The Andersons

Winter Salt Out & Freezing issues

Presented by Terry Robinson
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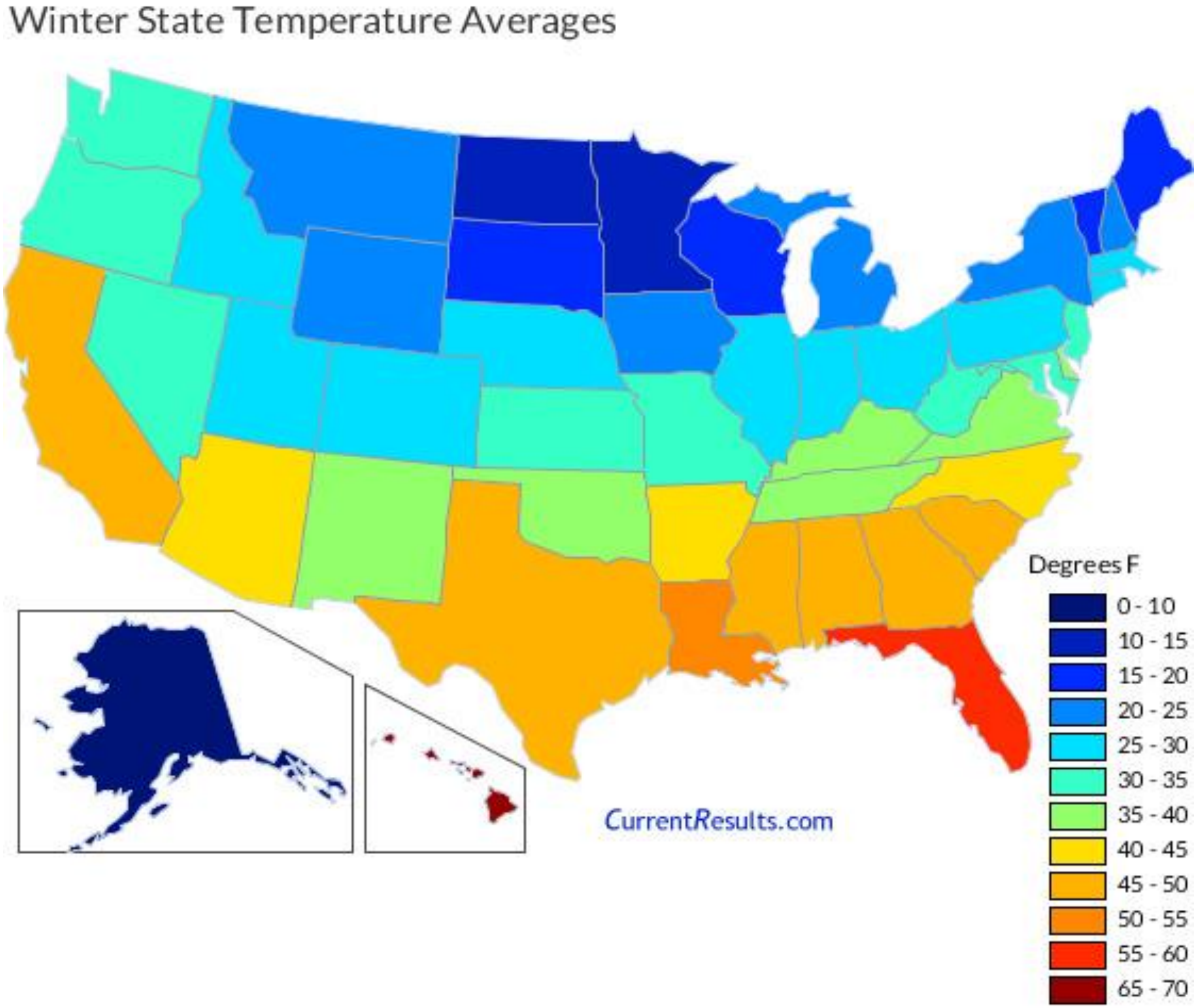
The Andersons

Winter State Temperature Averages supplied by NOAA National Climatic Data Center



What to do when winter arrives?

Methods of Determining Salt out Temperatures

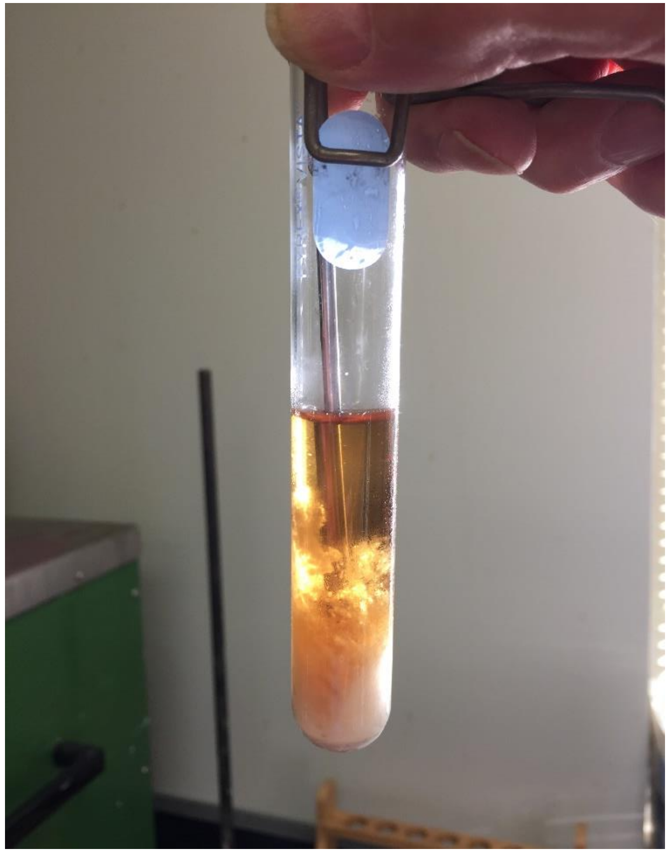
1. ASTM D97 (Method to determine Pour Point)
2. Polythermal/Thawing Method, Kadam, et.al., (Expose frozen sample to incremental increase in temperature)
3. Dauncy & Still Optical Method. (Change in refractive index as crystals form).

No standardized Method for the Fertilizer Industry

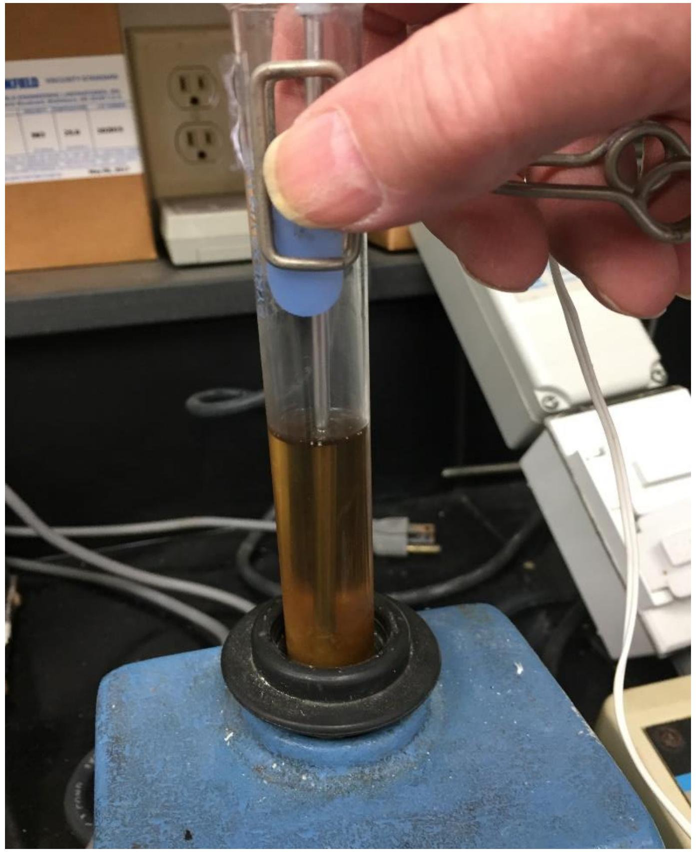
Adopted Andersons Methods for determining Salt out temperatures

1) **Quick Chiller Method:** Maintain Chiller at -24 F. Expose sample to chiller via clear test tube and record temperature and type of solids that form. Remove sample from chiller and stir vigorously with test tube stirrer at room temperature. Record temp when solution is clear and free of solids. Repeat if needed. This is the salt out temperature reported. This is a quick test and since you are using the temperature when the sample warms up to clear, it falls more so on the high side of alternative method values.
2) **Slow Cooling/thawing method:** Subject samples to slow incremental temperature decreases and record temperature and type of solids that form. Then slow incremental increases to temperature until samples is clear. Repeat 3 cycles. Record this temperature when sample is clear as the Salt out temperature. We have seen some salt out temperatures increase by 15-20 F because of freeze thaw concentration effects.

Salt Out Determination Chiller Method



Sample exposed to -25 °F until solids start to appear & temperature recorded as start temperature. Then exposed another 2-3 minutes longer.

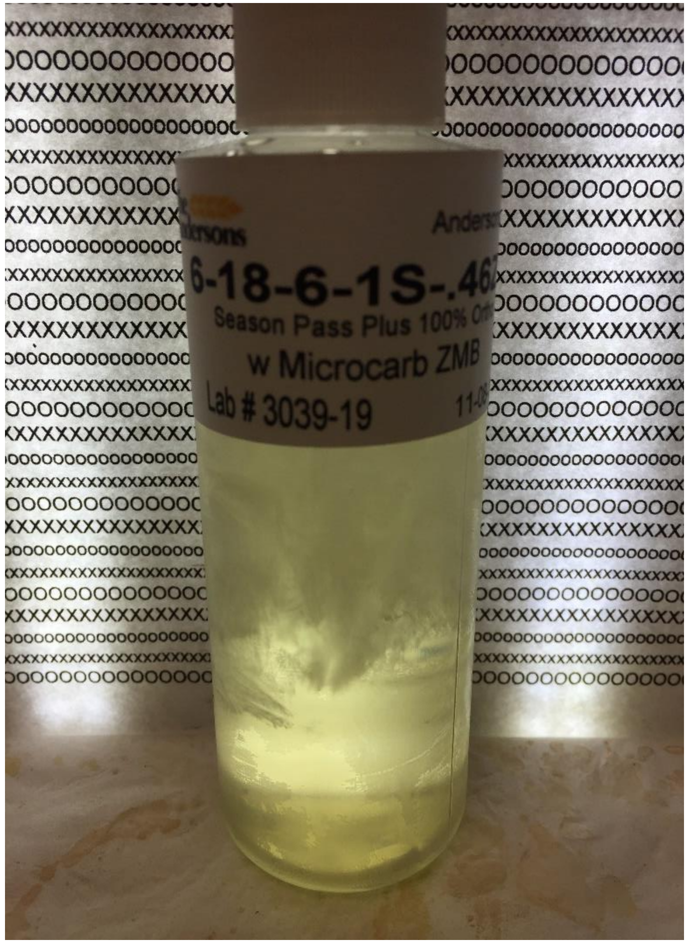


Sample is then stirred with test tube stirrer and temperature probe. Solids are observed as they slowly re dissolve.

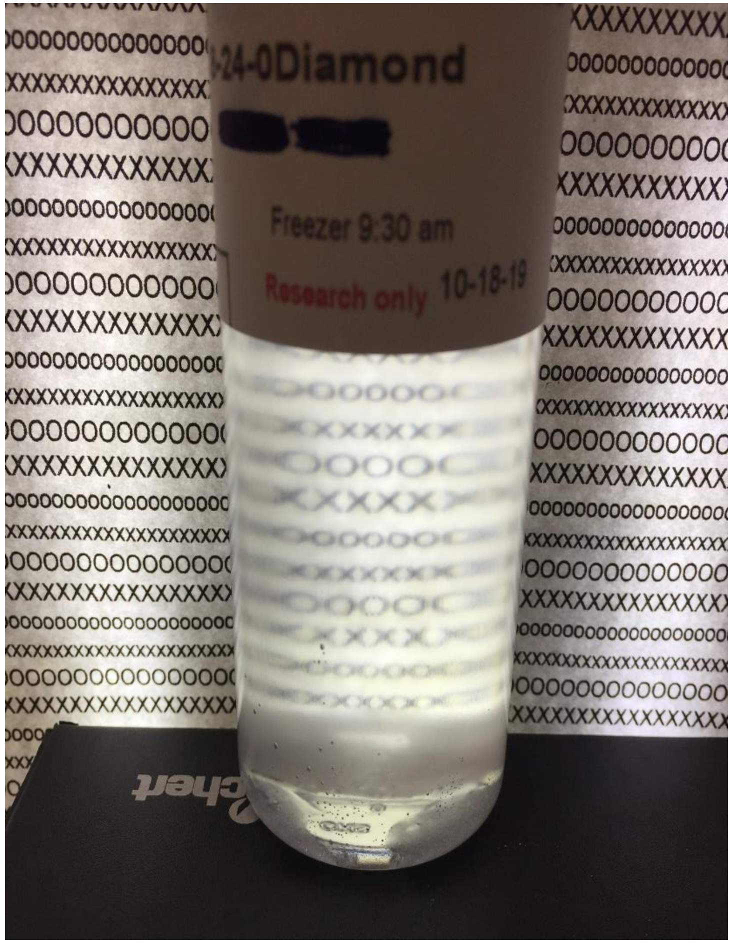
Sample right before the salt out temperature is recorded. You can see a small amount of ice phase still present.

100% Ortho Phosphate fertilizers exposed to freezer 4 ^{0}F

Ice phase on top and
MAP & DAP on the bottom.



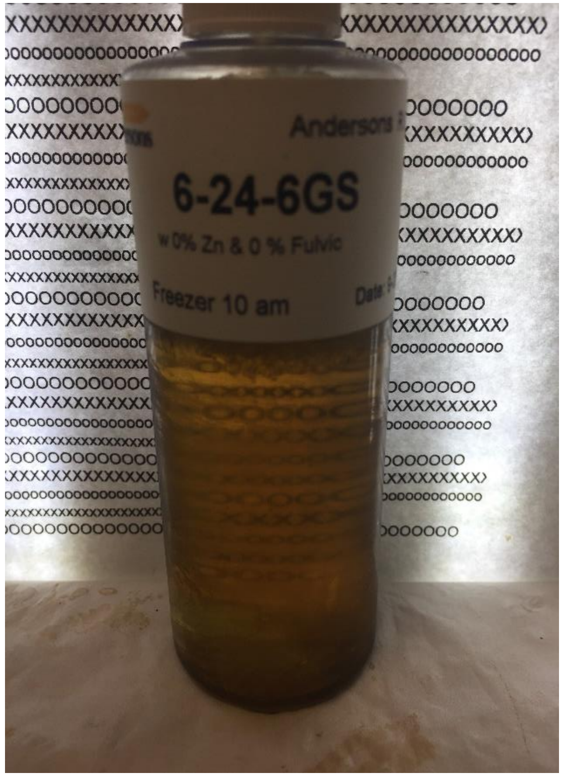
Ice phase that floated to the top



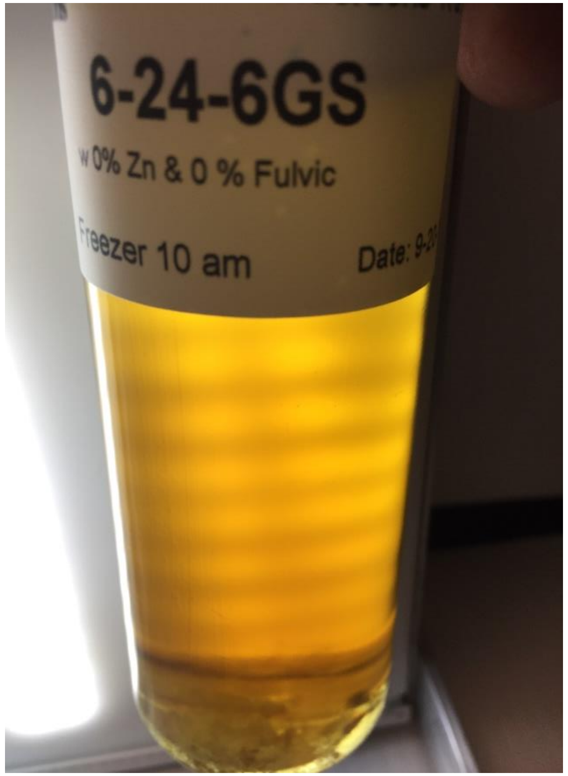
Sample was in freezer 5 days
then sat idle (68 ^{0}F) 5 days. MAP
& DAP crystals still not dissolved.

80% Ortho Phosphate fertilizers exposed to freezer 4 ^{0}F

6-24-6 80% Ortho Phosphate
In freezer 4 ^{0}F for 2 weeks.
Note the ice on top and MAP & DAP crystals on the bottom.



Same sample as on the left.
Clear liquid in the middle with ice on top and crystals on the bottom



Same sample as on the left. Exposed to 68 ^{0}F for 10 days no agitation. Note the MAP & DAP crystals still on the bottom.

Observations when Fertilizer Salts Out

- Ice phase usually forms first and floats to the top. Since the ice is primarily water, this process concentrates the other components in the fertilizer thus changing the physical characteristics of the system.

- With this increase in concentration of the liquid portion, the formation of MAP & DAP crystals becomes more possible. You now have a product that is non-homogeneous and will behave differently than before it salted out.

- **Solution after Salt out:** Heat of some kind is necessary to re-dissolve the MAP & DAP crystals as well as the Ice. With heat alone, the process will take an extended amount of time and the final product will be stratified with low concentration fertilizer on the top and high concentration fertilizer on the bottom, leaving the solution susceptible to further salt out episodes.

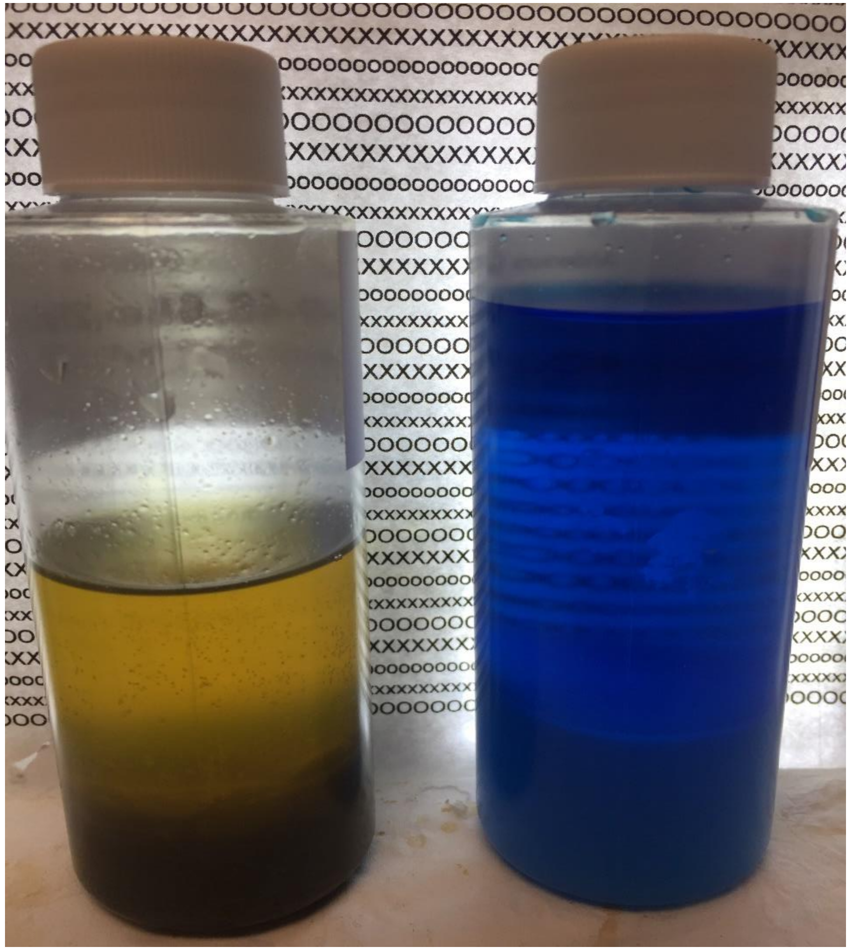
- Along with heat, one must also introduce some type of agitation/re-circulation. This helps the fertilizer return to the original concentration throughout the vessel before the salt out occurred.

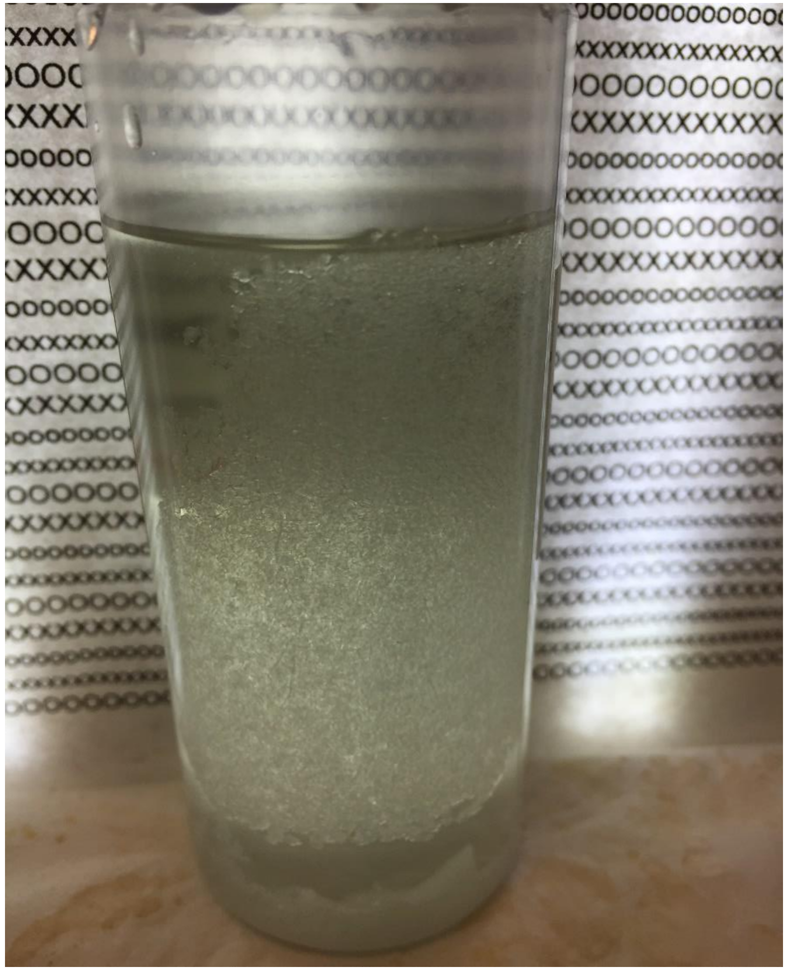
Salt Out vs Precipitation

- Salt out : When a liquid fertilizer is exposed to low temperatures for an extended time. These temperatures vary and the results can be ice or ice and crystalline salt complexes. Usually re dissolve with heat and agitation.

- Precipitation: Solids that form from incompatible mixing of products, pH change, hydrolysis of polyphosphates releasing insoluble metals. To mention a few causes. These solids typically don’t re dissolve. Identification of the precipitate and possible cause of precipitate can lead to a solution of further prevention.

Salt out vs Precipitation





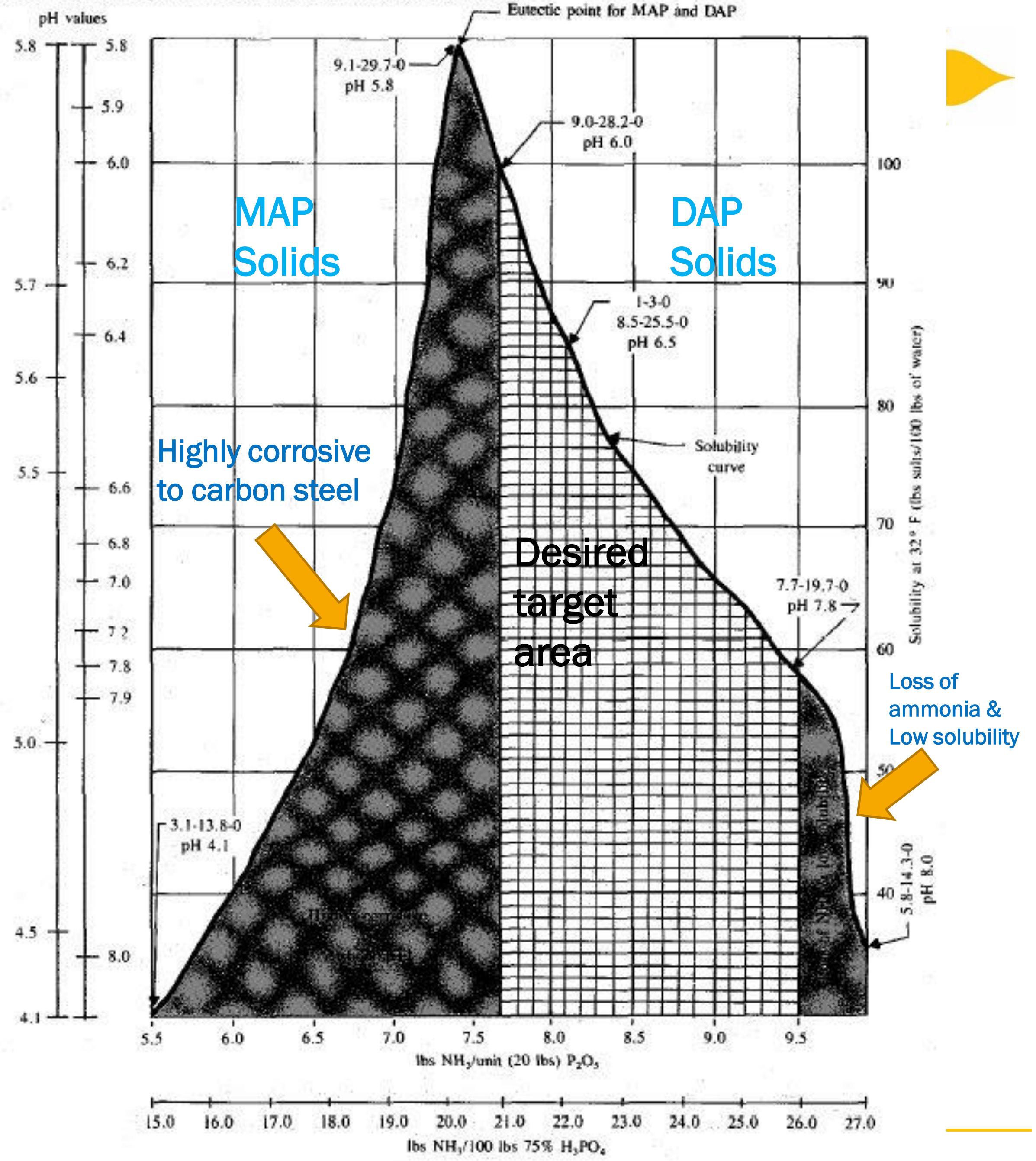
These samples precipitated at room temperature and will not re dissolve unless the chemistry is changed. Prime examples of precipitation failures.

Solubility of Ammonium Ortho Phosphates

The diagram located on the right has been in circulation for many years after being developed by TVA. The scale on the right is related to the total concentration (Solubility of Ammonium Phosphates 100% Ortho Salt lbs/100 lbs Water)

The scale on the left is related to the pH. 5.8 to 8.0 relates to the cross hatched section with the “Desired target area” of the diagram on the right hand side. The scale to the left pH 5.8 to 4.1 relates to the left side of the diagram. This area also has a lower pH and products that fall into this area can be corrosive to steel storage tanks.

Figure 3.1: Influence of pH on the solubilities of ammonium orthophosphates.



MAP Solids

DAP Solids

Highly corrosive to carbon steel

Desired target area

Loss of ammonia & Low solubility

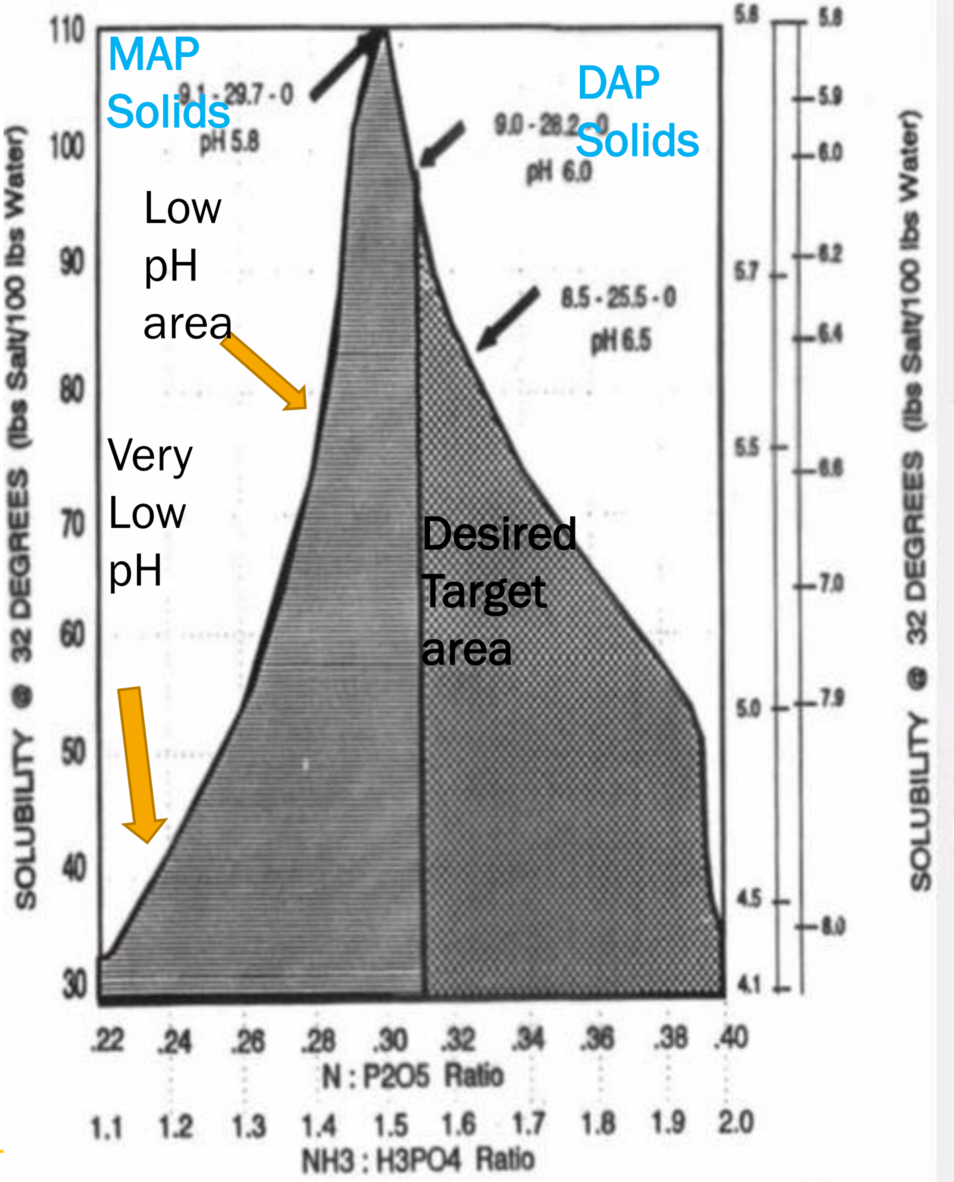
Solubility of Ammonium Ortho Phosphates

Same diagram as previous but with N:P2O5 ratio shown on the bottom scale of the diagram. This converted scale is much easier to work with when developing formulas. The key scale is the N:P2O5 Ratio. The N value is only counted for non neutralized N components ie: Aqua ammonia or Anhydrous ammonia.

The P2O5 value is only counted for Non neutralized P2O5 sources ie: Ortho phosphoric acid.

This diagram can also be used with some success with NPK systems that include (KOH). Accounting for the K2O from KOH, by subtracting that K2O value from the P2O5 then using that new P2O5 value to obtain the N:P2O5 ratio.

Ammonia and KOH are both bases and neutralize phosphoric acid but when KOH is in the system instead of KCl higher pH values can be obtained with lower salt out characteristics.



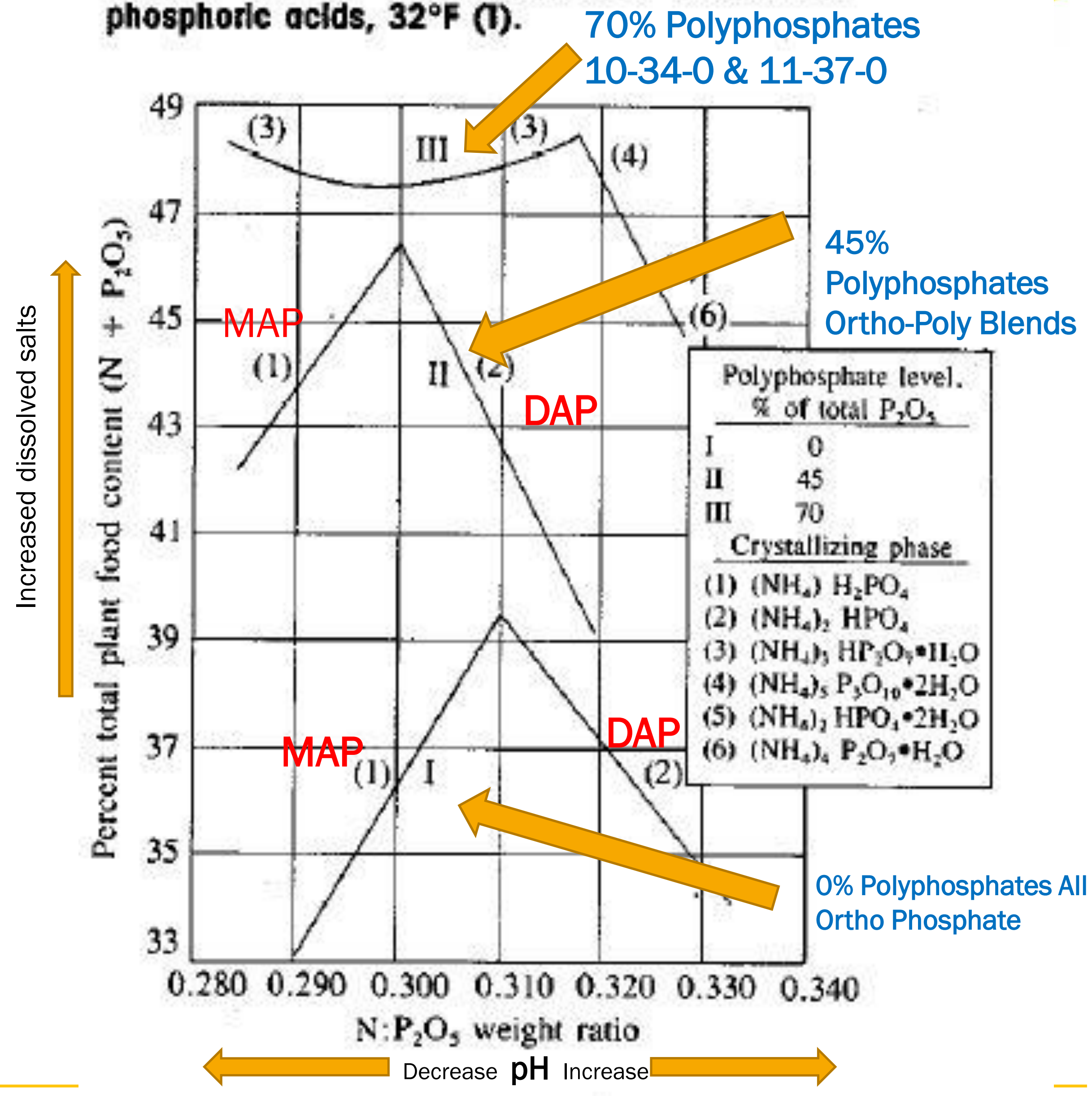
Effect of Polyphosphates on solubility of Ammonium Phosphate solutions

Scale from bottom to top shows an increase of dissolved salts NH4 & P2O5
Scale at bottom shows increase in N:P2O5 weight ratio (pH increase to the right)

This chart can give you a relative comparison of the solubility of ammonium polyphosphates versus Ortho phosphate. As you can see the higher polyphosphate are much more soluble and not so pH dependent. Notice the peak of the 45% Polyphosphate is representative of a 9-30-0 grade. The peak of the all ortho phosphate is representative of 7.5-24-0

Some work has been done to determine Potassium Phosphate solubility of 100% ortho products. Typically 0-20-23 will have a salt out of 20 F. Add a little ammonia in place of the K20, 1.4-20-20 and you will see a salt out of 0 F. We have found that pH plays a critical role in determining salt out values. TVA has limited data with NPK fertilizers containing KOH.

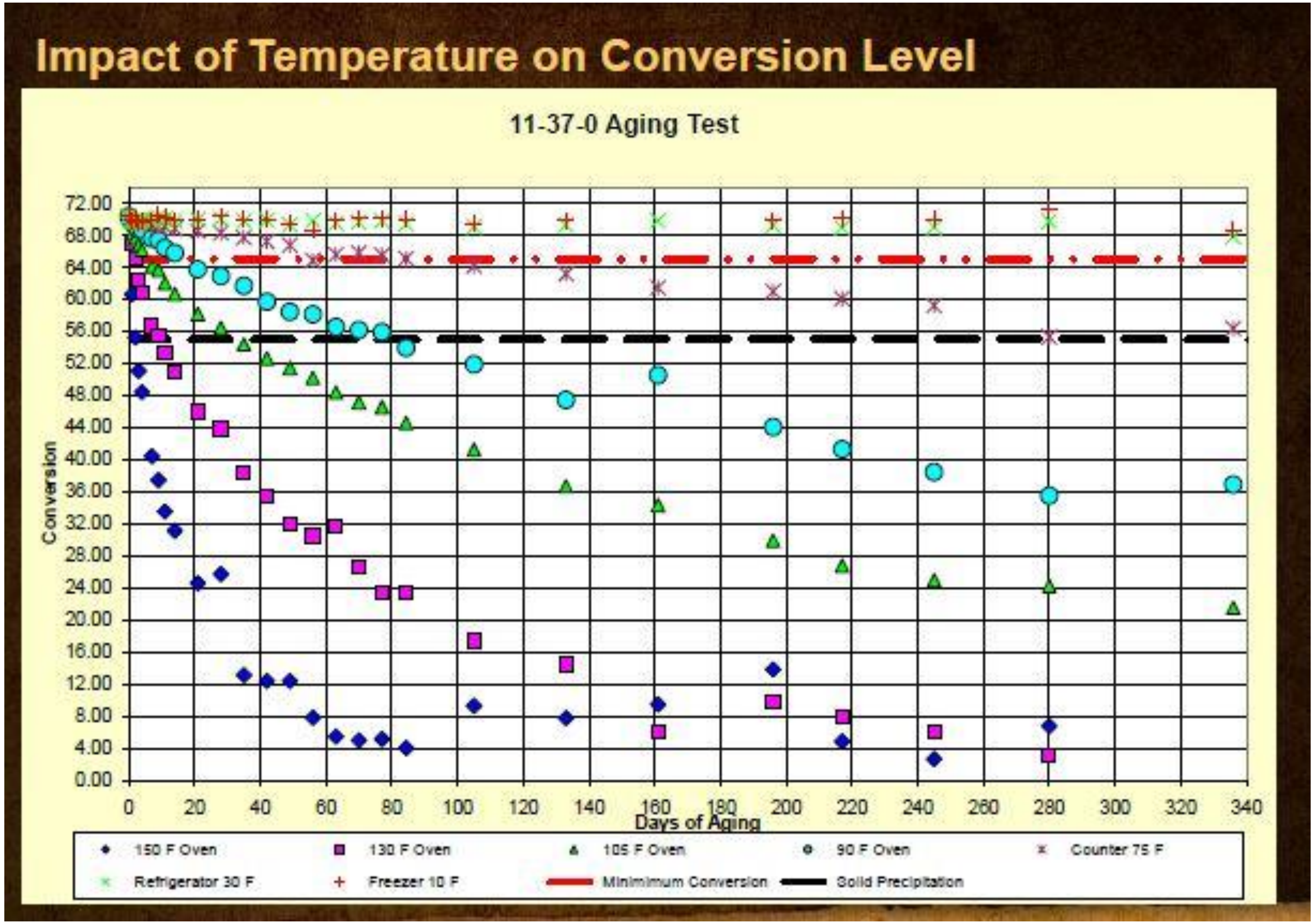
Figure 3.2: Effect of polyphosphate level and $N:P_2O_5$ weight ratio on solubility of ammoniated phosphoric acids, 32°F (1).



Temperature effects on conversion of 11-37-0
John Walker from Potash Corp

Left scale is conversion, or % Polyphosphates. The bottom scale is days of aging. The minimum conversion is shown at about 65%. This will be slightly different depending on the tramp metal content of the wet process acid used.

Obviously temperatures above 90 F have a detrimental effect on the % Polyphosphate content.



Compatibility of Micronutrients: Fully Chelated vs Sequestered

Fully Chelated metals are determined by the ability of the metal to remain in solution (dissolved) for the life of the product it is dissolved in. Our verification is determined by the ability of the chelated metal solution to be added to a 100% Orthophosphate solution and remain dissolved, with no precipitate, for an extended period of time.

Chelated/Sequestered: There are many molecules that hold metals in solution. Some of the most popular are EDTA (Ethylenediaminetetraacetic acid), Di Sodium EDTA, HEDTA, MEA (Monoethanolamine), TEA (Triethanolmine), Glucoheptonate, Ammonium, Acetate, Citrate, Formate, Polyamino acids etc.....

We prefer to work with the EDTA groups which we find have the strongest chelating capability for most metals.
When working with solutions containing tramp metals it is important to keep the Metal Chelate Selectivity (Displacement) series in mind. This chart on the right shows the preference of EDTA chelation based on the metals. Similar to the Noble Metals chart. Ex: Fe $^{+}$3 must be chelated before attempting to chelate Cu $^{+}$2 etc when both are present in an unchelated or sequestered form.

$V^{+}3$	Vanadium
$Fe^{+}3$	Iron (Ferric)
$Hg^{+}3$	Mercury
$Ti^{+}3$	Titanium
$Cu^{+}2$	Copper
$VO^{+}2$	Vanadium Oxide
$Ni^{+}2$	Nickel
$Pb^{+}2$	Lead
$TiO^{+}2$	Titanium Oxide
$Zn^{+}2$	Zinc
$Cd^{+}2$	Cadminum
$Co^{+}2$	Cobalt
$Al^{+}3$	Aluminum
$Fe^{+}2$	Iron (Ferrous)
$Mn^{+}2$	Manganese
$V^{+}2$	Vanadium
$Ca^{+}2$	Calcium
$Mg^{+}2$	Magnesium
$Ba^{+}2$	Barium

Adding non EDTA metal micronutrients to poly phosphates

10-34-0 & 11-37-0 blends with a minimum of 70% polyphosphates can keep most metals in solution , up to about 1.5% wt total of the metals. This value is based on ignoring the tramps Mg, Al, Fe,& S contained in the wet process acid.

We found that non EDTA metals can be added to 50% polyphosphates and stay in solution, totaling about 0.5 to 0.75% depending on the metals

We have also found that non EDTA metals can be added to 20% polyphosphates and stay in solution, totaling 0.2 to 0.25% depending on the metals.

Those metals sequestered by acetate, citrate, ammonium, etc will vary to the amount and length of stability in the above solutions. Stability tests can be performed to verify.

Some Nutrient Incompatibilities

- Sulfate, Nitrate, and Chloride based metals have very limited solubility's in low polyphosphate fertilizers.
- Low value phosphate fertilizers IE: 8-1-8 do not mix well with hard water. Phosphates will precipitate.
- We have found some solubility inconsistencies with the mixtures of Manganese EDTA and Boron MEA.
- Iron EDTA and Copper EDTA have been found to degrade in the presence of sunlight/UV light. The EDTA bond is broken/destroyed and Iron will take the place of copper leaving it to precipitate as a solid.
- Potassium mixed with UAN can cause the precipitation of potassium nitrate crystals at certain concentrations.
- Potassium mixed with Sulfur in the form of sulfate can cause potassium sulfate to precipitate.
- I am sure you know of other incompatible mixtures.

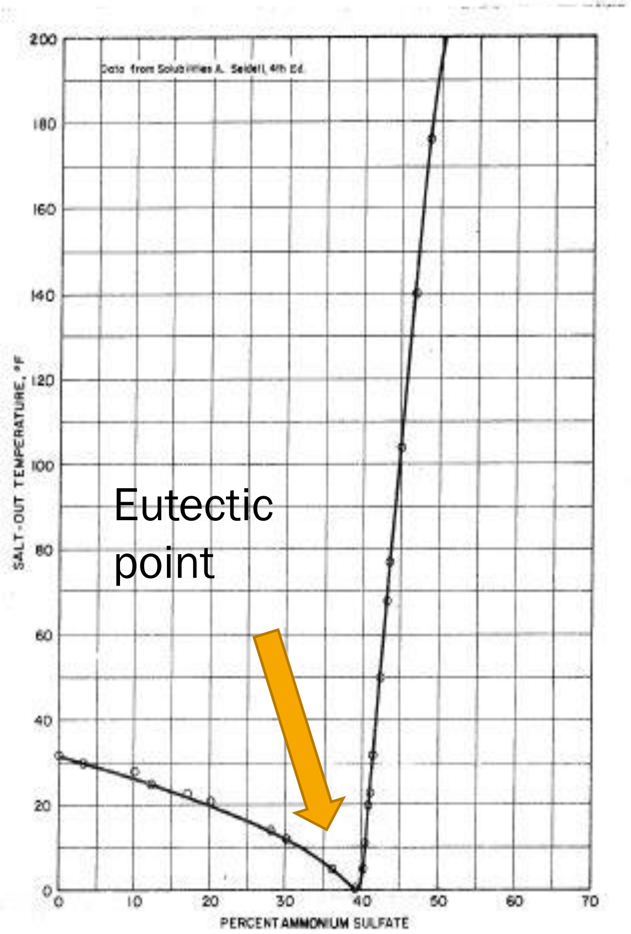
Storage & Compatibility Properties of different formulations

- Know and/or verify salt out values for products to be stored. Internet can be a useful tool or a trap sometimes.

- If salt out value is undesirable then look at changing the chemistry, the location, or time of year, to obtain successful storage.

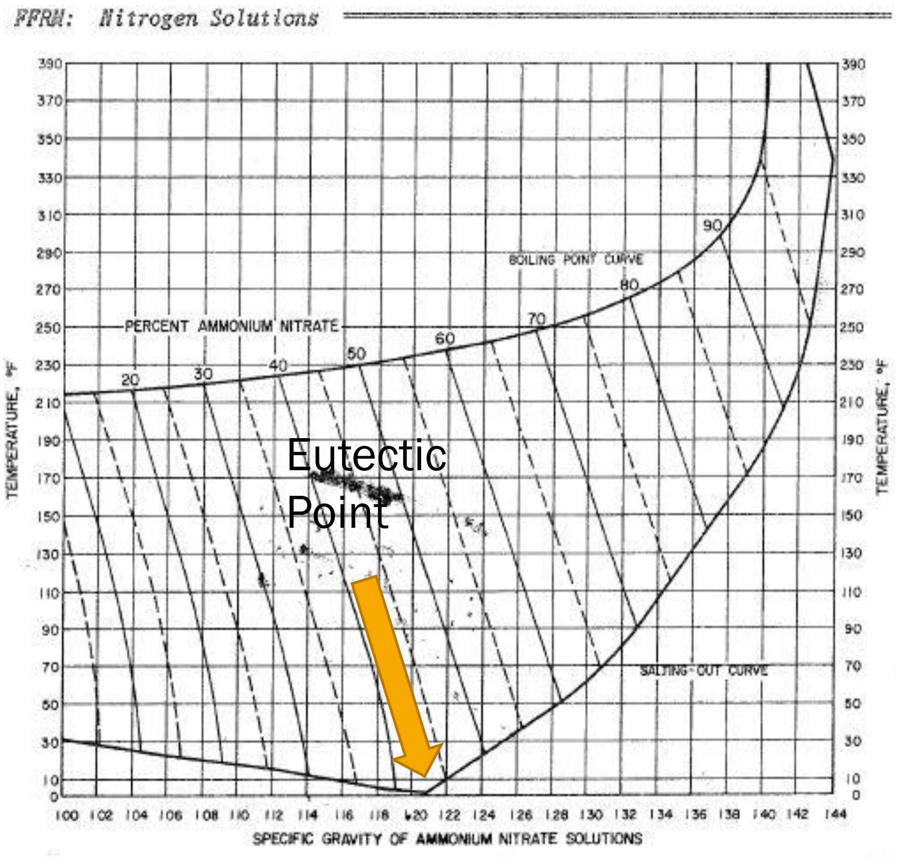
- One must also recognize that hot temperatures can be just as damaging to high polyphosphate products.

Aqua Ammonia & Ammonium Salts



Eutectic point

Ammonium Sulfate Salt out diagram. Typical 8-0-0-9S solution falls in the eutectic point.



Eutectic Point

Figure 2-2. Physical Properties of Ammonium Nitrate Solutions

Ammonium Nitrate Salt out and boiling point curve. 45% Solution falls in the eutectic point.

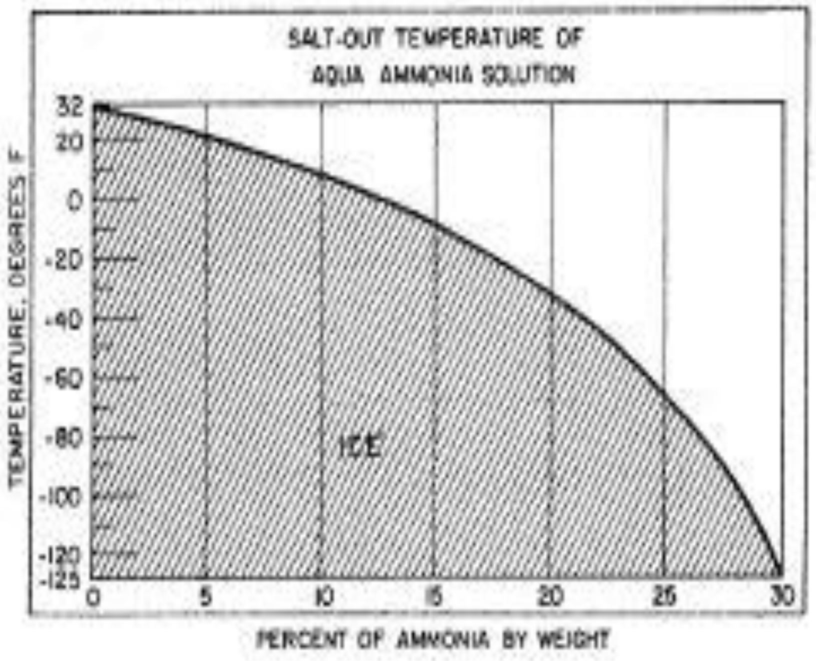
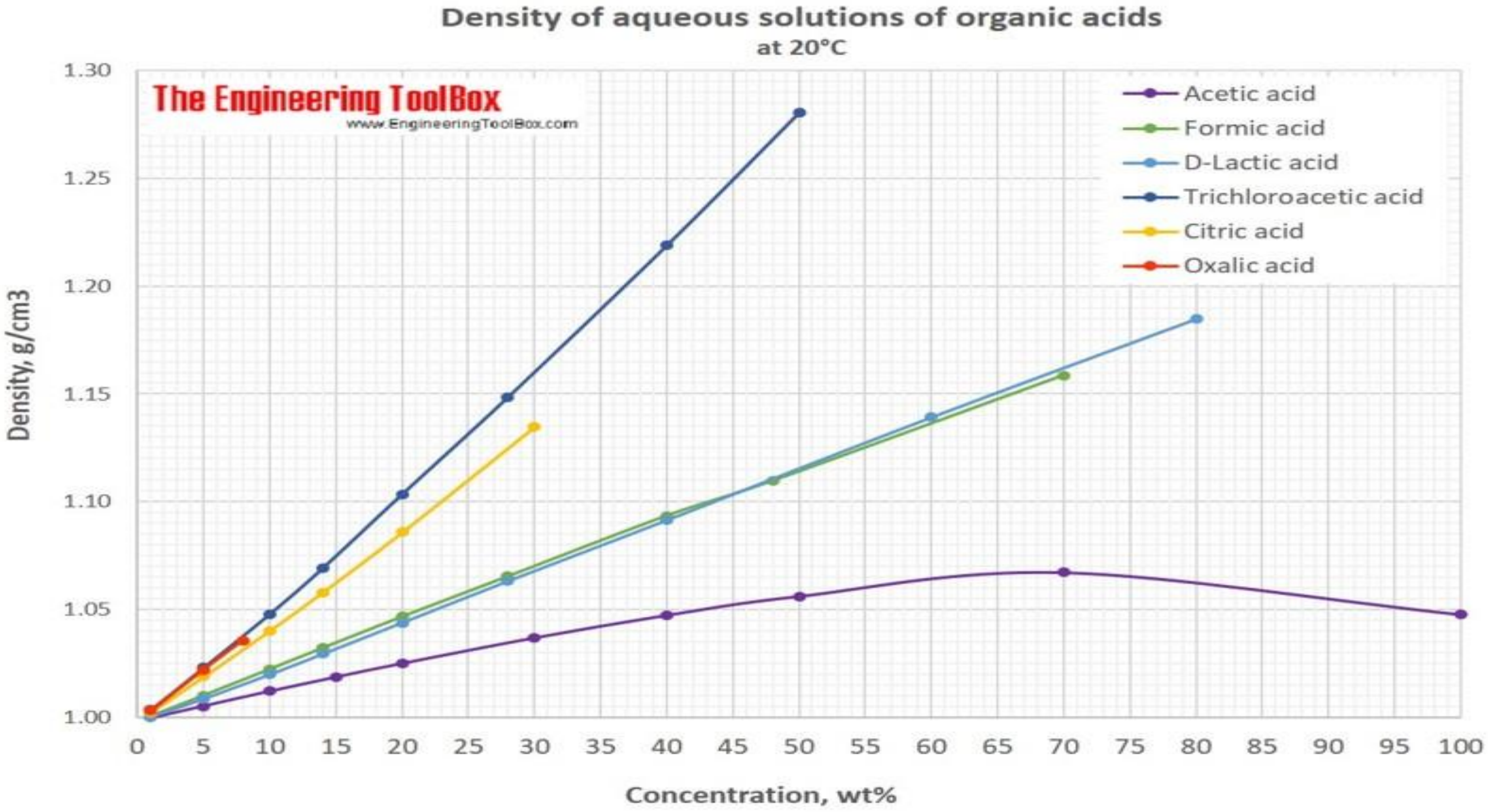


Figure 2-6. Salt-Out Temperature of Aqua Ammonia Solutions

Typical Salt out diagram for Aqua Ammonia.

Acetic acid 45% or 100%?

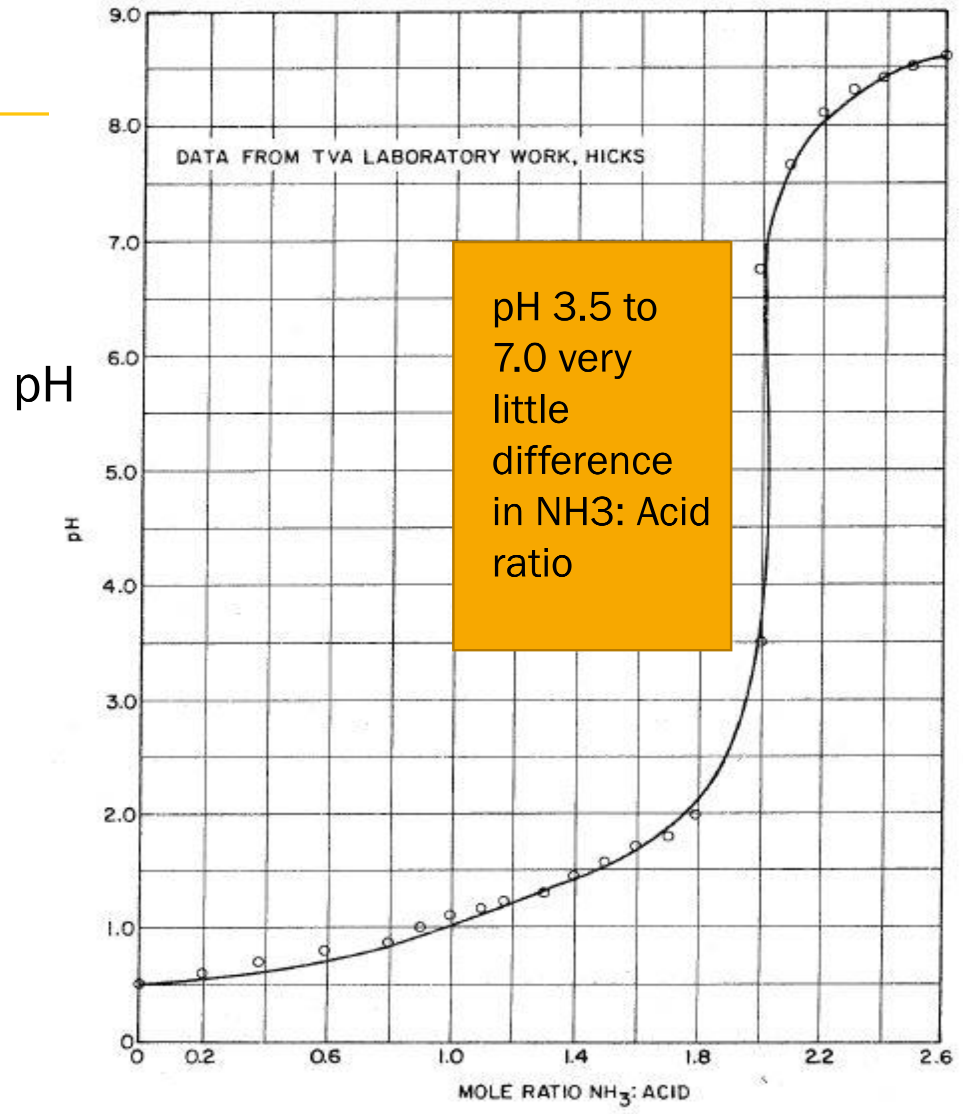
The concentration curve for acetic acid (purple line) is another example of the reason for verification. The density is the very close to the same for 45% & 100%



Ammonium Sulfate pH curve

Data is not always what we expect.
That is why we need to verify!!

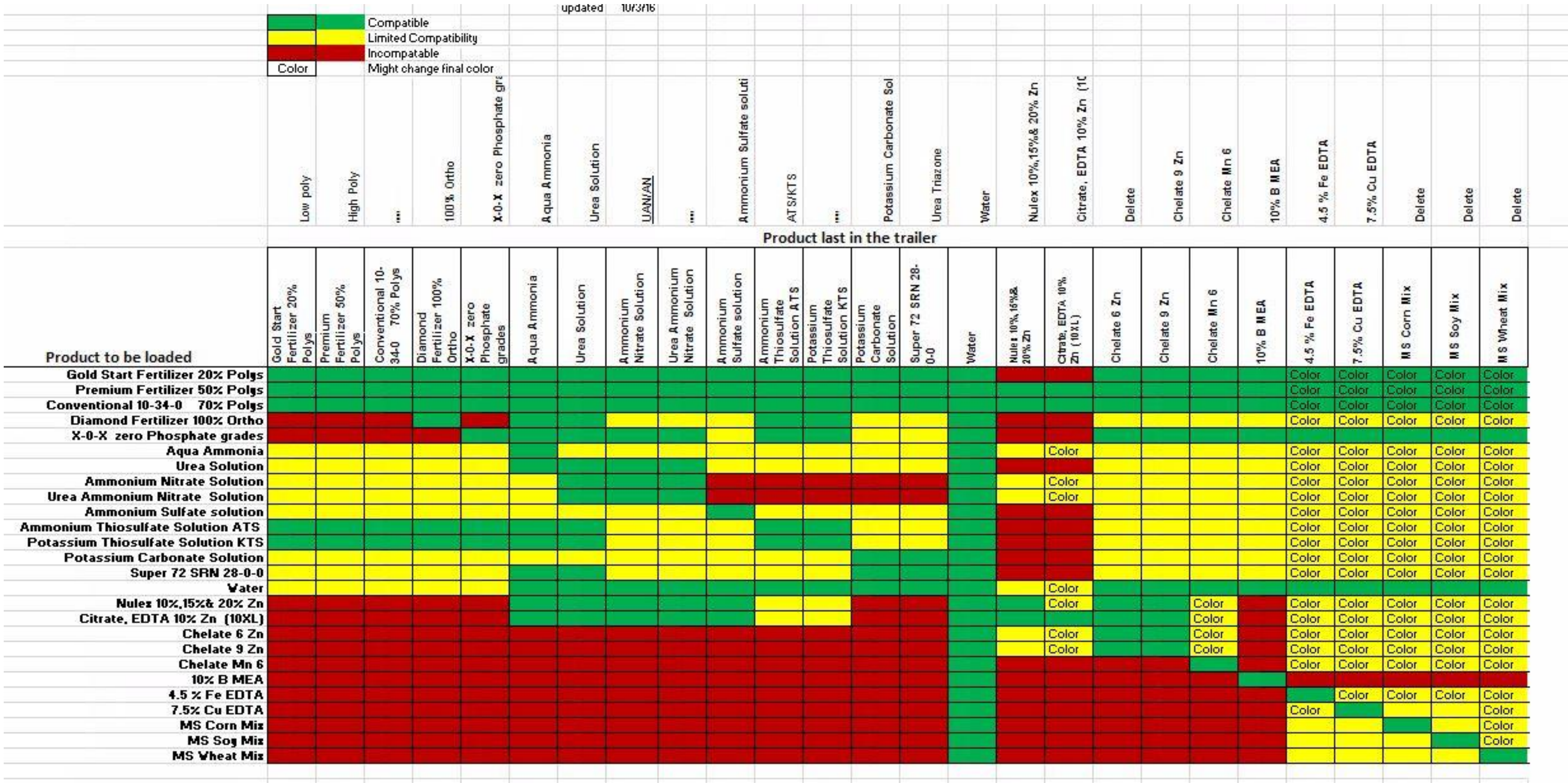
So when you expect the ammonium sulfate solution to have a pH of 7.0 don't be surprised if the meter shows a value of 4.0 or 5.0. All the same ..



pH 3.5 to 7.0 very little difference in NH3: Acid ratio

Figure 2-4. Effect of Adding Ammonia to Sulfuric Acid

Truck Loading Product Compatibility Chart



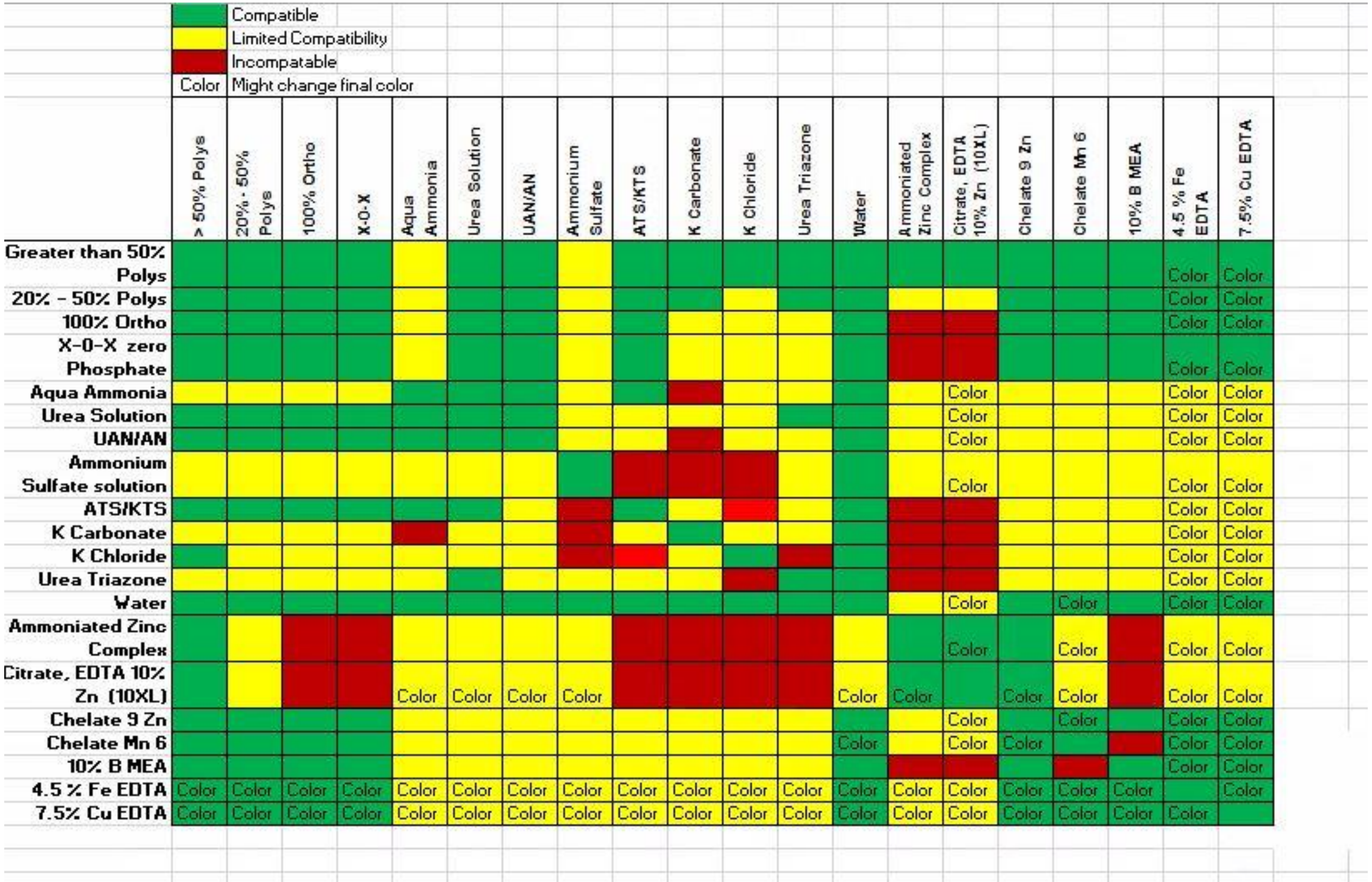
updated 10/3/16

🟩 🟩 Compatible
🟨 🟨 Limited Compatibility
🟥 🟥 Incompatable
Color Might change final color

Product last in the trailer

	Low poly	High Poly	...	100% Ortho	X-0-X zero Phosphate gra	Aqua Ammonia	Urea Solution	UAN/AN	...	Ammonium Sulfate soluti	ATS/KTS	...	Potassium Carbonate Sol	Urea Triazone	Water	Nulex 10%,15%& 20% Zn	Citrate, EDTA 10% Zn (10	Delete	Chelate 9 Zn	Chelate Mn 6	10% B MEA	4.5 % Fe EDTA	7.5% Cu EDTA	Delete	Delete	Delete
Product to be loaded	Gold Start Fertilizer 20% Polys	Premium Fertilizer 50% Polys	Conventional 10-34-0 70% Polys	Diamond Fertilizer 100% Ortho	X-0-X zero Phosphate grades	Aqua Ammonia	Urea Solution	Ammonium Nitrate Solution	Urea Ammonium Nitrate Solution	Ammonium Sulfate solution	Ammonium Thiosulfate Solution ATS	Potassium Thiosulfate Solution KTS	Potassium Carbonate Solution	Super 72 SRN 28-0-0	Water	Nulex 10%, 15%& 20% Zn	Citrate, EDTA 10% Zn (10XL)	Chelate 6 Zn	Chelate 9 Zn	Chelate Mn 6	10% B MEA	4.5 % Fe EDTA	7.5% Cu EDTA	MS Corn Mix	MS Soy Mix	MS Wheat Mix
Gold Start Fertilizer 20% Polys	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟩	🟩	🟩	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟩 Color
Premium Fertilizer 50% Polys	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟩 Color
Conventional 10-34-0 70% Polys	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟩 Color
Diamond Fertilizer 100% Ortho	🟥	🟥	🟥	🟩	🟥	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
X-0-X zero Phosphate grades	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟨	🟩	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Aqua Ammonia	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Urea Solution	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Ammonium Nitrate Solution	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Urea Ammonium Nitrate Solution	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Ammonium Sulfate solution	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Ammonium Thiosulfate Solution ATS	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Potassium Thiosulfate Solution KTS	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Potassium Carbonate Solution	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Super 72 SRN 28-0-0	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟥	🟥	🟨	🟨	🟨	🟨	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Water	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨 Color	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Nulex 10%,15%& 20% Zn	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟩	🟩	🟨 Color	🟩	🟩	🟨 Color	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Citrate, EDTA 10% Zn (10XL)	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟨 Color	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Chelate 6 Zn	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟨	🟨 Color	🟩	🟩	🟨 Color	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Chelate 9 Zn	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟨	🟨 Color	🟩	🟩	🟨 Color	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
Chelate Mn 6	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟩	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color
10% B MEA	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥
4.5 % Fe EDTA	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟨 Color	🟨 Color	🟨 Color	🟨 Color
7.5% Cu EDTA	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟨 Color	🟩	🟨	🟨	🟨 Color
MS Corn Mix	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟩	🟨	🟨 Color
MS Soy Mix	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟨	🟩	🟨 Color
MS Wheat Mix	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟨	🟨	🟩

Plant Blending Compatibility Chart



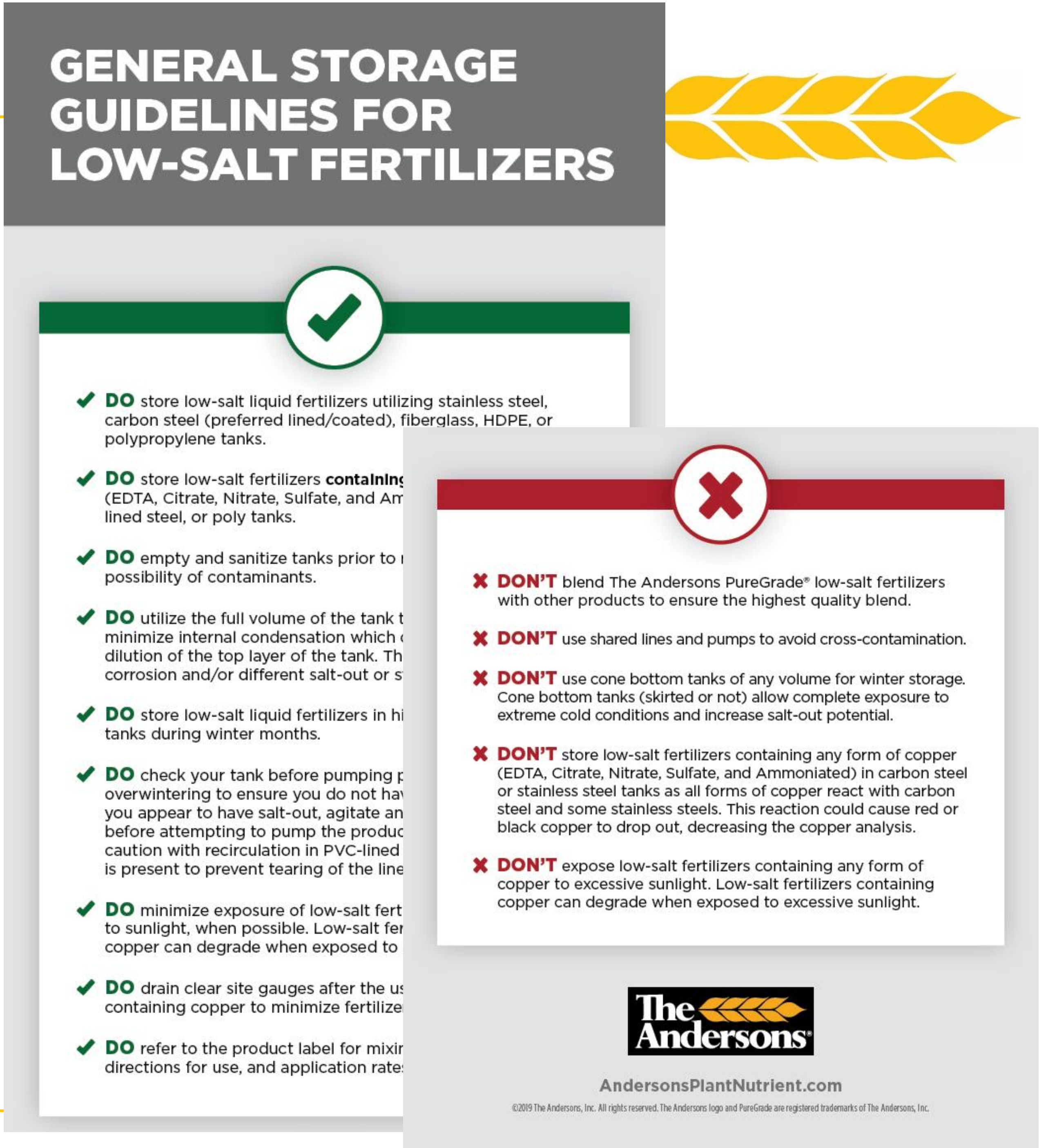
🟩 Compatible
🟨 Limited Compatibility
🟥 Incompatable
Color Might change final color

	> 50% Polys	20% - 50% Polys	100% Ortho	X-0-X	Aqua Ammonia	Urea Solution	UAN/AN	Ammonium Sulfate	ATS/KTS	K Carbonate	K Chloride	Urea Triazone	Water	Ammoniated Zinc Complex	Citrate, EDTA 10% Zn (10XL)	Chelate 9 Zn	Chelate Mn 6	10% B MEA	4.5 % Fe EDTA	7.5% Cu EDTA
Greater than 50% Polys	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩 Color	🟩 Color
20% - 50% Polys	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟩	🟨	🟨	🟩	🟩	🟩	🟩 Color	🟩 Color
100% Ortho	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟥	🟥	🟩	🟩	🟩	🟩 Color	🟩 Color
X-0-X zero Phosphate	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟥	🟥	🟩	🟩	🟩	🟩 Color	🟩 Color
Aqua Ammonia	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟨	🟩	🟥	🟨	🟨	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨 Color	🟨 Color
Urea Solution	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟩	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨 Color	🟨 Color
UAN/AN	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟨	🟨	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨 Color	🟨 Color
Ammonium Sulfate solution	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟨	🟩	🟨	🟨 Color	🟨	🟨	🟨	🟨 Color	🟨 Color
ATS/KTS	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟩	🟨	🟥	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨 Color	🟨 Color
K Carbonate	🟨	🟨	🟨	🟨	🟥	🟨	🟨	🟥	🟨	🟩	🟨	🟨	🟩	🟥	🟥	🟨	🟨	🟨	🟨 Color	🟨 Color
K Chloride	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟥	🟥	🟨	🟩	🟥	🟩	🟥	🟥	🟨	🟨	🟨	🟨 Color	🟨 Color
Urea Triazone	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨	🟨	🟨	🟥	🟩	🟩	🟥	🟥	🟨	🟨	🟨	🟨 Color	🟨 Color
Water	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨 Color	🟩	🟩 Color	🟩	🟩 Color	🟩 Color
Ammoniated Zinc Complex	🟩	🟨	🟥	🟥	🟨	🟨	🟨	🟨	🟥	🟥	🟥	🟥	🟨	🟩	🟩 Color	🟩	🟨 Color	🟥	🟨 Color	🟨 Color
Citrate, EDTA 10% Zn (10XL)	🟩	🟨	🟥	🟥	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟥	🟥	🟥	🟥	🟨 Color	🟩 Color	🟩	🟩 Color	🟨 Color	🟥	🟨 Color	🟨 Color
Chelate 9 Zn	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨 Color	🟩	🟩 Color	🟩	🟩 Color	🟩 Color
Chelate Mn 6	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩 Color	🟨	🟨 Color	🟩 Color	🟩	🟥	🟩 Color	🟩 Color
10% B MEA	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟩	🟥	🟩	🟩 Color	🟩 Color
4.5 % Fe EDTA	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟩 Color	🟨 Color	🟨 Color	🟩 Color	🟩 Color	🟩 Color	🟩	🟩 Color
7.5% Cu EDTA	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟨 Color	🟩 Color	🟨 Color	🟨 Color	🟩 Color	🟩 Color	🟩 Color	🟩 Color	🟩

General Storage Guidelines

Summary:

1) Avoid Over Winter storage if there is a potential for salt out issues.
2) When designing tanks for Over Winter storage make sure to plumb discharge pump with the ability to recirculate the material from the bottom of the tank to the top.
3) If winter storage is a necessity, then make sure tanks are clean before filling for winter storage. This will allow agitation of the product in the tank in the spring if salt out does occur.
4) Take samples top and bottom before removing product from storage tank. Evaluate for solids and/or ice.
5) Use of Hydrometers are an easy and effective method for determining the specific gravity. If the top and bottom sample are the same specific gravity then life is good!!



GENERAL STORAGE GUIDELINES FOR LOW-SALT FERTILIZERS

- ✓ **DO** store low-salt liquid fertilizers utilizing stainless steel, carbon steel (preferred lined/coated), fiberglass, HDPE, or polypropylene tanks.
- ✓ **DO** store low-salt fertilizers **containing**
  (EDTA, Citrate, Nitrate, Sulfate, and Am
  lined steel, or poly tanks.
- ✓ **DO** empty and sanitize tanks prior to
  possibility of contaminants.
- ✓ **DO** utilize the full volume of the tank t
  minimize internal condensation which
  dilution of the top layer of the tank. Th
  corrosion and/or different salt-out or s
- ✓ **DO** store low-salt liquid fertilizers in hi
  tanks during winter months.
- ✓ **DO** check your tank before pumping
  overwintering to ensure you do not ha
  you appear to have salt-out, agitate an
  before attempting to pump the produc
  caution with recirculation in PVC-lined
  is present to prevent tearing of the line
- ✓ **DO** minimize exposure of low-salt fert
  to sunlight, when possible. Low-salt fer
  copper can degrade when exposed to
- ✓ **DO** drain clear site gauges after the us
  containing copper to minimize fertilize
- ✓ **DO** refer to the product label for mixi
  directions for use, and application rate

- ✗ **DON'T** blend The Andersons PureGrade® low-salt fertilizers with other products to ensure the highest quality blend.
- ✗ **DON'T** use shared lines and pumps to avoid cross-contamination.
- ✗ **DON'T** use cone bottom tanks of any volume for winter storage. Cone bottom tanks (skirted or not) allow complete exposure to extreme cold conditions and increase salt-out potential.
- ✗ **DON'T** store low-salt fertilizers containing any form of copper (EDTA, Citrate, Nitrate, Sulfate, and Ammoniated) in carbon steel or stainless steel tanks as all forms of copper react with carbon steel and some stainless steels. This reaction could cause red or black copper to drop out, decreasing the copper analysis.
- ✗ **DON'T** expose low-salt fertilizers containing any form of copper to excessive sunlight. Low-salt fertilizers containing copper can degrade when exposed to excessive sunlight.

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Questions? Comments ?

Directions to the reception?