000 Pounds Water x 1 BTU/ºF) = 110º F the Water will Cool

Salt Out = 56º F

110º F + S.O.T. 56º F = 166º F Minimum Hot Water Temperature to Dissolve the 1,000 Pounds of Urea

Desired Finish Product Temperature 80ºF

110º F the Water will Cool + 80º F Desired = 190º F Production Water Temperature.

UREA SOLUTION

UREA – WATER SOLUTIONS							
GRADE	% UREA	Ton Formula Urea *	Water	Specific Gravity	LBS/GALS	SALT OUT TEMP	MINIMUM HOT WATER TEMP.
14-0-0	30.43	610	1390	1.087	9.06	10°F	58°F
15-0-0	32.60	652	1348	1.092	9.10	14°F	67°F
16-0-0	34.78	696	1304	1.098	9.15	18°F	76°F
17-0-0	36.96	740	1260	1.105	9.20	23°F	88°F
18-0-0	39.13	783	1217	1.110	9.25	28°F	99°F
19-0-0	41.30	826	1174	1.117	9.31	33°F	110°F
20-0-0	43.47	870	1130	1.123	9.36	39°F	124°F
21-0-0	45.46	910	1090	1.129	9.41	45°F	137°F
22-0-0	47.82	957	1043	1.136	9.47	52°F	153°F
23-0-0	50.00	1000	1000	1.157	9.64	56°F	166°F

OTHER UREA USE

- About 40 pounds of urea per ton in clear liquid blends with micronutrients will sequester micronutrients and reduce settling or separation

AMMONIUM SULFATE

21-0-0-24S

Negative -110 BTU per Pound

Makes a 8.7-0-0-10S

If you use Hot Water for a higher analysis it will saltout quickly

Limited in Blends by the Low Analysis

KCL, 0-0-62+

- Most Use 0-0-62 for Formulas
- If the supplier list it as a higher analysis 0-0-62.4. use the higher analysis. It could offset part of the freight. Also adds to profit

Negative 90 BTU per Pound

Add to Batch As Soon As Possible

PROPERTIES OF POTASSIUM CHLORIDE SOLUTION

Source: NFDC, Fluid Fertilizer Reference Manual

Potassium Chloride containing 62% K2O

K_2O Wt %	Potassium Chloride Lb/Ton	Water Lb/Ton	Saltout Temp ° F	Heat Needed +BTU	Est. H_2O Temp
10	323	1.677	18	29,070	35
11	355	1,645	16	31,950	35
12	388	1,612	13	34,920	35
13	420	1,580	24	37,800	48
14	452	1,548	36	40,680	62
15	484	1,516	50	43,560	79
16	517	1,483	68	46,530	99

APP, The "Standard"

- 10-34-0 or 11-37-0
- Easy To Use, Not Indestructible
- NEVER AMMONIATE APP
- If In A Blend With Phos Acid and NH_3, It Must Be Added After The NH_3
- Water Credit 25% of Amount In Blend

Ammonium ThioSulfate 12-0-0-26

- **Thio-Sul® TECHNICAL DATA**
- Total Nitrogen (N).....12%
- (As Ammoniacal Nitrogen)
- Total Sulfur (S).....26%
- (Derived From: Ammonium Thiosulfate)
- Density pounds per gallon at 60ºF..... 11.10
- Gallons per ton..... 181.00
- Salting out temperature ºF..... 43ºF to 45ºF
- Typical pH.....7.2 - 8.00
- Specific Gravity ..... 1.325 lbs. per gallon
- Lbs. N per Gallon..... 1.3
- Lbs. S per Gallon..... 2.8
- Ammonium thiosulfate (NH4) S203

UAN, Urea Ammonium Nitrate Solution

- **32-0-0**
  - TYPICAL PROPERTIES:
  - Total Nitrogen (as N), Wt% 32%
  - Free Ammonia, ppm 500 maximum
  - Ammonium Nitrate, wt. % 43 – 48
  - Urea, wt. % 33 – 36
  - Water, wt. % 19 – 20
  - Corrosion Inhibitor, ppm 150 – 250
  - Specific Gravity at 60°F 1.32
  - Density at 60°F, lbs/gallon 11.0
  - Vapor Pressure 0
  - Salt-Out Temperature, °F 32

- **28-0-0**
  - TYPICAL PROPERTIES: Total Nitrogen (as N), Wt% 28.00%
  - Ammoniacal Nitrogen, Wt % 6.90%
  - Nitrate Nitrogen, Wt % 6.90%
  - Urea Nitrogen, Wt % 14.20%
  - Pounds of N Per Gallon at 60 Degrees F 2.98
  - Specific Gravity @ 60 degrees F 1.279
  - pH, as is 6.5 - 7.0
  - Wt Per Gallon 10.66 lbs.
  - Gallons Per Ton 187.60
  - Odor slight ammonia smell
  - Freezing Point Degree F -16

IT HAPPENS SOMETIMES!!

- When making cold blends from 10-30-0 suspension and 32-0-0 OR 28-0-0, crystals form. Lots of crystals !!!
- These are usually clear, cubical DAP crystals.
- The cause is free ammonia in the Nitrogen Solution. Discuss with your supplier, usually does not do any good but you get to B_ _ _ _
- Over ammoniates the MAP, causes high pH and crystals form quickly.
- Can also create high viscosity

HOW TO COPE !!

- With a mix system recirculate through the eductor. The venturi tube will break the crystals down.
- Back pressure in the pump will also break them up
- High shear agitation

METER BLENDING

- Blend in the transport with all liquid ingredients and a meter system
- Legal For trade meters are expensive…
- Use a truck scale for Sales and a less expensive meter can be used
- Blend without water. Unless you need a “filler” to meet an exact analysis

METER BLENDING

- With all liquids the end product typically will not be more viscous that the most viscous ingredient in the blend.
- Take care with some product reactions
- Blending is by fluid velocity. Do not scrimp on the pump.
- One product into the transport at a time. Sparge if possible. Slosh in the transport to help mix.

COLD BLENDS

- Easy
- Use a formulation sheet
- KNOW WHAT YOU ARE MAKING, CLEAR LIQUID or SUSPENSION
- NO NH3 or AQUA
- Especially do not ammoniate 10-34-0, not even “just a little”

Lab Worksheet:

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LAB WORKSHEET

PRODUCT	ANALYSIS	-N-	-P-	-K-	- -	- -
BLEND	ANALYSIS					
	Ounces					
INGREDIENTS						
Total						

Beginning Temp_____ Reaction Temp _____ Final Temp _____
Comments:

_____
_____
_____
_____
_____
_____

Sample Visual Separation; 1 Day _____ Room Temp ___ Cold _____
Summary:

_____
_____
_____
_____

MAKE IT ALL

- Prescription blends to a soil sample
- Commodity blends to a ton
- Clear Liquids
- Suspensions
- Even Dissolve MAP 50%/50% in Hot water
- Base Grades Speed production during busy times
- Maximum Product Output

IT'S ALL POSSIBLE

J. May *Equipment Group* **FORMULATION WORKSHEET** **Date: 12-8-2015**

Customer: KITCHEN SINK **Field #/ Location Louisville, KY**

Number of Acres	X	Pounds Per Acre =	Total Pounds Required
Total Pounds Required		÷ 2,000 =	Total Tons÷ Batch Size= Number Batches

1 to 3 Ammonia N to P_2O_5 Ratio

Total P_2O_5 ÷ 3=		Total Ammonia N
Less MAP/DAP N		
Total		N from NH_3/Aqua

		GRADE						Total % Units						
		N	P	K	S									
		% 15	% 5	% 7	% 4	%	%	* Credit Equiv.						
Material	**Pounds**	Lb. 300	Lb. 100	Lb. 140	Lb. 80	Lb.	Lb.	Lb. H_2O	Lb. Clay	Cost/ Ton	Cost / Lb.	Total Cost	Pounds/ Batch	Scale Stop
WATER	584													
10-34-0	294	29.5	100											
46-0-0	236	108.5												
0-0-62	226			140										
32-0-0	339	108.5												
12-0-0-26	154	18.5			40									
21-0-0-24	167	35			40									
TOTALS	2000	300	100	140	80									

TEMPERATURE CALCULATION

HEATERS				VS	COOLERS			
Pounds	Product	BTU/ Lb.	Total BTU		Pounds	Product	BTU/ Lb.	Total BTU
	NH_3	1750				Urea	< 110	
	Aqua	1400 / Lb. NH_3				Ammonium Nitrate	< 145	
	Phos Acid	100				Ammonium Sulfate	< 110	
	Steam	1000				Potash	< 90	
	160° Water	120						
	Total Heaters					Total Coolers		

Total Heaters		
Less Total Coolers		
Net BTU		
Net BTU ÷ (Batch Weight X .8) = Degrees Temperature Change		° F

Example: +16,000 Net BTU ÷ (2000x.8) 1600 = +10° F *Starting Water/ Batch Temp + Change = Final Temp. (55°+10°= 65°F)*

***H2O CREDIT % EQUIVALENT**

32-0-0	20%	28-0-0	25%	Aqua	70%	10-34-0	25%	12-0-0-26	25%
10-30-0	20%	Phos Acid	15%	High K-Base Grades	15%				

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FLUID FORMULATION 102
And
Other Stuff !!

Thank You !!!

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