Blending Compatibility Issues

Allen Haynes
Simplot SGS California
PCA - CCA
Reality

• Issues will occur – You will at some point make a “brick” or create a tub of “cottage cheese”.
• Improper mixing sequences or procedures will occur.
• You will rush the blending time.
• Physical incompatibility will sometimes arise and may create precipitates or “salting out”.
• pH concerns will arise.
• Ambient temperatures will make a difference.
Reality

• A combination that at first seems compatible sits for a few hours and a reaction occurs.
  o An example is CAN 17 mixed with Zinc EDTA- its produced pretty clear, but turns into a white paste looking mixture within 1 or 2 hrs.

• Water quality is your base.
  o It’s the building block that starts your blend.
  o Pay attention to salts, pH, and foreign material.
  o Any issues can reduce solubility, compatibility and cause stability issues.
Classification of Essential Plant Nutrients

Essential plant nutrients (17)

- Framework elements (Taken from air and water: 3)
  - Carbon
  - Hydrogen
  - Oxygen

- Mineral elements (Taken mainly from soil in ionic forms: 14)

  - Macronutrients (6)
    - Primary nutrients (3)
      - Nitrogen
      - Phosphorus
      - Potassium
    - Secondary nutrients (3)
      - Calcium
      - Magnesium
      - Sulphur

  - Micronutrients (8)
    - Zinc
    - Copper
    - Manganese
    - Iron
    - Boron
    - Molybdenum
    - Chlorine
    - Nickel
Advantages of Liquid Fertilizers

• Ease of handling and use
• Require less labor to handle
• 65% \(\text{(est.)}\) of California Agriculture is under micro irrigation. Utilizes the growers equipment.
• Allows for custom blending to specifications (Soil & Tissue test)
• Allows for applying nutrients at critical plant growth stages
• Adheres to the 4R principals
Types of Base Liquid fertilizers

• **Straight Fertilizers**
  o UAN Fertilizers

• **Complex Fertilizers**
  o 10-34-0
  o 11-37-0

• **Mixed Fertilizers**
  o NPK + Micronutrients: Can be classified into
  o Suspension fertilizers: partially dissolved in water, but some of the nutrients, are suspended in the water using suspension agents such as Bentonites, clays, or other gells.
  o Solution fertilizers: Dissolved completely in water
Diagram for Mixing Fertilizers

Select Nutrient Analysis
NPK + Micros

Select Raw Materials

Calculate Nutrient Analysis of mix and prepare a recipe for the mixer

Check for Compatibility Issues
1- Perform a Jar test with same ratios as mix
2- Looks ok: Proceed with the mix
3- Doesn’t look Ok, change the raw materials

Instructions on the Mix order
1- List of all raw materials needed for the mix
2- Total volume of mix
3- Volume of water to be added first
4- Order of addition of the mix raw materials
5- Any special instructions for handling the mix
Formulation Steps

• Confirm Solubility
  o Solubility is defined as the maximal amount of the fertilizer, that can be completely dissolved
  o To be available to plants, at least some of a nutrient must be slightly soluble in the soil solution.

• Confirm Compatibility
  o Put a sample together to make sure of compatibility.

• Make sure of your Order of Addition

• Be aware of the “Ion Effect”
  o Solubility is dependent on other inputs. The solubility becomes reduced when materials have the same element or ion.
  o An example would be Potassium Nitrate and Potassium Sulfate. They are both compatible, however their solubility becomes reduced because each contain potassium.

• Make sure of the quality of product your using.
  o 10-34-0 is a good example.
    ➢ Watch for polyphosphate content or impurities
Water Quality

• Important for formulating the Fertilizer Mix
  o pH
  o EC

• Important for injecting through the irrigation System
  o pH
  o EC
  o Hardness
Salt Out Temp

- Salt out Temp: The Temp at which the fertilizer will fall out of solution and precipitate.
- Reduced Solubility due to high ionic strength
- Important why:
  - Storage of liquid Fertilizers through Winter
  - Mixed fertilizers will have a different Salt out Temp than the separate fertilizers before mixing

<table>
<thead>
<tr>
<th>Product</th>
<th>Salt-out Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-0-0</td>
<td>-1</td>
</tr>
<tr>
<td>32-0-0</td>
<td>28</td>
</tr>
<tr>
<td>10-34-0</td>
<td>-10</td>
</tr>
<tr>
<td>12-0-0-26S</td>
<td>&lt;20</td>
</tr>
<tr>
<td>10-0-0-10Zn</td>
<td>32</td>
</tr>
<tr>
<td>7-21-7</td>
<td>20</td>
</tr>
<tr>
<td>4-10-10</td>
<td>18</td>
</tr>
<tr>
<td>8-21-4-3S-.5Zn</td>
<td>&lt;5</td>
</tr>
<tr>
<td>9-18-4-6S-.5Zn</td>
<td>&lt;5</td>
</tr>
<tr>
<td>9-20-2-7S-.5Zn</td>
<td>&lt;5</td>
</tr>
<tr>
<td>18-13-0-7S</td>
<td>&lt;5</td>
</tr>
<tr>
<td>10-30-0-3S</td>
<td>&lt;5</td>
</tr>
</tbody>
</table>
Order of Addition

• Check your product labels and SDS’s about known incompatibility or insolubility issues
• Should always save a little water to mix with at the end. Use about 50 to 80% up front.
• Should always add your liquid materials before drys. It gives a little more breathing room and sometimes provides a little heat if there is a chemical reaction.
• Always put acid into water – not water into acid!
• Acid products first-then alkaline products- then neutral products last. This reduces the risk of forming precipitates.
• Add your dry material slowly. Too fast just produces clumps and adds to mixing time.
• Don’t mix 2 or more liquid concentrates directly together
Other Factors

• Target your desired salt out temperature.
  o Colder materials take longer to mix.
  o Heat source can speed up mixing time.
  o Potash can can cool your solution and add to mix time.

• On-site storage temperature.

• Confirm any potential tank contamination issues at the delivery site.

• Know your materials!
  o Specific gravity
  o Acid , Base, or Neutral
  o Individual salt out temperatures
  o Individual solubility boundaries

• Most of the issues encountered when producing solution blends are related to the quality of source materials
Compatibility

• When mixing fertilizers to prepare a custom blend. The mix is incompatible if it forms a precipitate.

\[ \text{Ca(NO}_3\text{)}_2 + (\text{NH}_4\text{)}_2\text{SO}_4 \rightarrow \text{CaSO}_4 \downarrow \]

- Calcium Nitrate
- Ammonium Sulfate
- Precipitate of Calcium Sulfate (gypsum)
Don’t be afraid to “Bench Test”
Your Best Friends
Fertilizer Solubility

<table>
<thead>
<tr>
<th>Fertilizer Material</th>
<th>Chemical Formula</th>
<th>Solubility (lb/100 gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>NH₃</td>
<td>750</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>NH₄NO₃</td>
<td>983</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>(NH₄)₂SO₄</td>
<td>592</td>
</tr>
<tr>
<td>Borax</td>
<td>Na₂B₄O₇*10H₂O</td>
<td>25</td>
</tr>
<tr>
<td>Calcium carbonate (limestone)</td>
<td>CaCO₃</td>
<td>0.050</td>
</tr>
<tr>
<td>Calcium metaphosphate</td>
<td>Ca₅(PO₄)₂</td>
<td>0.008</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>Ca(NO₃)₂*4H₂O</td>
<td>1.117</td>
</tr>
<tr>
<td>Calcium sulfate</td>
<td>CaSO₄*2H₂O</td>
<td>2</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>CuSO₄*5H₂O</td>
<td>287</td>
</tr>
<tr>
<td>Diammonium phosphate</td>
<td>(NH₄)₂HPO₄</td>
<td>209</td>
</tr>
<tr>
<td>Dicelium phosphate</td>
<td>CaHPO₄*2H₂O</td>
<td>0.188</td>
</tr>
<tr>
<td>Magnesia</td>
<td>MgO</td>
<td>0.005</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>MgSO₄*7H₂O</td>
<td>709</td>
</tr>
<tr>
<td>Manganese sulfate</td>
<td>MnSO₄*4H₂O</td>
<td>875</td>
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<tr>
<td>Monoammonium phosphate</td>
<td>NH₄H₂PO₄</td>
<td>358</td>
</tr>
<tr>
<td>Monocelium phosphate</td>
<td>CaH₂(PO₄)₂*2H₂O</td>
<td>15.4</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>KCl</td>
<td>233</td>
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<tr>
<td>Potassium nitrate</td>
<td>KNO₃</td>
<td>108</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>K₂SO₄</td>
<td>67</td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>NaNO₃</td>
<td>608</td>
</tr>
<tr>
<td>Urea</td>
<td>CO(NH₂)₂</td>
<td>559</td>
</tr>
<tr>
<td>Zinc sulfate</td>
<td>ZnSO₄*6H₂O</td>
<td>584</td>
</tr>
</tbody>
</table>

Graph showing solubility vs. water temperature for different fertilizers:

- Potassium nitrate
- Potassium chloride
- Potassium sulfate
## Fluid Fertilizer Foundation

### Solutions for Agriculture

**Caution:** This chart contains information based on the opinions of people in the fluid fertilizer industry. This information has been compiled as a general guide only. Neither the Fluid Fertilizer Foundation or contributors guarantee the accuracy of the information. Please refer to manufacturer/supplier product information and also perform a small jar compatibility test prior to final mixing.

<table>
<thead>
<tr>
<th>Fluid 1</th>
<th>Fluid 2</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous Ammonia; 82-0-0</td>
<td>Urea Solution; 23-0-0</td>
<td>Compatible</td>
</tr>
<tr>
<td>Aqua Ammonia; 20-0-0</td>
<td>Ammonium Nitrate Solution; 20-0-0</td>
<td>Limited Compatibility</td>
</tr>
<tr>
<td>Urea Ammonium Nitrate Solution; UAN 28/32-0-0</td>
<td>Ammonium Sulfate Solution; 8-0-0-9S</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Ammonium Polyphosphate Solution; 10-34-0</td>
<td>Ammonium Chloride Solution; 6-0-0-16CI</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Ammonium Thiosulfate Solution; ATS; 12-0-0-26S</td>
<td>Potassium Thiosulfate Solution; KT S; 0-0-25-17S</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Magnesium Thiosulfate; MgTS; 10% S</td>
<td>Calcium Thiosulfate; CaTS; 6%Ca; 10% S</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Calcium-Ammonium Nitrate Solution; 17-0-0-8.Ca</td>
<td>Calcium Nitrate Solution; 8-0-0-11Ca</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Potassium Carbonate Solution; 0-0-32</td>
<td>Calcium Nitrate Solution; 8-0-0-11Ca</td>
<td>Incompatible</td>
</tr>
<tr>
<td>N-pHurch; 28-0-0-9S</td>
<td>N-pHurch; 15/49, 15-0-0-16S</td>
<td>Incompatible</td>
</tr>
<tr>
<td>N-pHurch; 15/49, 15-0-0-16S</td>
<td>N-pHurch; 10/55, 10-0-0-18S</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
<td>Compatible</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>Nitric Acid</td>
<td>Compatible</td>
</tr>
<tr>
<td>Phosphoric Acid (white)</td>
<td>Phosphoric Acid (green)</td>
<td>Compatible</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>Sulfuric Acid</td>
<td>Compatible</td>
</tr>
<tr>
<td>Urea; 46-0-0</td>
<td>Ammonium Nitrate; 34-0-0</td>
<td>Limited Compatibility</td>
</tr>
<tr>
<td>Ammonium Nitrate; 34-0-0</td>
<td>Calcium Nitrate; 15:5-0-0-19Ca</td>
<td>Limited Compatibility</td>
</tr>
<tr>
<td>Calcium Nitrate; 15:5-0-0-19Ca</td>
<td>Potassium Chloride; 0-0-62</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Potassium Chloride; 0-0-62</td>
<td>Potassium Nitrate; 13-0-0</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Potassium Nitrate; 13-0-0</td>
<td>Magnesium Nitrate; 10-0-0-9Mg</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Magnesium Nitrate; 10-0-0-9Mg</td>
<td>Monoammonium Phosphate (Technical; 12-61-0)</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Monoammonium Phosphate (Technical; 12-61-0)</td>
<td>Monopotassium Phosphate (0-52-34)</td>
<td>Incompatible</td>
</tr>
<tr>
<td>Monopotassium Phosphate (0-52-34)</td>
<td>PeKacid; 0-60-20</td>
<td>Incompatible</td>
</tr>
</tbody>
</table>

**Fluid Fertilizer Foundation**

2805 Claffin Road, Suite 200
Manhattan, KS 66502

785-776-0273
FluidFertilizer@sbcglobal.net

3/1/09
This is what it's all about!

THANK YOU