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
I’ll ask you again sir! Did you, or did you not look at my client and, in a crowded shopping mall, in front of her children, call her, not once, but three times...a “ho”!
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 $\text{P}_2\text{O}_5$ 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 !!!
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, Clear, 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 (1\textsuperscript{ST})

  Urea < 110 (2\textsuperscript{ND})

  Ammonium Sulfate < 100 (3\textsuperscript{RD})

  Potash < 100 (3\textsuperscript{RD})

  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**
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/°F) = 110° F

the Water will Cool

Salt Out = 56° F

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

Desired Finish Product Temperature 80°F

110° F the Water will Cool + 80° F Desired = 190° F Production Water Temperature.
## UREA SOLUTION

### UREA – WATER SOLUTIONS

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

Potassium Chloride containing 62% K2O*

<table>
<thead>
<tr>
<th>K₂O Wt %</th>
<th>Potassium Chloride Lb/Ton</th>
<th>Water Lb/Ton</th>
<th>Saltout Temp °F</th>
<th>Heat Needed +BTU</th>
<th>Est. H₂O Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>323</td>
<td>1.677</td>
<td>18</td>
<td>29,070</td>
<td>35</td>
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<tr>
<td>11</td>
<td>355</td>
<td>1.645</td>
<td>16</td>
<td>31,950</td>
<td>35</td>
</tr>
<tr>
<td>12</td>
<td>388</td>
<td>1.612</td>
<td>13</td>
<td>34,920</td>
<td>35</td>
</tr>
<tr>
<td>13</td>
<td>420</td>
<td>1.580</td>
<td>24</td>
<td>37,800</td>
<td>48</td>
</tr>
<tr>
<td>14</td>
<td>452</td>
<td>1.548</td>
<td>36</td>
<td>40,680</td>
<td>62</td>
</tr>
<tr>
<td>15</td>
<td>484</td>
<td>1.516</td>
<td>50</td>
<td>43,560</td>
<td>79</td>
</tr>
<tr>
<td>16</td>
<td>517</td>
<td>1.483</td>
<td>68</td>
<td>46,530</td>
<td>99</td>
</tr>
</tbody>
</table>
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 NH₃, It Must Be Added After The NH₃
- 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 60°F ...................................... 11.10
  - Gallons per ton ....................................................................... 181.00
  - Salting out temperature °F ............................... 43°F to 45°F
  - 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
### 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

## J.MAY

**Equipment Group**

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817-733-6563
Fax 817-274-1255
3544 Center Blvd. Arlington, TX 76013

www.jmayequipment.com  e-mail: jmay@jmayequipment.com

## LAB WORKSHEET

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>ANALYSIS</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BLEND</td>
<td>ANALYSIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ounces</td>
<td></td>
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<td></td>
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</table>

### INGREDIENTS

<p>| | | | | | |</p>
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<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
</table>

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

**Date: 12-8-2015**

**FORMULATION WORKSHEET**

<table>
<thead>
<tr>
<th>Number of Acres</th>
<th>Pounds Per Acre =</th>
<th>Total Tons</th>
<th>Batch Size=</th>
<th>Number Batches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Pounds Required</td>
<td>+ 2,000</td>
<td>Total Pounds Required</td>
<td>Total P2O5 ÷ 3=</td>
<td>Total Ammonia N</td>
</tr>
</tbody>
</table>

**GRADE**

<table>
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<tr>
<th>Material</th>
<th>Pounds</th>
<th>Lb.</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>Lb.</th>
<th>Lb.</th>
<th>Lb.</th>
<th>Cost/ Ton</th>
<th>Cost / Lb.</th>
<th>Total Cost</th>
<th>Pounds/ Batch</th>
<th>Scale Stop</th>
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<tr>
<td>WATER</td>
<td>584</td>
<td>300</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>15</td>
<td>80</td>
<td>140</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td>10-34-0</td>
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<td>100</td>
<td>29.5</td>
<td>108.5</td>
<td>140</td>
<td>40</td>
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<td>140</td>
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<td></td>
<td></td>
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<td>80</td>
<td></td>
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<tr>
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<td>108.5</td>
<td></td>
<td></td>
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<tr>
<td>12-0-0-26</td>
<td>154</td>
<td>80</td>
<td>18.5</td>
<td>40</td>
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</tr>
<tr>
<td>21-0-0-24</td>
<td>167</td>
<td>100</td>
<td>35</td>
<td></td>
<td>40</td>
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<tr>
<td>TOTALS</td>
<td>2000</td>
<td>300</td>
<td>100</td>
<td>140</td>
<td>80</td>
<td>20%</td>
<td>15</td>
<td>32</td>
<td>25%</td>
<td>70%</td>
<td>25%</td>
<td>10%</td>
<td>25%</td>
<td>25%</td>
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**TEMPERATURE CALCULATION**

<table>
<thead>
<tr>
<th>HEATERS</th>
<th>VS</th>
<th>COOLERS</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Pounds</td>
<td>Product</td>
<td>BTU/ Lb.</td>
<td>Total BTU</td>
</tr>
<tr>
<td>NH₃</td>
<td>1750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aqua</td>
<td>1400 / Lb. NH₃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phos Acid</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160° Water</td>
<td>120</td>
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</table>

Total Heaters  
Less Total Coolers  
Net BTU  

*H₂O CREDIT % EQUIVALENT*

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>32-0-0</td>
<td>20%</td>
<td>28-0-0</td>
<td>25%</td>
<td>Aqua</td>
<td>70%</td>
<td>10-34-0</td>
<td>25%</td>
<td>12-0-0-26</td>
<td>25%</td>
<td>10-30-0</td>
<td>20%</td>
</tr>
</tbody>
</table>

Example: +16,000 Net BTU ÷ (2000x.8) 1600 = +10°F  
Starting Water/ Batch Temp + Change = Final Temp. (55°F+10°F= 65°F)
FLUID FORMULATION 102
And Other Stuff !!
Thank You !!!

Please click to return to the Main Menu and close the current presentation