Fluid Basics: Composition & Characteristics

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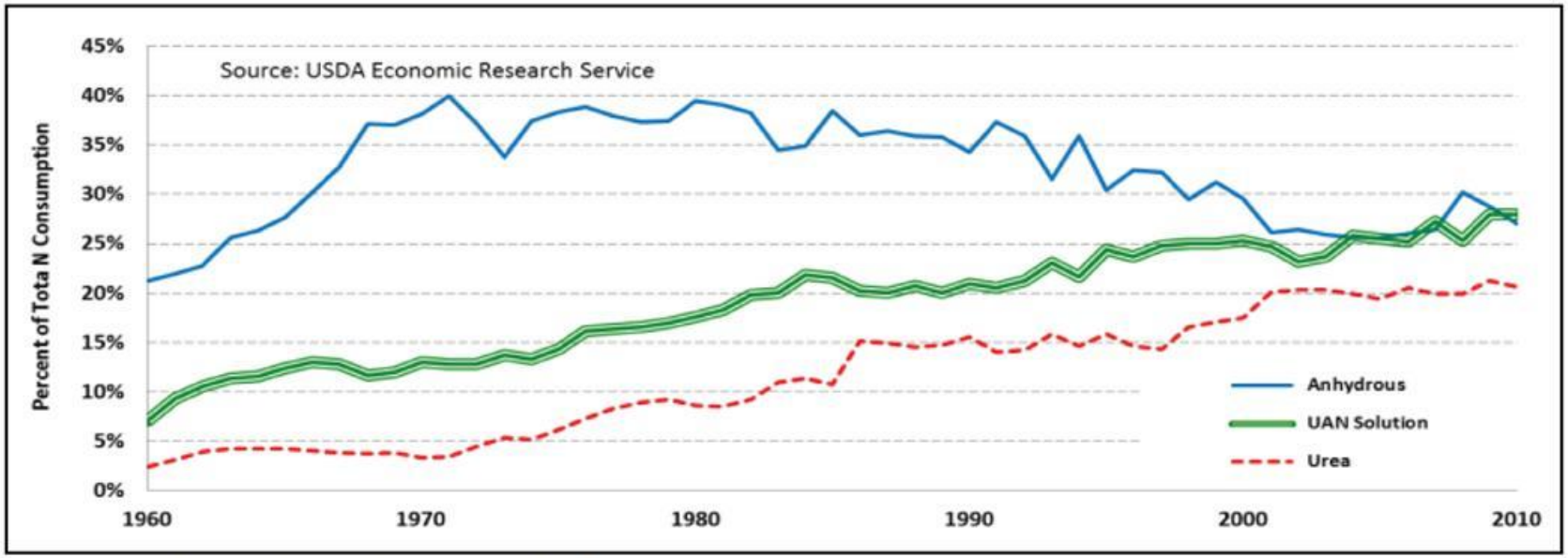


U.S. Nitrogen Product Market Share, 1960-2010.

Fluid Fertilizers

- Increasing in popularity in U.S. and elsewhere
- Advantages include
  - ✓ Flexibility and versatility in application
  - ✓ Efficiency and adaptability
  - ✓ Benefits of continuous bands
  - ✓ Ease of handling
  - ✓ Does not segregate
  - ✓ Homogeneous blends
  - ✓ Etc., Etc., Etc

- Limitations
  - ✓ Salt-out and precipitate formation potential with certain products and blends

Fluid Fertilizers

Terminology, Solubility, Density and N Solutions

Solution – All salts totally dissolved in water. No solids allowed!

Slurry – Fluid product containing water, dissolved salts and undissolved salts. Settles out quickly. Not Common.

Suspension – Fluid product containing water, dissolved salts, fine undissolved salt crystals and a suspending agent – normally attapulgite clay.

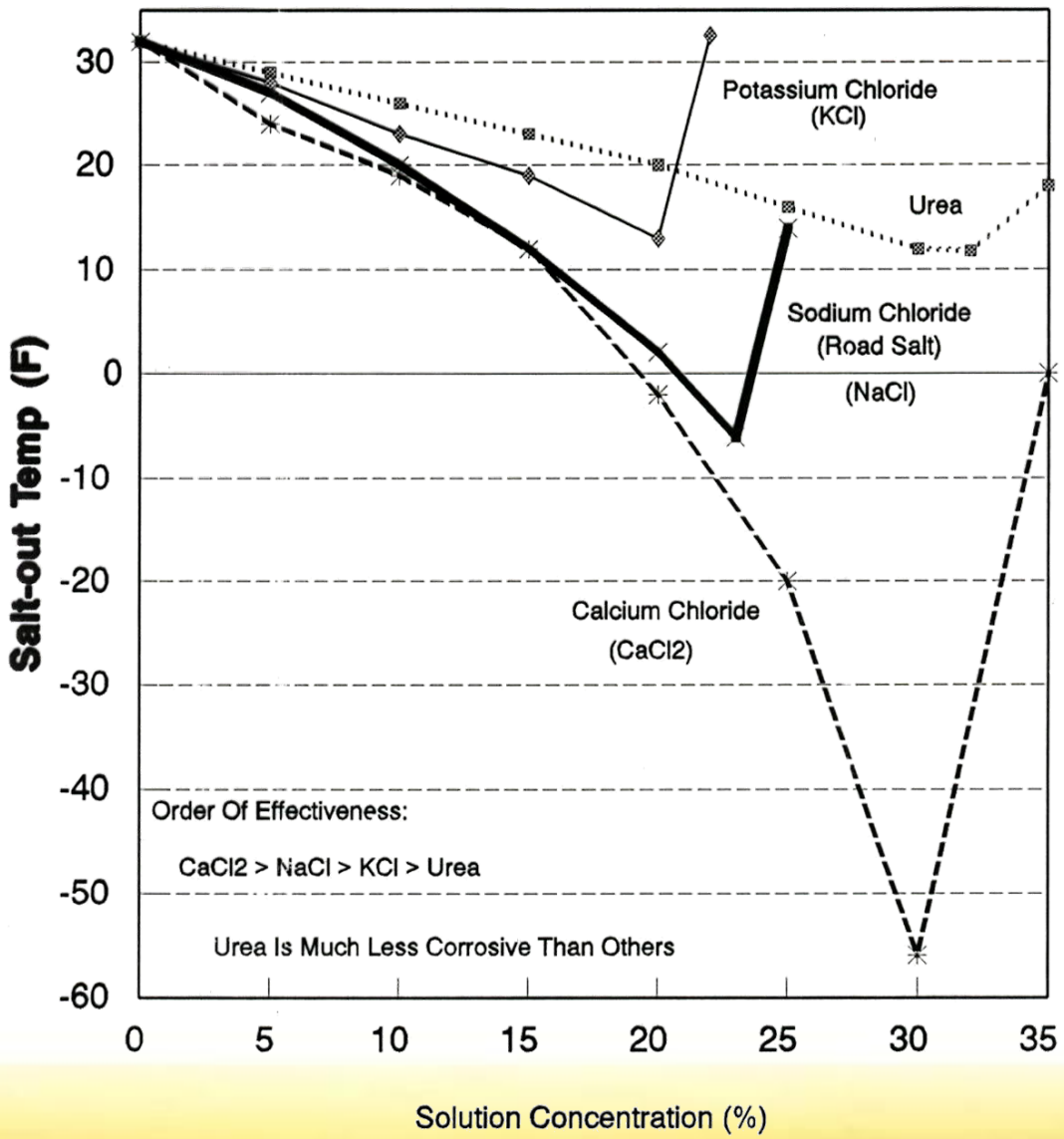
Muddy Water – Solutions with undissolved solids or suspensions containing too few undissolved salt crystals. Not a good range to try and operate in!!.

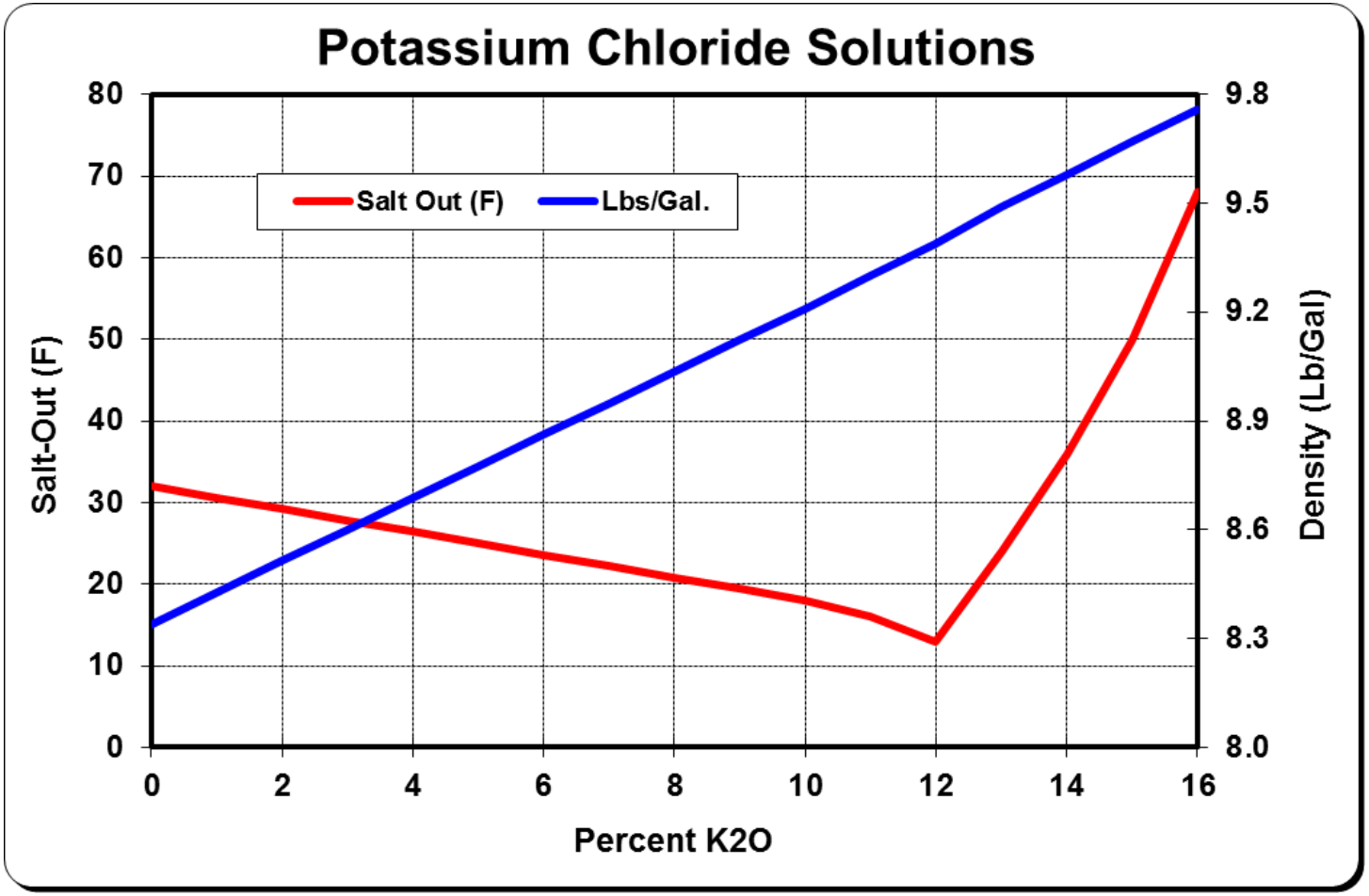
Falling Out Of Solution – No such thing.

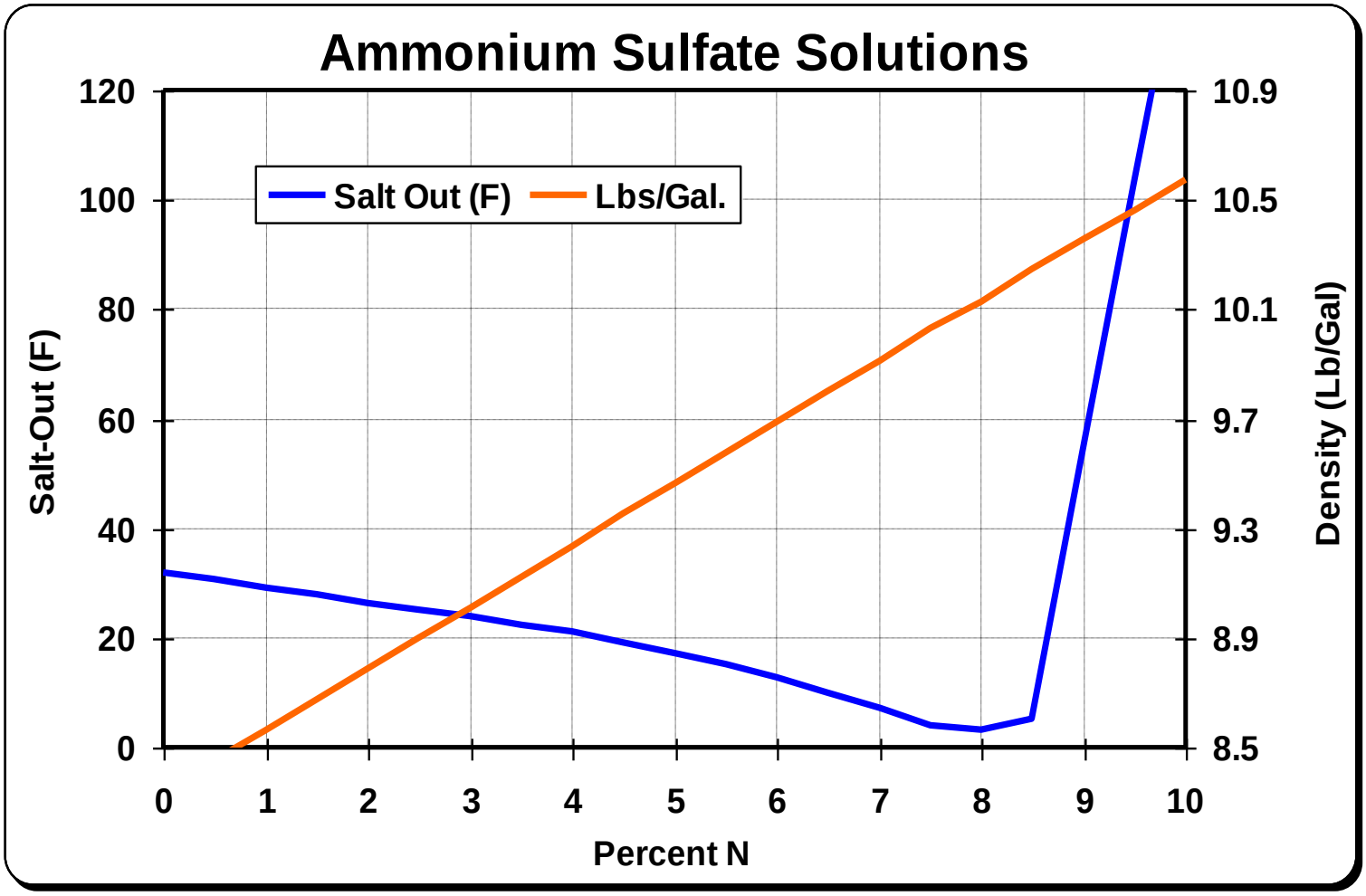
Salt-Out – Crystals form as solution cools; goes back in solution when product is warmed and agitated sufficiently. Example; UAN Solution.

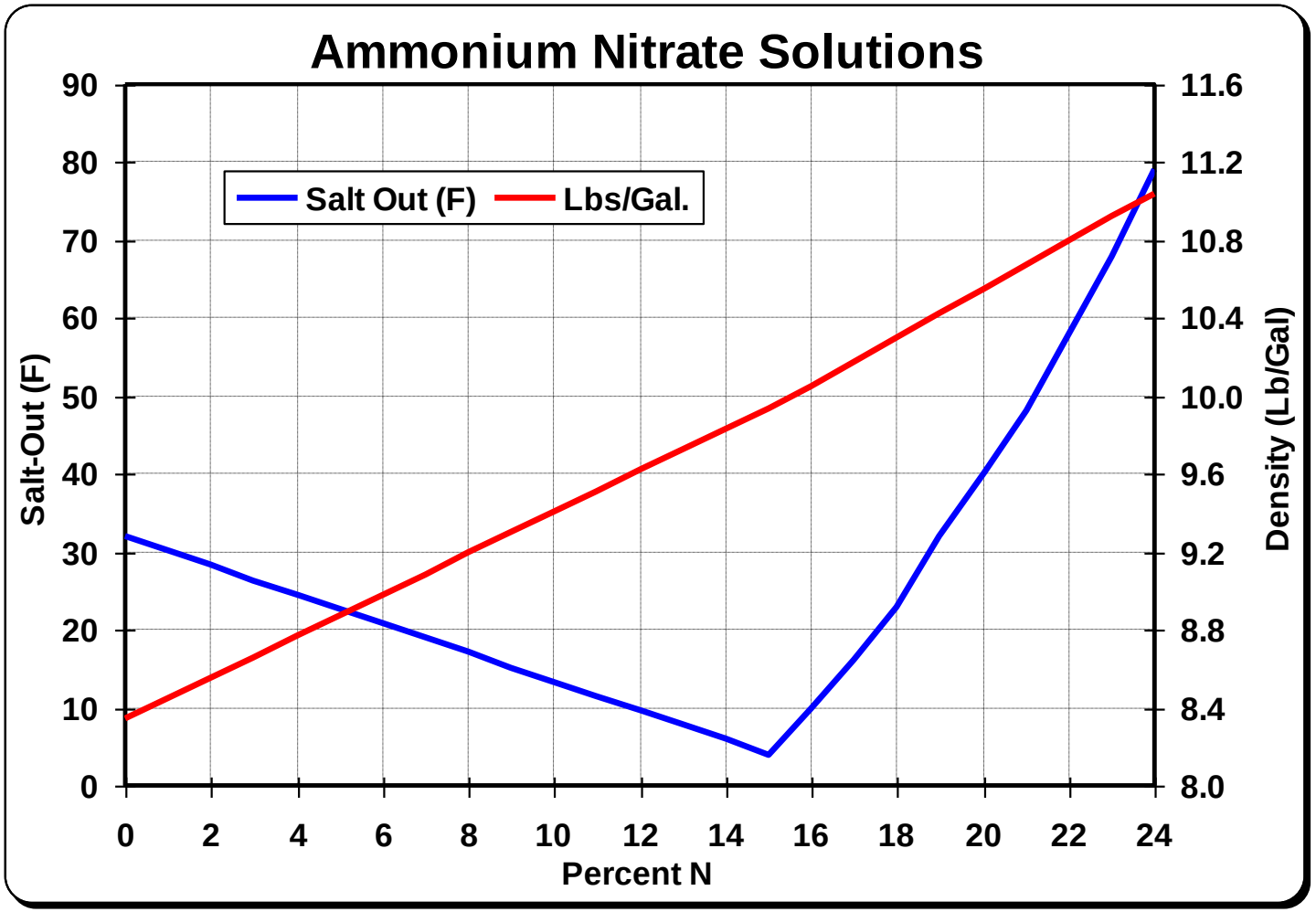
Precipitate Formation – Non-crystalline mass forms which has much lower solubility than original ingredients in solution. Example; Improperly stored fluid phosphates.

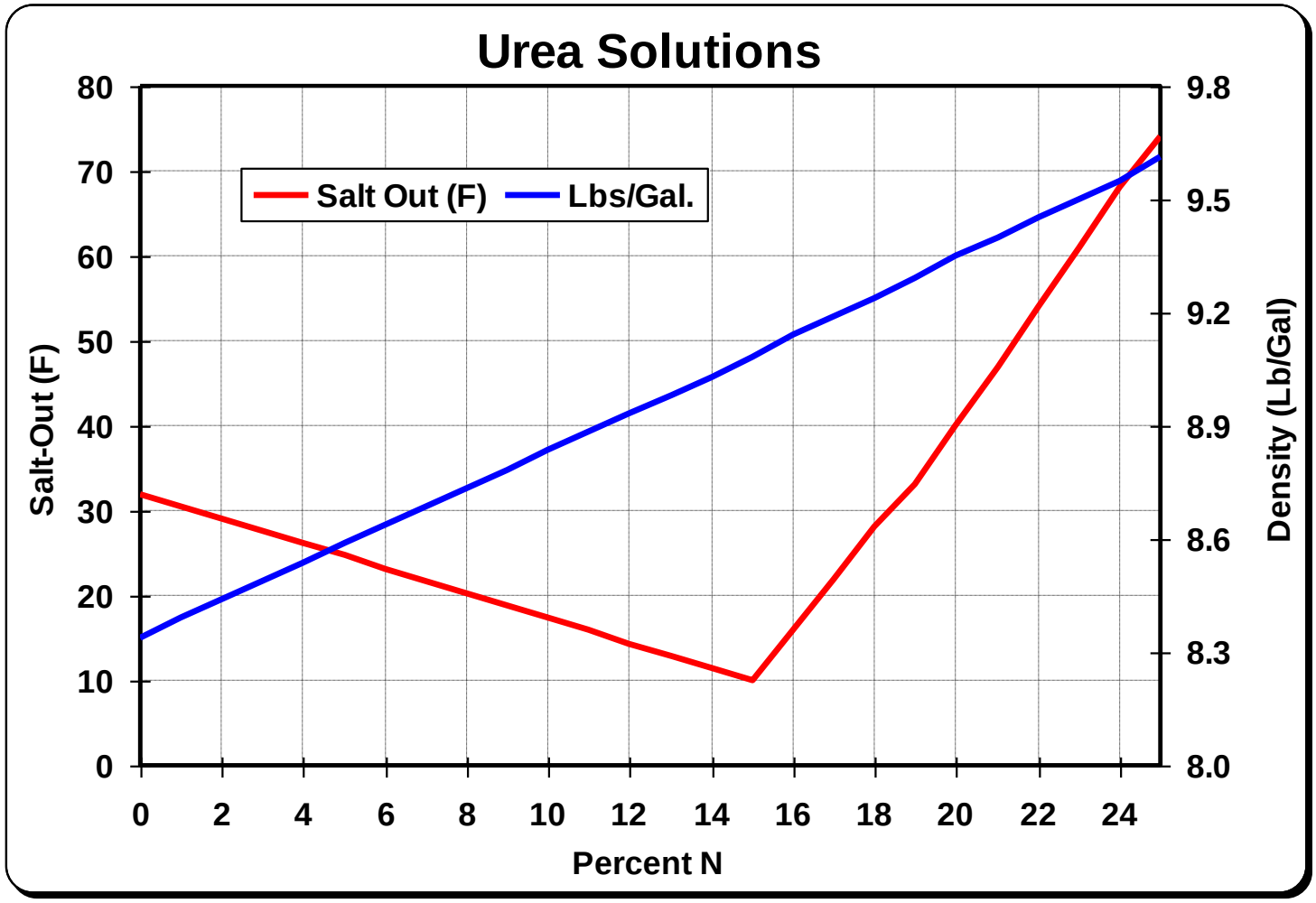
EFFECT OF SALTS ON FREEZING POINT

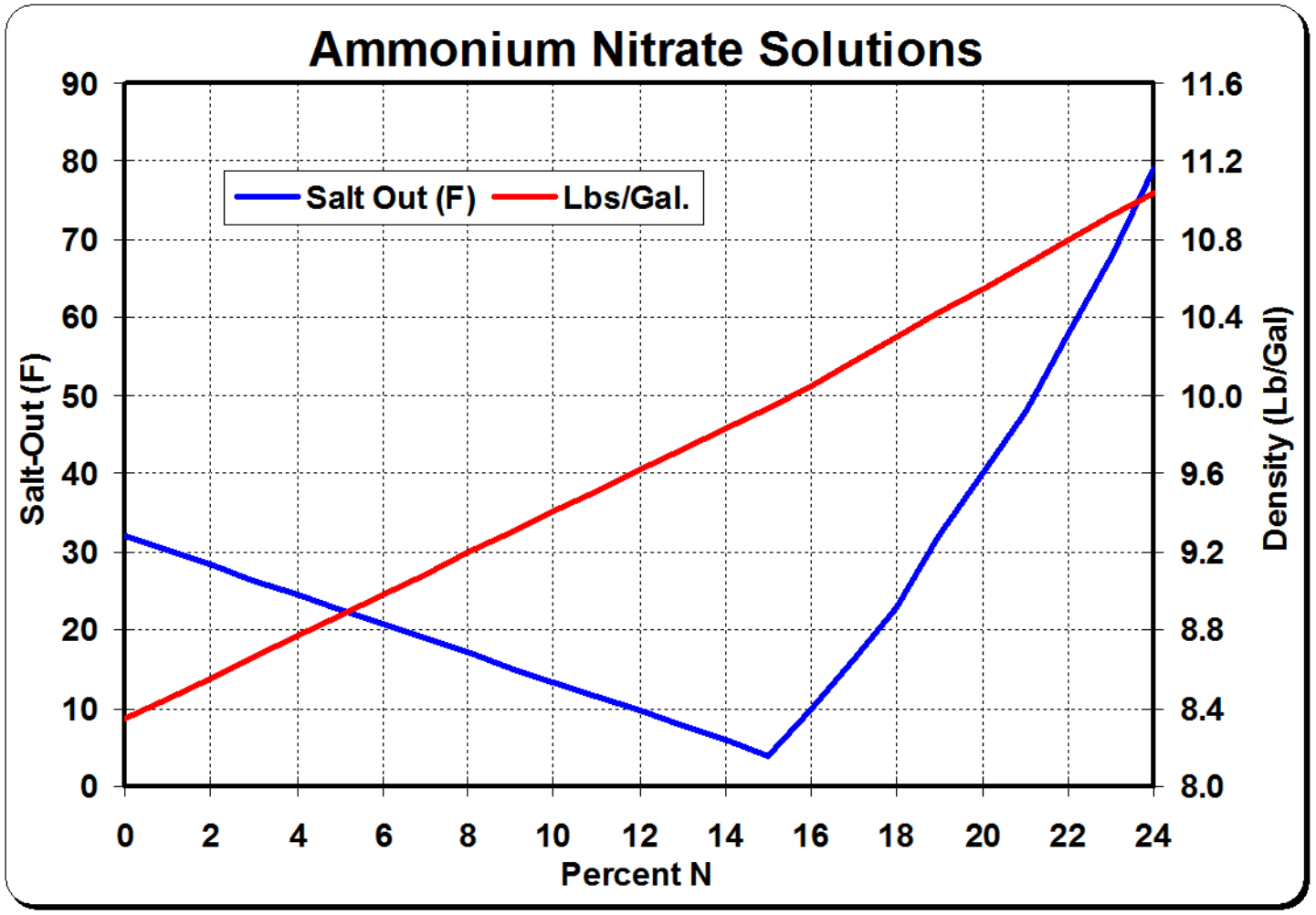


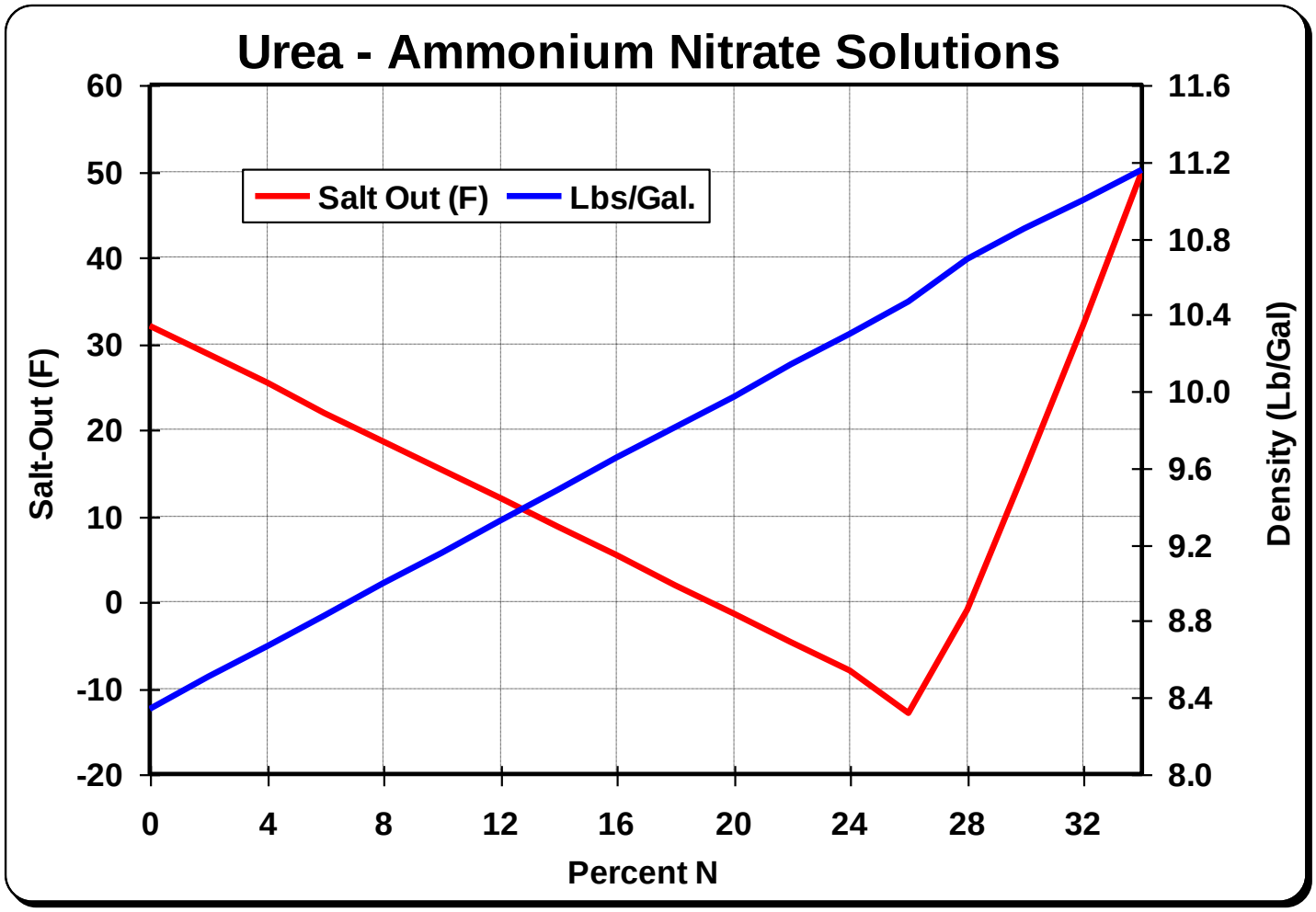

Potassium Chloride Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent K2O
0
10
20
30
40
50
60
70
80
8.0
8.3
8.6
8.9
9.2
9.5
9.8
0
2
4
6
8
10
12
14
16


Ammonium Sulfate Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
120
100
80
60
40
20
0
10.9
10.5
10.1
9.7
9.3
8.9
8.5
0
1
2
3
4
5
6
7
8
9
10


Ammonium Nitrate Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
90
80
70
60
50
40
30
20
10
0
11.6
11.2
10.8
10.4
10.0
9.6
9.2
8.8
8.4
8.0
0
2
4
6
8
10
12
14
16
18
20
22
24

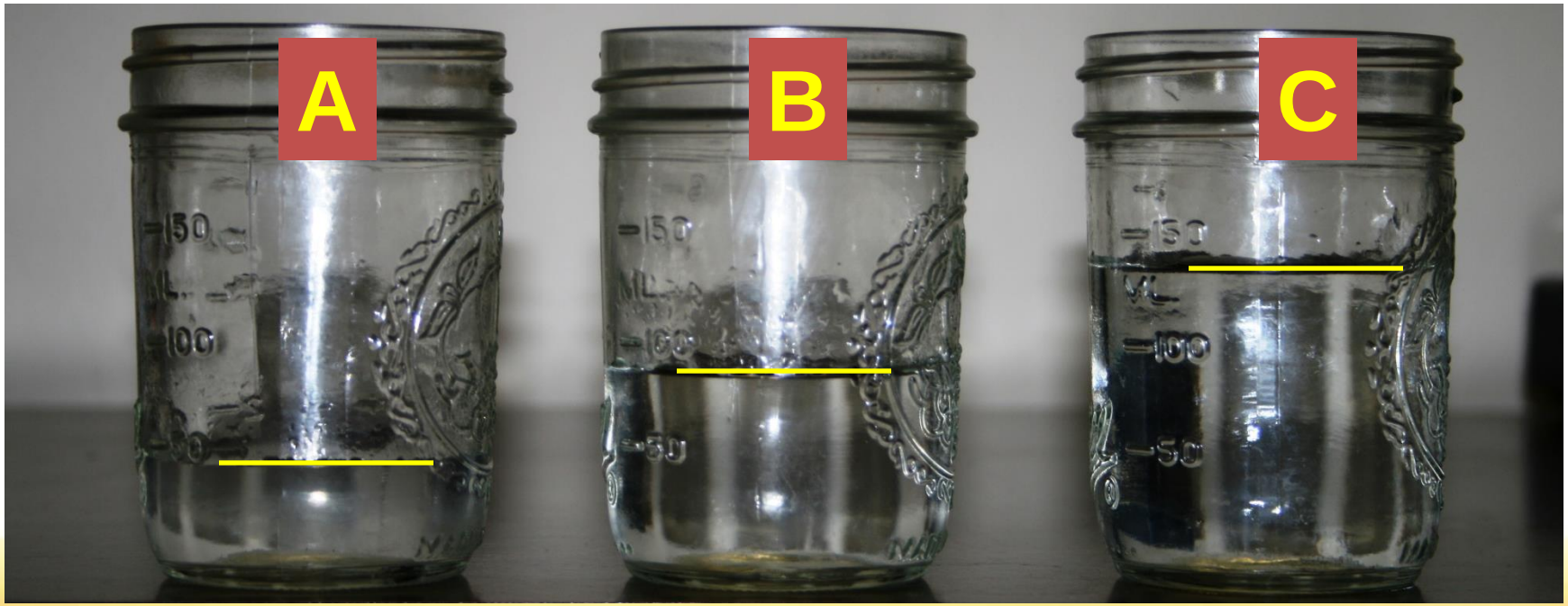

Urea Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
80
70
60
50
40
30
20
10
0
9.8
9.5
9.2
8.9
8.6
8.3
8.0
0
2
4
6
8
10
12
14
16
18
20
22
24


Ammonium Nitrate Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
90
80
70
60
50
40
30
20
10
0
11.6
11.2
10.8
10.4
10.0
9.6
9.2
8.8
8.4
8.0
0
2
4
6
8
10
12
14
16
18
20
22
24

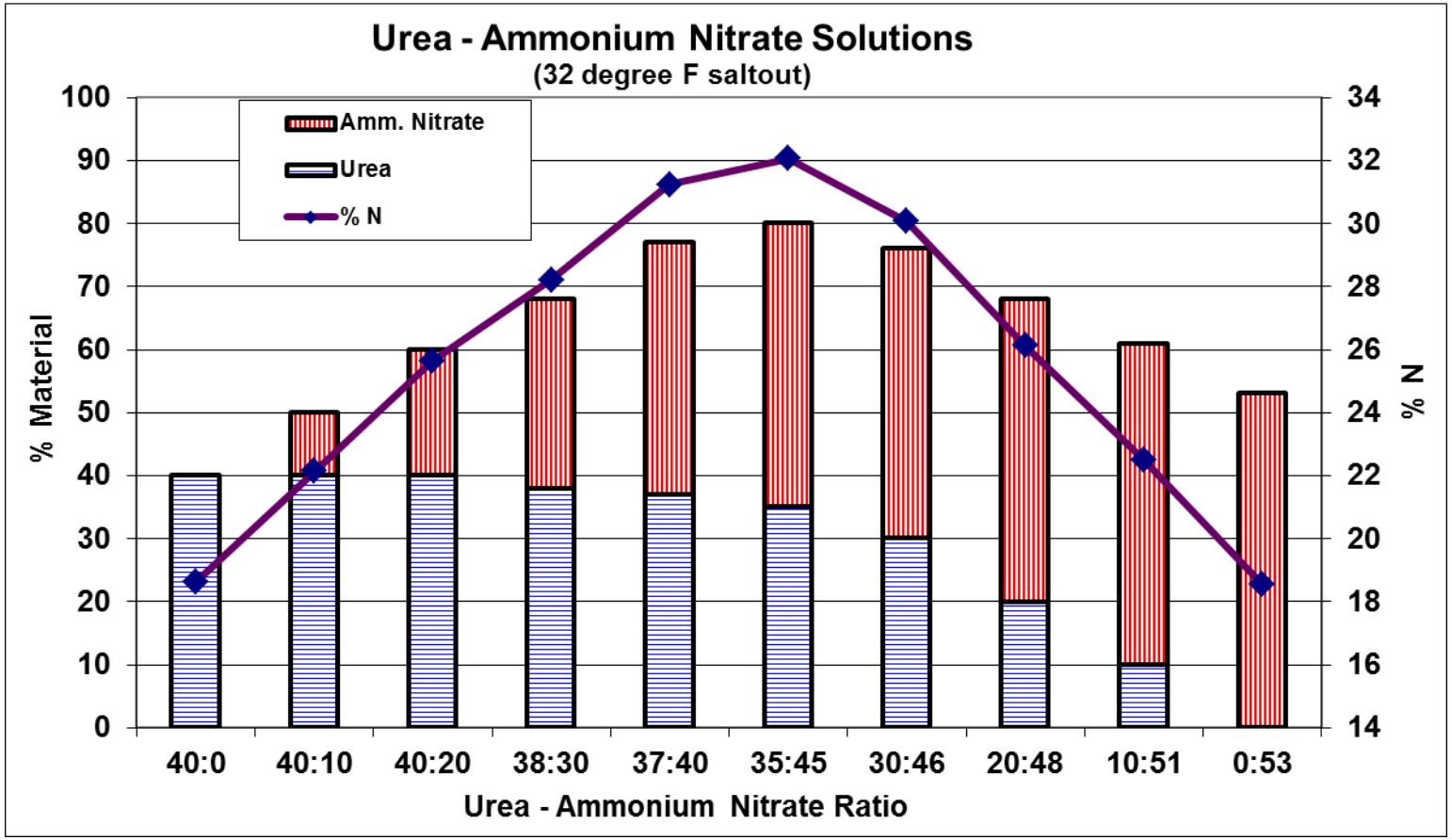

Urea - Ammonium Nitrate Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
60
50
40
30
20
10
0
-10
-20
11.6
11.2
10.8
10.4
10.0
9.6
9.2
8.8
8.4
8.0
0
4
8
12
16
20
24
28
32

To Make 32-0-0 UAN Solution –

How Much Water Is Needed ?



Fluid Fertilizer Foundation



Eutectic Point – point of maximum solubility

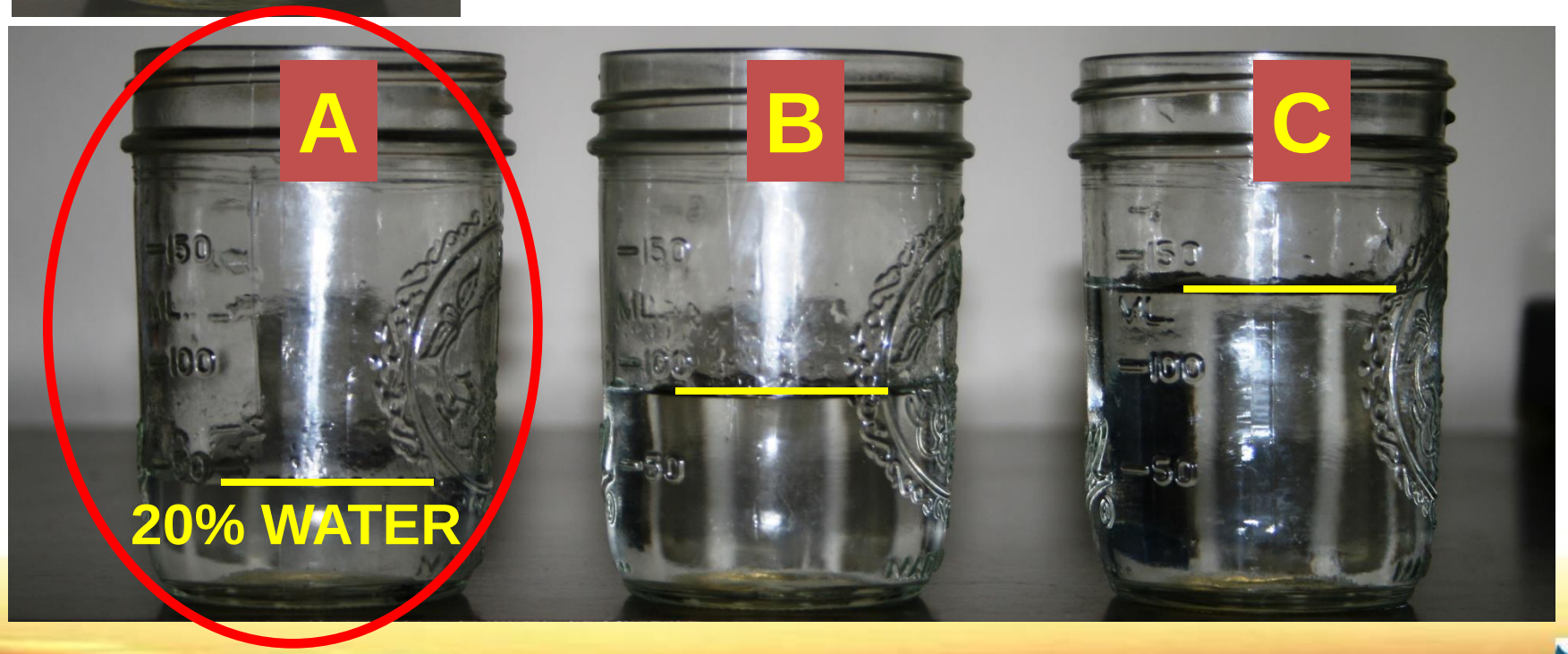
32% UAN contains:

- approximately 35% urea, 45% ammonium nitrate and 20% water at eutectic point

28% UAN contains 30% water

To Make 32-0-0 UAN Solution –

How Much Water Is Needed ?

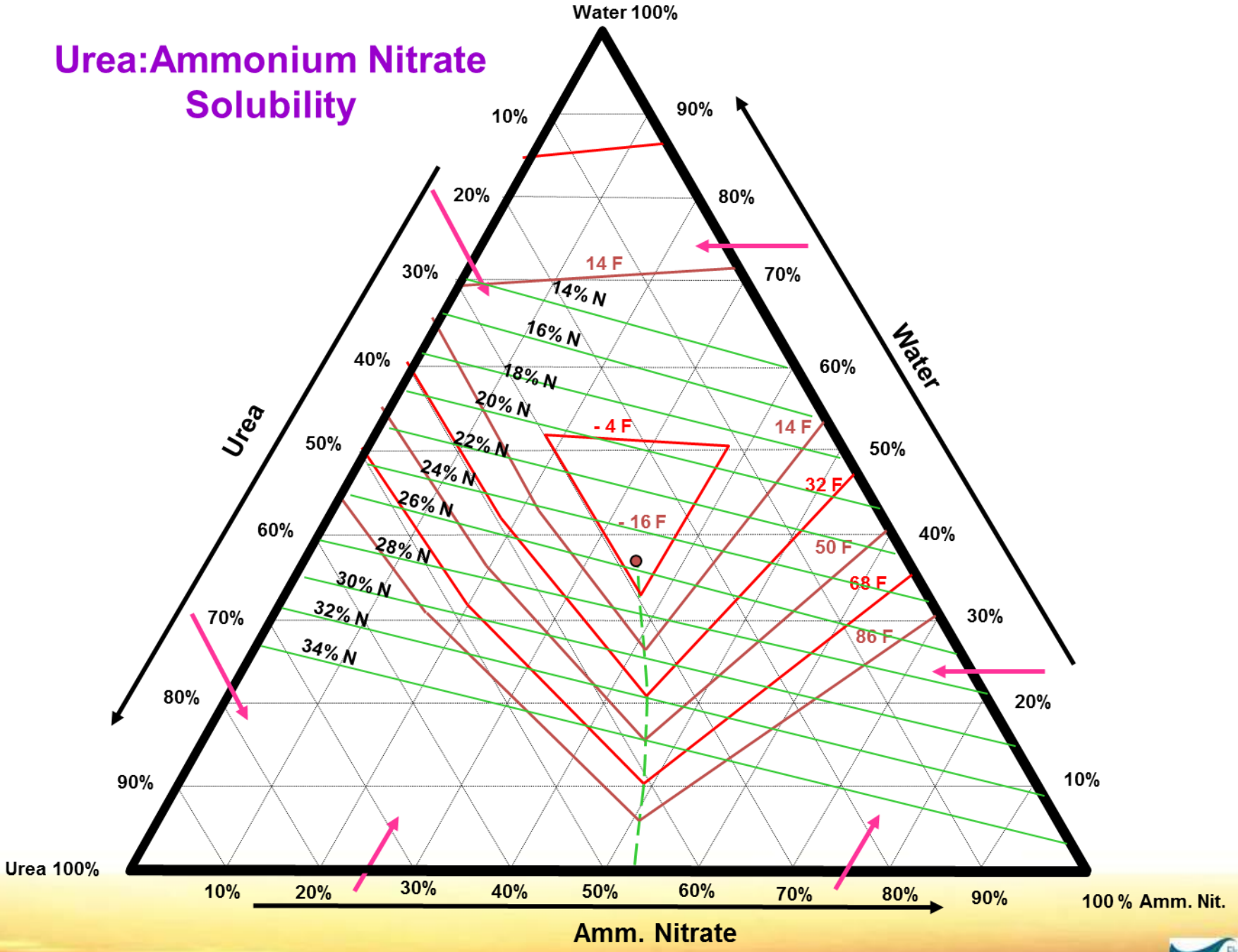


Fluid Fertilizer Foundation

UAN Solution

- **Salt-out is an issue in many environments**
  - ✓ There is very little water in UAN solution.
  - ✓ Warm water has ability to dissolve more salts than cold water
  - ✓ Salt-out occurs when salt content exceeds solubility at a given product temperature
  - ✓ Crystals form on tank walls as temperature cools
  - ✓ Eventually salts accumulate at tank bottom
  - ✓ Salts will re-dissolve with sufficient heat and recirculation

Urea:Ammonium Nitrate Solubility



UAN Solution

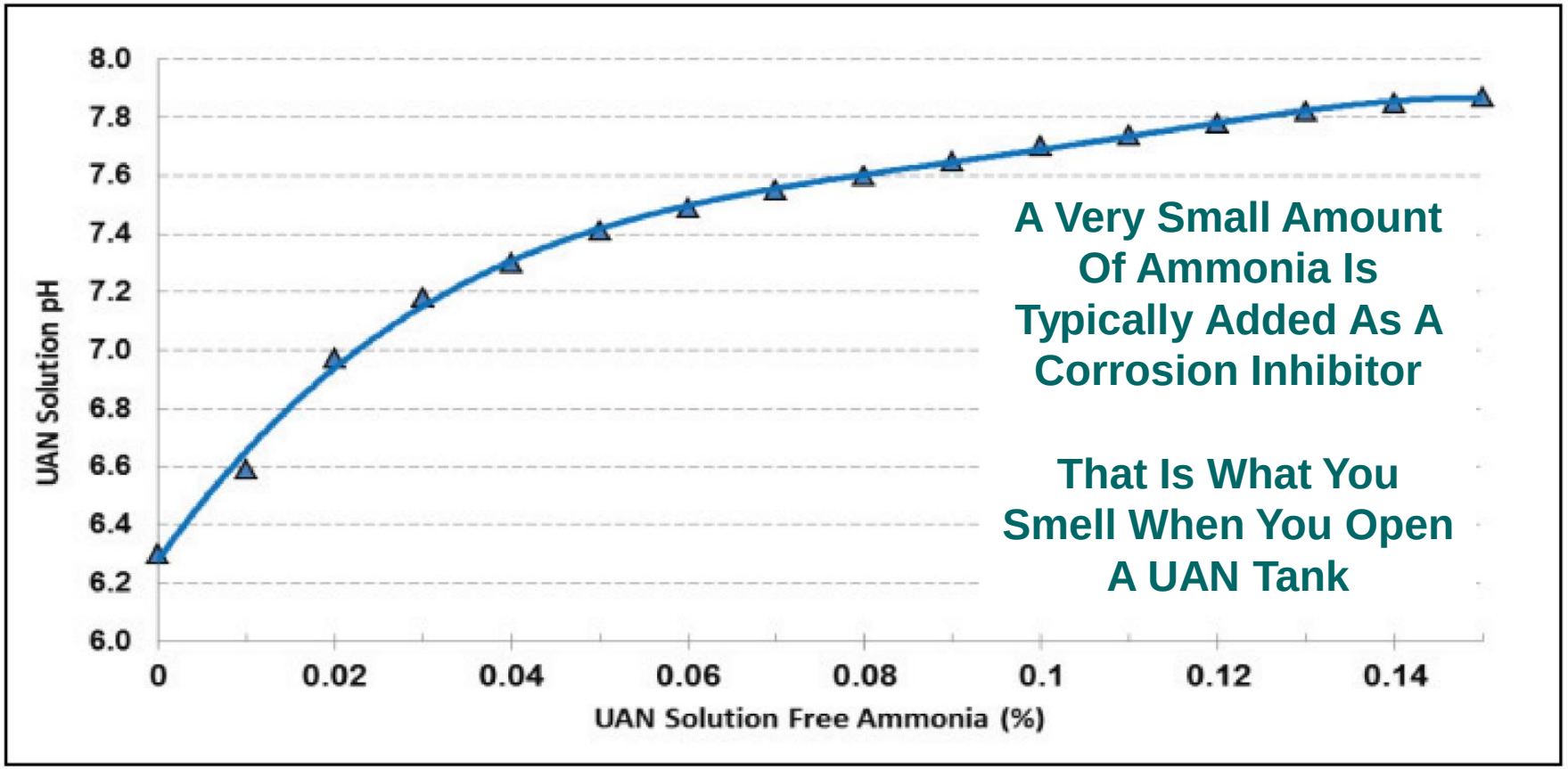


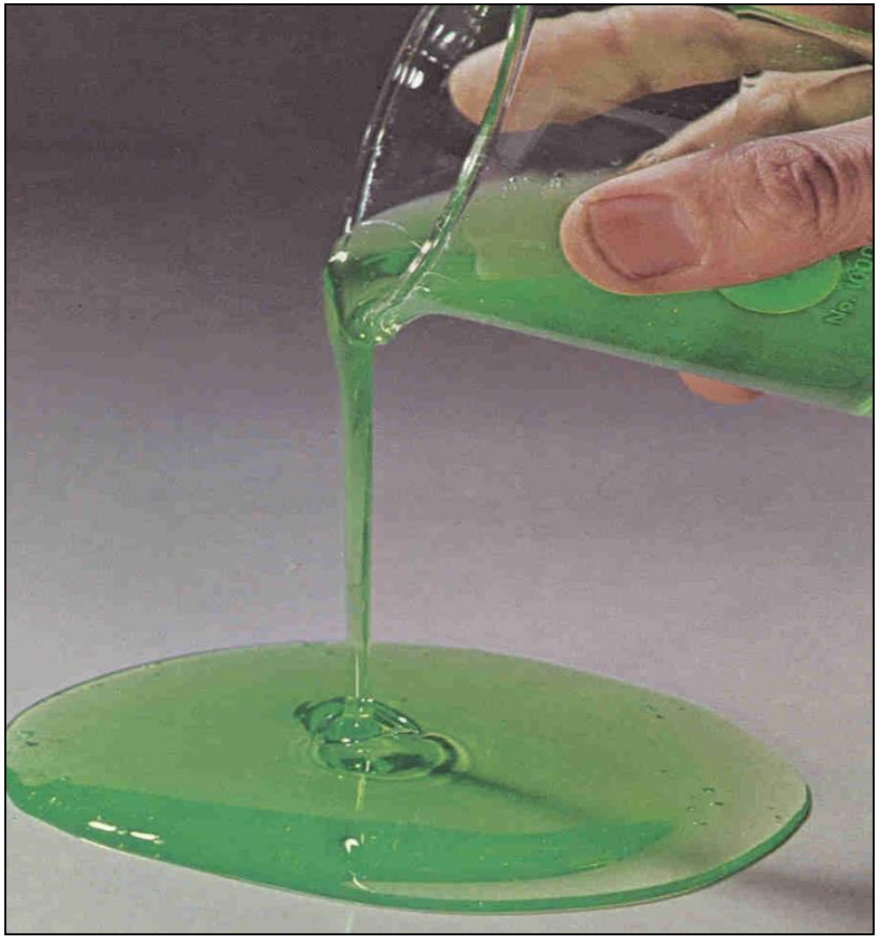
Figure 3. *Free Ammonia Effect On UAN Solution pH.*

UAN Solutions

Component Name	Weight Percentage (approximate in each type of solution)			CAS Number
	32%N	30%N	28%N	
Ammonium nitrate	45	42.2	39.4	6484-52-2
Urea	35	32.8	30.6	57-13-6
Water	20	25	30	7732-18-5
Ammonium hydroxide	0.1	0.1	0.1	1336-21-6
Density (lbs/gal)	**11.06**	**10.86**	**10.67**	

Liquid Phosphate Products

Fluid Phosphate Products and Characteristics



Phosphoric Acid

Wet-Process Acid

- Black, brown, green (calcined)
- Contains many rock impurities
- Widely used in fertilizer industry

PCS Sales

INDUSTRIAL PRODUCTS

Source: White Springs, FL

Alternate Names: LOMAG, SPA

oduct Name: **Superphosphoric Acid**

TYPICAL ANALYSIS	TYPICAL PERCENT
Total Phosphoric Acid, as P_2O_5, Wt. %	69.3
Polyphosphate, % of Total P_2O_5	20.0
Iron, as Fe_2O_3, Wt. %	1.40
Aluminum, as Al_2O_3, Wt. %	1.20
Magnesium, as MgO, Wt. %	0.45
Fluoride, as F, Wt. %	0.16
Sulfate, as SO_4, Wt. %	3.40
[illegible] as CaO, Wt. %	0.03
PHYSICAL DATA	**TYPICAL**
Specific Gravity @ 100°F	1.950
Appearance	Dark Green
Density @ 100°F:	
Pounds/Gallon	16.4

Dark Green

White, Furnace, Purified Acid

- Colorless
- No impurities
- Thermal or Kiln Process
- Food and industrial products
- Used in fluid fertilizer industry

Simplot

PRODUCT DATA SHEET

PURIFIED PHOSPHORIC ACID

0-55-0

Clear, Colorless, no visible particles

GUARANTEED ANALYSIS

Available Phosphate (P_2O_5) 55

Derived from Phosphoric Acid.

Warning: This product contains a chemical known to the State of California to cause cancer, birth defects or other reproductive harm. Proposition 65, the Safe Drinking Water and Toxic Enforcement Act of 1986, requires notification of potential exposure to substances identified by the State of California as causing cancer, birth defects or other reproductive harm.

Information regarding the contents and levels of metals in this product is available on the Internet at http://www.regulatory-info.com

PHYSICAL CHARACTERISTICS

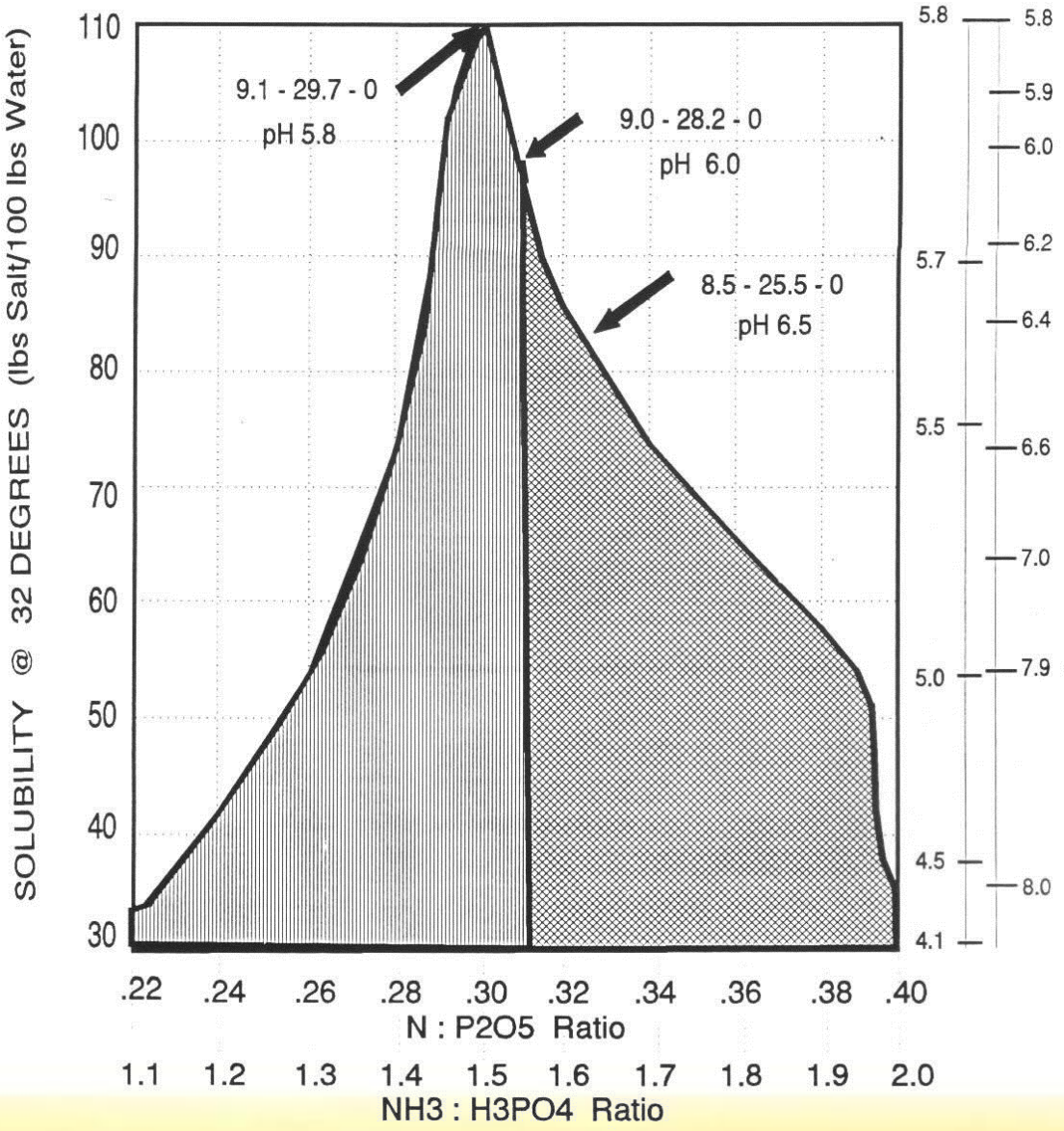
Appearance ..... clear, colorless, no visible particles

Specific Gravity @ 70°F 1.61

Weight (lbs. per gal.) 13.4

Fluid Fertilizer Foundation

SOLUBILITY OF AMMONIUM PHOSPHATES
(ORTHO- SOLUTIONS)



Ammonium Polyphosphate (APP)

- Primary P source for much of fluid industry
- Most NPKS products made from APP
- Produced from ammonia, wet-process superphosphoric acid and water
- Contains most P (65-70%) as polyphosphate

PCS Sales

INDUSTRIAL PRODUCTS

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Alternate Names: LOMAG, SPA

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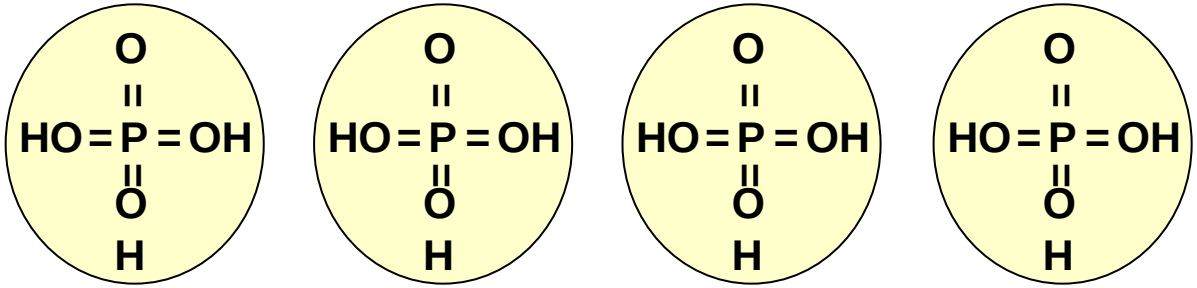
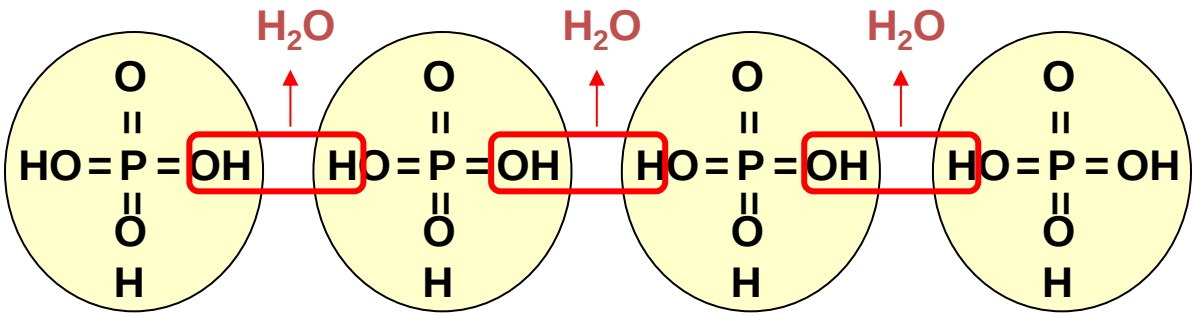
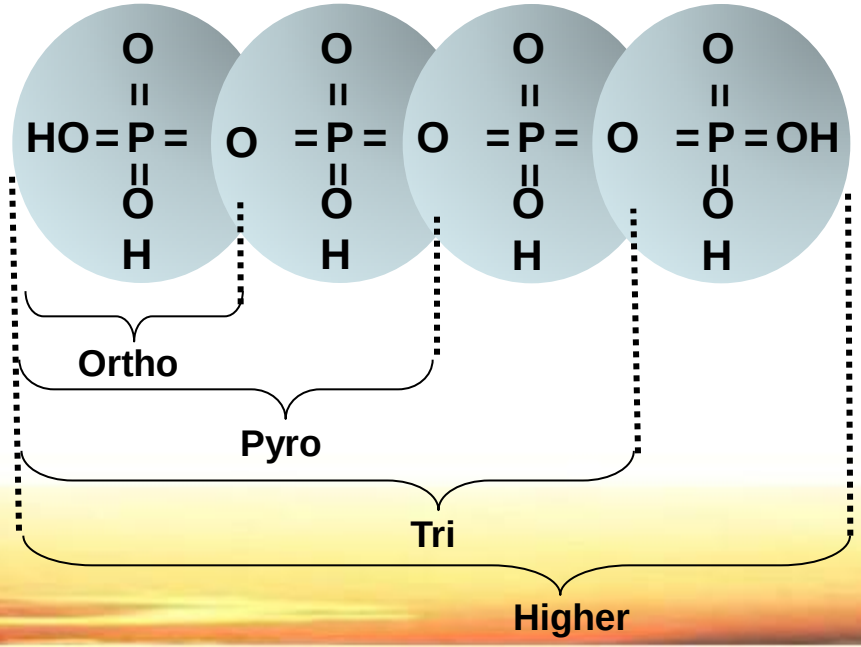
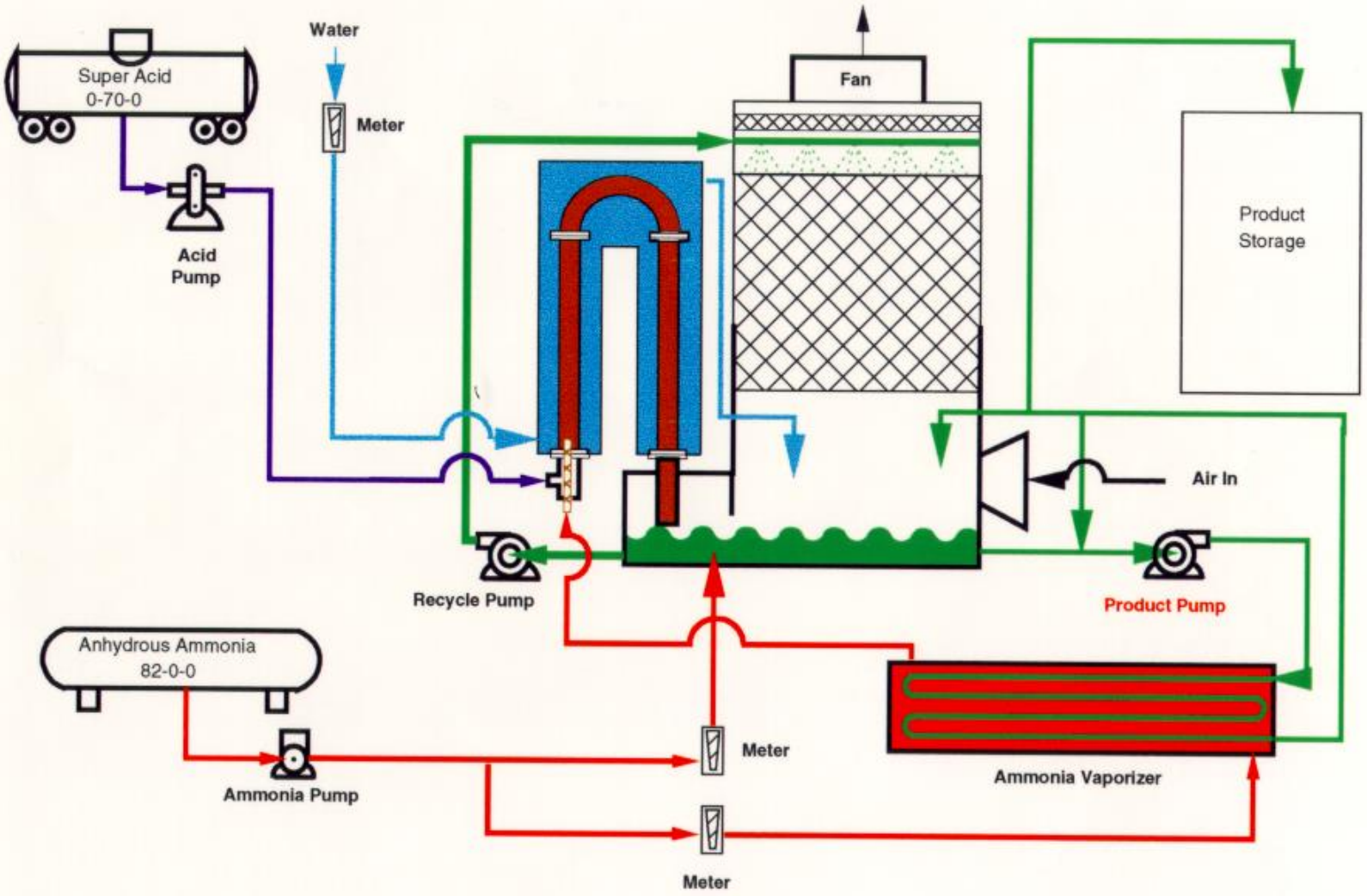




Heat links phosphates by removing chemically bound water

Heat comes from chemical reaction of reacting phosphoric acid with ammonia





TVA PIPE REACTOR PROCESS SCHEMATIC

Orthophosphoric Acid Examples

Source	Acid 1	Acid 2	Acid 3	Acid 4
P2O5	61	53.2	52.8	57
MgO	0.3	1.2	1.1	0.2
Fe2O3	0.35	0.5	1	0.32
Al2O3	0.18	0.4	0.5	0.16
F	0.3	0.4	2.1	0.1
Solids	0.5	0.1	0.1	Nil
Visc.@100F	40	90	100	27

Source: Texas Gulf

Superphosphoric Acid Examples

	Acid 1	Acid 2	Acid 3	Acid 4
% P_2O_5	72.8	69.54	69.8	69.6
%Fe_2O_3	0.4	1.28	1.88	2.54
%Al_2O_3	0.2	1.07	1.29	1.09
%MgO	0.25	0.23	0.38	0.5
% Poly	40	27	19	29.9
% Solids	<0.01	0.1	0.06	0.15

Source: Texas Gulf

Why Do We Want Polyphosphates ?

- Not necessarily for agronomic reasons
- Manage sludge problems in fluid P products
  - ✓ Polyphosphates sequester metal cation impurities in the product (especially Mg) to form relatively insoluble precipitates
  - ✓ Provides superior storage qualities
- Increased analysis compared to orthophosphate
- Provides ability to include higher amounts of micronutrients in product (not Ca or Mg)

Hydrolysis Of Polyphosphate To Orthophosphate

Soil Temperature	24 Hour Polyphosphate Hydrolysis (%)
41 F	30-40 %
68 F	50-60 %
95 F	80-90 %

Chang and Racz, 1977

After application to soils, polyphosphate is converted to orthophosphate by abundant soil enzymes – quicker in warm soils, slower in cold soils

Plants utilize orthophosphates

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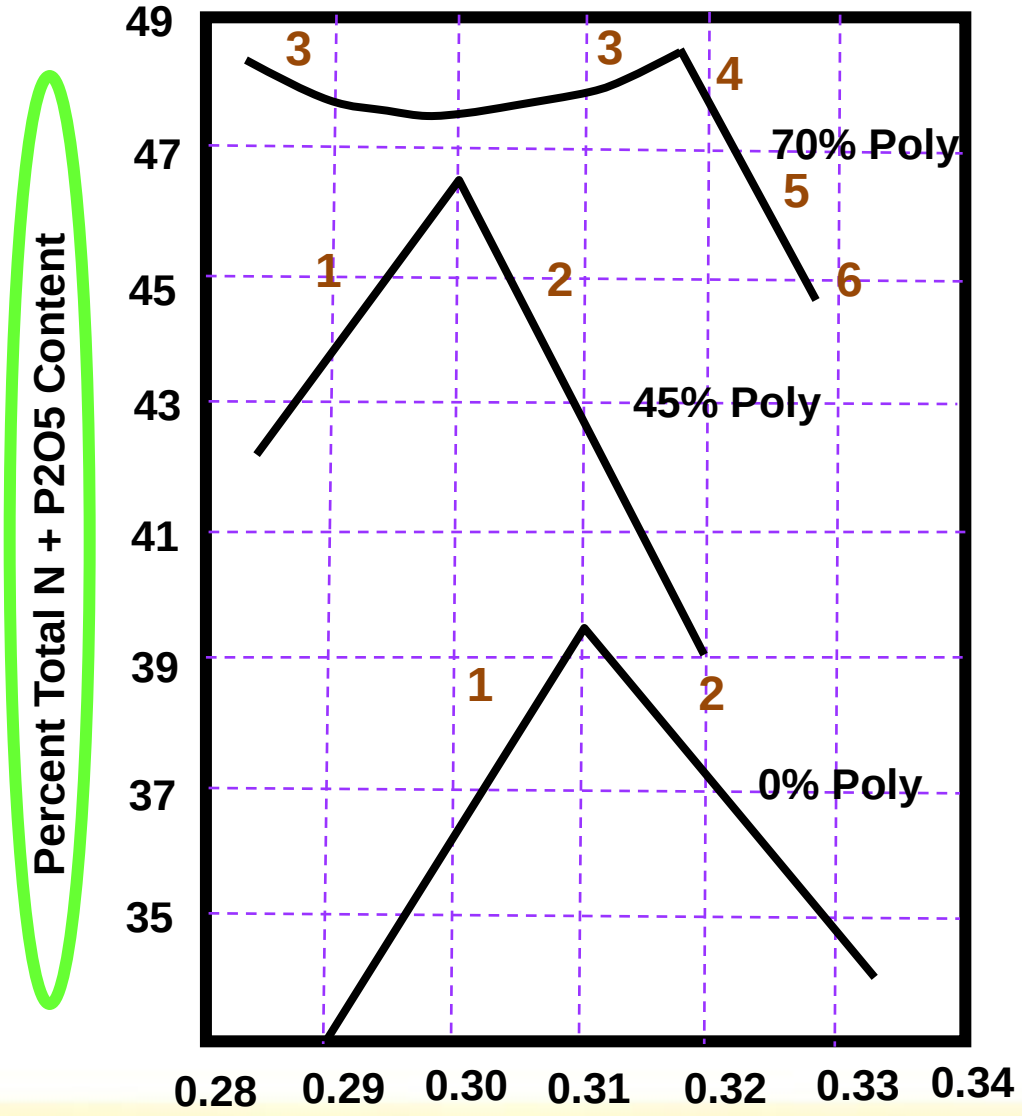
- Increased analysis compared to orthophosphate
- Provides ability to include higher amounts of micronutrients in product (not Ca^{++} or Mg^{++})

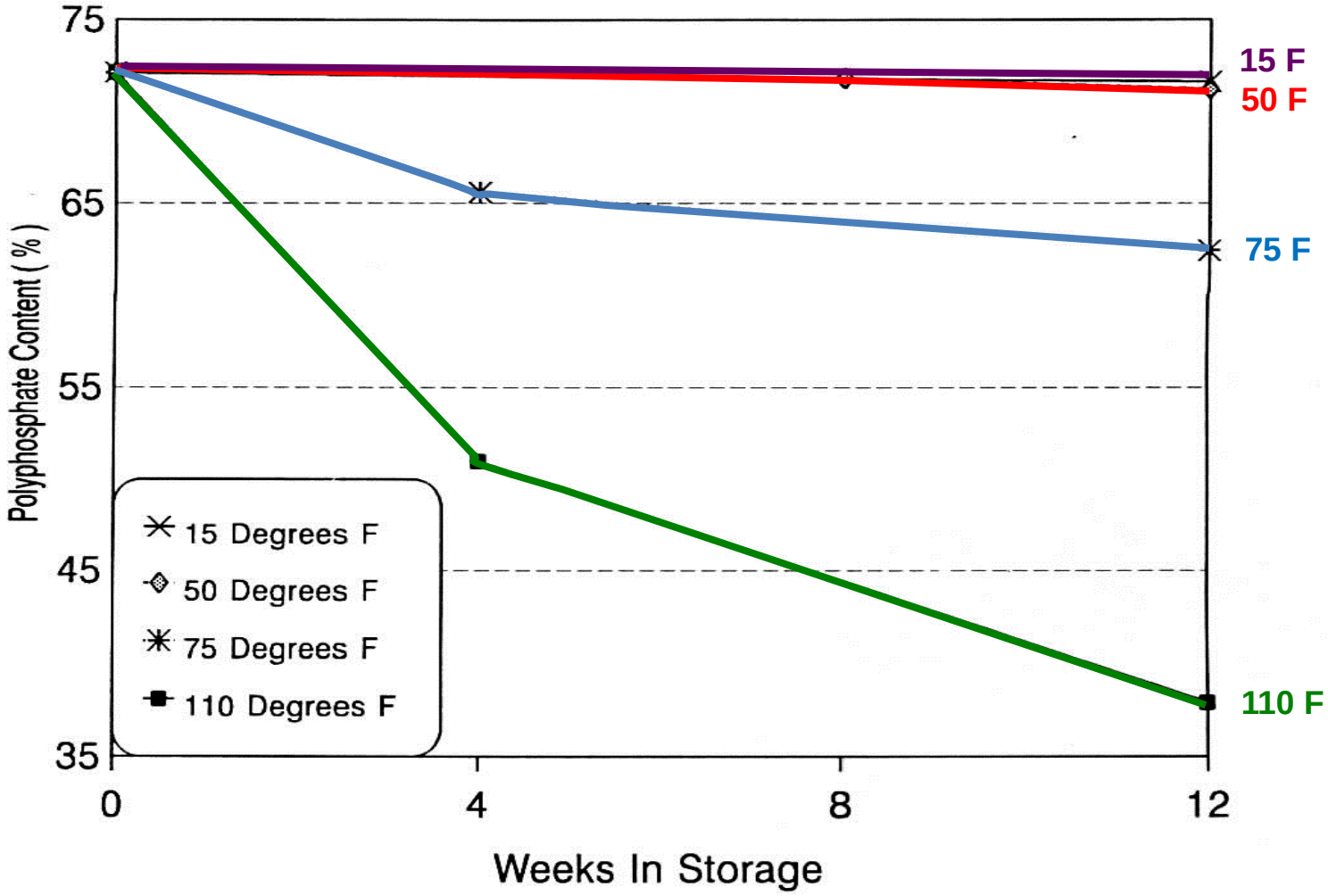
Effect of Poly Content and N:P2O5 Ratio On Solubility



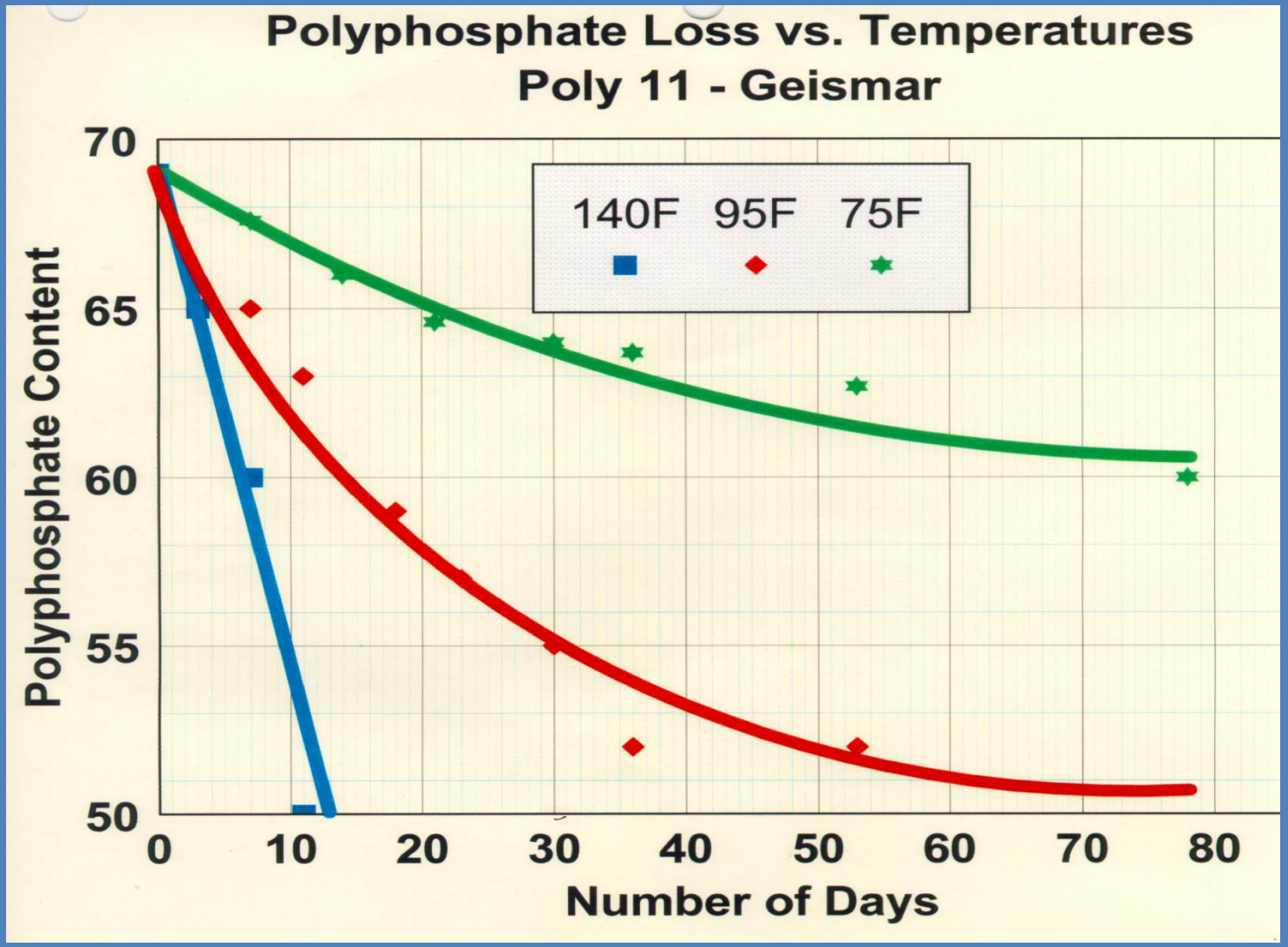
Polyphosphate level, % of total P_2O_5	
I	0
II	45
III	70

Crystallizing phase	
(1)	$(NH_4)\ H_2PO_4$
(2)	$(NH_4)_2\ HPO_4$
(3)	$(NH_4)_3\ HP_2O_7 \bullet H_2O$
(4)	$(NH_4)_5\ P_3O_{10} \bullet 2H_2O$
(5)	$(NH_4)_2\ HPO_4 \bullet 2H_2O$
(6)	$(NH_4)_4\ P_2O_7 \bullet H_2O$

Temperature Effect On 10-34-0 Quality



Source: Farmland Industries


Polyphosphate Loss vs. Temperatures
Poly 11 - Geismar
140F
95F
75F
Polyphosphate Content
70
65
60
55
50
0
10
20
30
40
50
60
70
80
Number of Days

Zinc Sequestering Ability Of 10-34-0

University of Nebraska

Original Zn Source	% Zn Remaining As Original As Original	% Zn Sequestered By By Polyphosphate
Zn EDTA	100	0
Zn Sulfate	4	96
Zn-Ammonia Complex	8	92
Zn Phenolic Acid	11	89
Zn Citrate	8	92
Zn Nitrate + UAN	15	85
Zn HEIDA	19	81

Measurements taken four minutes after mixing

Factors Impacting Precipitate Formation In Storage

- Amount of polyphosphate initially present
- Amount of impurities in super-acid
- Other 'impurities' added to product
  - ✓ Zinc
  - ✓ Previous product sludge
- Temperature of stored product
- Length of time product stored

APP Storage and Housekeeping Suggestions

- Do not store longer than necessary
- Avoid storage in summer months
  - Shelf Life is About 6-12 Months at 75 °F or cooler – Longer With Cooler Temperatures, Much Shorter With Warmer Temperatures
  - Product Converted to NPK/Micro Grades Shorter Yet
- Completely empty and clean tanks regularly
- Know the quality of remaining product before adding additional product to tanks
  - Problems likely below 60% polyphosphate
  - Don't contaminate Good Product

APP Storage and Housekeeping Suggestions

- Do not contaminate with products/impurities that may affect storage properties
  - Never, ever contaminate storage, mix plant or lines with any calcium or magnesium
- Make sure that **farmers** and dealers lines, tanks and equipment are completely cleaned after use
- Paint Storage Tanks White To Aid In Keeping Product Cooler

High Orthophosphate Content ('Low Salt')

Some Portion of P From Furnace or White Orthophosphoric Acid

K From Potassium Hydroxide or Potassium Carbonate

S from ATS or KTS

Micros From Fully Chelated Sources

Excellent/Exceptional Shelf life

High Polyphosphate Content

P From Wet-Process Superphosphoric Acid

K Typically From Potassium Chloride

S from ATS or KTS

Micros From Inorganic, Complexed or Chelated Sources

Limited Shelf Life

NACHURS®
9-18-9-1

GUARANTEED ANALYSIS:

Total Nitrogen (N)	**9%**
Available Phosphate (P_2O_5)	**18%**
Soluble Potash (K_2O)	**9%**
Sulfur (S)	**1%**

Derived from: urea, ammonium hydroxide, phosphoric acid, potassium hydroxide, and ammonium thiosulfate.

Weight: 11.15 lbs. per gallon

PRODUCT PROPERTIES:

Specific gravity:	1.34
pH:	6.8 – 7.2
Appearance:	clear, water white liquid
Odor:	no odor, or mild ammonia

Nutra-Flo PureGrade® Liquid Fertilizer

- **100% Orthophosphate**
- **100% Water Soluble**
- **Low-Salt Index**
- **Chloride Free**
- **Trouble-free**
- **Neutral pH**
- **Environmentally friendly**

DIAMOND Liquid Plant Food

Simplot

6-24-6

GUARANTEED ANALYSIS: 6-24-6 **BY WT.**

Total Nitrogen 6.00%
- 5.30% Ammoniacal Nitrogen
- 0.70% Urea Nitrogen

Available Phosphate (P_2O_5) 24.00%
Soluble Potash (K_2O) 6.00%

Derived from potassium hydroxide, phosphoric acid, ammonium polyphosphate, urea, and aqua ammonia.

Weight per gallon 11.1 lbs. per gallon @ 68°F STORE ABOVE 32°F

PRODUCT PROPERTIES

Specific Gravity	1.33
pH	6.3 - 7.0
Appearance	Clear Green
Orthophosphate	50%
Odor	Nearly orderless, or mild ammonia odor

Simplot

3-18-18

GUARANTEED ANALYSIS: 3-18-18 **BY WT.**

Total Nitrogen 3.00%
- 0.80% Ammoniacal Nitrogen
- 2.20% Urea Nitrogen

Available Phosphate (P_2O_5) 18.00%
Soluble Potash (K_2O) 18.00%

Derived from Urea, Anhydrous ammonia, Phosphoric Acid and Potassium Hydroxide.

Weight per gallon 11.8 lbs. per gallon @ 68°F STORE ABOVE 32°F

PRODUCT PROPERTIES

Specific Gravity	1.42
pH	7.4-7.8
Appearance	Clear
Orthophosphate	100%
Odor	Nearly odorless, or mild ammonia odor

Fluid Fertilizer Foundation

Salt Indexes Vary Among Starter Products

Salt index values of fertilizer materials.

Material & analysis	Salt Index: Per equal wts of materials	Salt Index: Per unit of nutrients*
NITROGEN/SULFUR		
Ammonia, 82% N	47.1	0.572
Ammonium nitrate, 34% N	104.0	3.059
Ammonium sulfate, 21% N, 24% S	68.3	3.252
Ammonium thiosulfate, 12% N, 26% S	90.4	7.533
PHOSPHORUS		
APP, 10% N, 34% P_2O_5	20.0	0.455
DAP, 18% N, 46% P_2O_5	29.2	0.456
MAP, 11% N, 52% P_2O_5	26.7	0.405
POTASSIUM		
Monopotassium phosphate, 52% P_2O_5, 35% K_2O	8.4	0.097
Potassium chloride, 62% K_2O	120.1	1.936
Potassium sulfate, 50% K_2O, 18% S	42.6	0.852
Potassium thiosulfate, 25% K_2O, 17% S	68.0	2.720

Salt index of some common liquid formulations.

Formulation	Salt index	Salt index per unit of plant nutrient (20 lb)
3-18-18[a]	8.5	0.22
6-24-6[a]	11.5	0.32
9-18-9[a]	16.7	0.48
10-34-0[b]	20.0	0.45
7-21-7[c]	27.8	0.79
4-10-10[c]	27.5	1.18
8-20-5-5S-5Zn[c]	39.4	1.17
28% UAN[c]	63.0	2.25

Different materials can be used to make the same analysis fertilizer

Comparison Of Some Typical Fluid Zinc Sources, Suggested Uses and Compatability

Typical Analysis*	Inorganic 16-0-0-20 Zn	Complex 10% Zn	'Partially' Chelated - 10% Zn	Fully Chelated - 9% Zn
Complexing Agent	Ammonia	Citric Acid	Citric Acid + EDTA	EDTA
Compatible With 10-34-0	Yes	Yes	Yes	Yes
Compatible With Orthophosphate	No	No	No	Yes
Foliar Application	No	Yes*	Yes	Yes
Fertigation	No	No	Yes*	Yes

Tetra

Fluid Fertilizer Foundation

Make Sure You Know What Form Of Micronutrient You Have – And Jar Test !

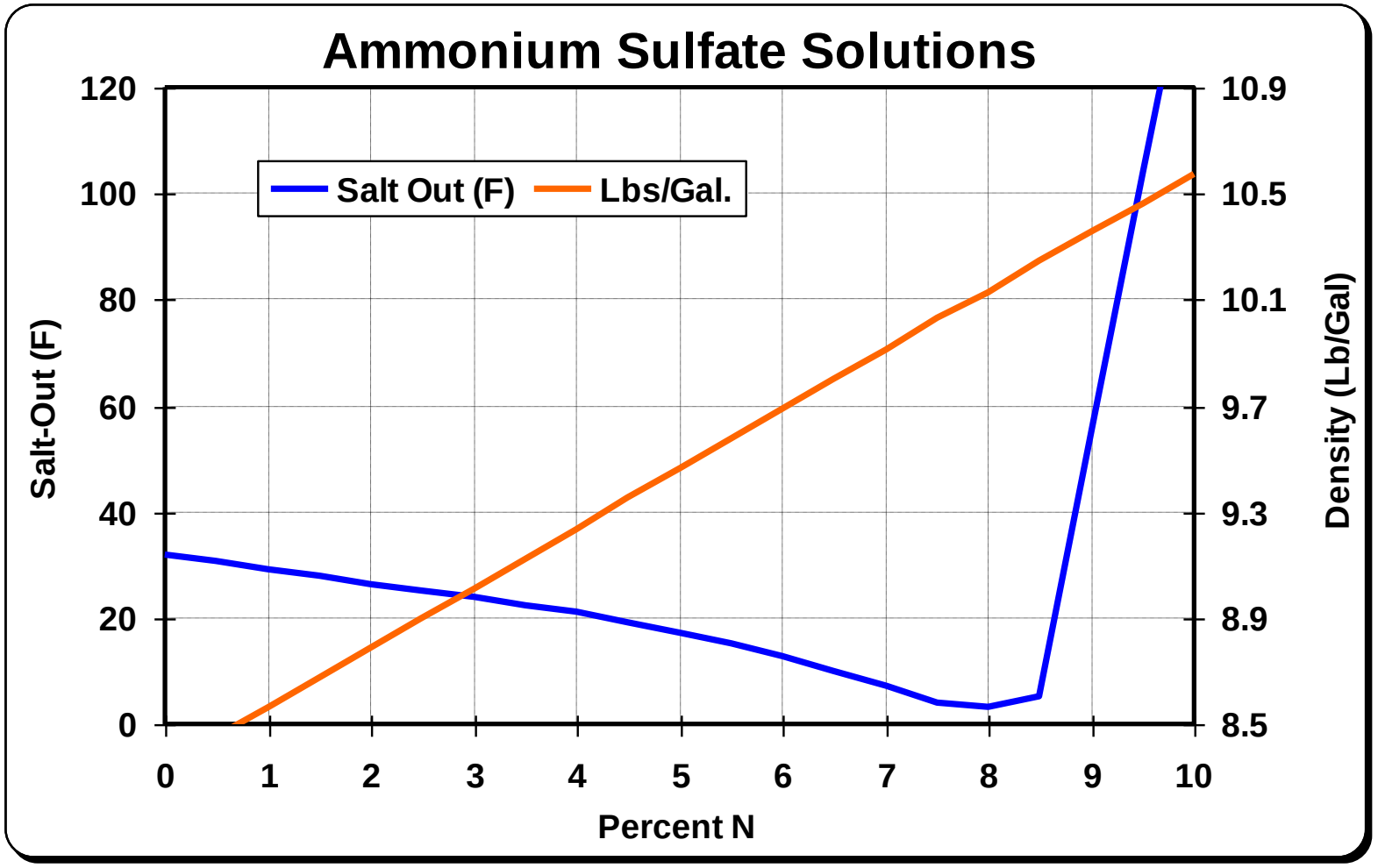
Ammoniated Zinc

Citric Complex

Citric/EDTA Blend

EDTA Zinc

Fluid Fertilizer Foundation


Ammonium Sulfate Solutions
Salt Out (F)
Lbs/Gal.
Salt-Out (F)
Density (Lb/Gal)
Percent N
120
100
80
60
40
20
0
10.9
10.5
10.1
9.7
9.3
8.9
8.5
0
1
2
3
4
5
6
7
8
9
10

Properties of Ammonium Sulfate Solutions

N	S	Ammonium Sulfate	Water	Salt-out Temperature	Product Density
- - - - - -		wt % - - - - - - -		˚F	lbs/gal
7.0	8.0	33.0	67.0	9	9.91
7.5	8.5	35.4	64.6	4	10.03
8.0	9.1	37.7	62.3	3	10.13
8.5	9.7	40.1	59.9	5	10.25
8.7	10.0	41.3	58.7	32	10.3
9.0	10.2	42.4	57.6	56	10.35
9.5	10.8	44.8	55.2	104	10.45
10.0	11.4	47.2	52.8	151	10.57

Source: NFDC-TVA

Satisfactory Grades Using UAN and Ammonium Sulfate Solutions

(32% UAN, 8.7-0-0-10S Amm. Sulfate Solution -- 32° F Salt-out)

	Ammonium	Soulution Grade	
32% UAN	Sulfate Solution	N	S
- - - - wt % of final solution - - - -		- - - - % - - - -	
90	10	29.7	1.0
80	20	27.3	2.0
70	30	25.0	3.0
60	40	22.7	4.0
50	50	20.4	5.0
40	60	18.0	6.0
30	70	15.7	7.0
20	80	13.4	8.0
10	90	11.0	9.0

Source: TVA-NFDC

Thio-Sul®
12-0-0-26S

PLANT NUTRIENT CONTENT	WEIGHT %
Total Nitrogen (N) as Ammoniacal Nitrogen	12
Total Sulfur (S)	26
TYPICAL PROPERTIES	
Specific Gravity	1.33
pH	6.5 - 8.5
Appearance	Clear, Colorless to Yellow
Salt-Out Temperature	45°F
FORMULATION AND APPLICATION FACTORS, 68°F	
Density: pounds per gallon	11.1

Ammonium Thiosulfate
12-0-0-26S

$(NH_4)_2S_2O_3$

Source: Tessenderlo Kerley

KTS® 0-0-25-17S	
PLANT NUTRIENT CONTENT WEIGHT %	
Potassium (as K_2O)	25
Total Sulfur (S)	17
TYPICAL PROPERTIES	
Specific Gravity	1.46
pH	6.5 - 8.0
Appearance	Clear, Colorless
Salt-Out Temperature	< 5°F
FORMULATION AND APPLICATION FACTORS, 68°F	
Density: pounds per gallon	12.2

Potassium Thiosulfate
0-0-25-17S

$K_2S_2O_3$

Jar test when mixing with UAN solution since formation of potassium nitrate is possible (lower solubility)

Source: Tessenderlo Kerley

SOME EXAMPLES OF STARTER FERTILIZER BLENDS

BLEND	PRODUCTS	POUNDS PER TON
6-21-6-4S	10-34-0	1235
	KTS	480
	Water	285
7-25-6-4S	10-34-0	1470
	KTS	480
	Water	50
10-13-5-3S	UAN 32	388
	10-34-0	765
	KTS	400
	Water	447

Potassium Thiosulfate 0-0-25-17S

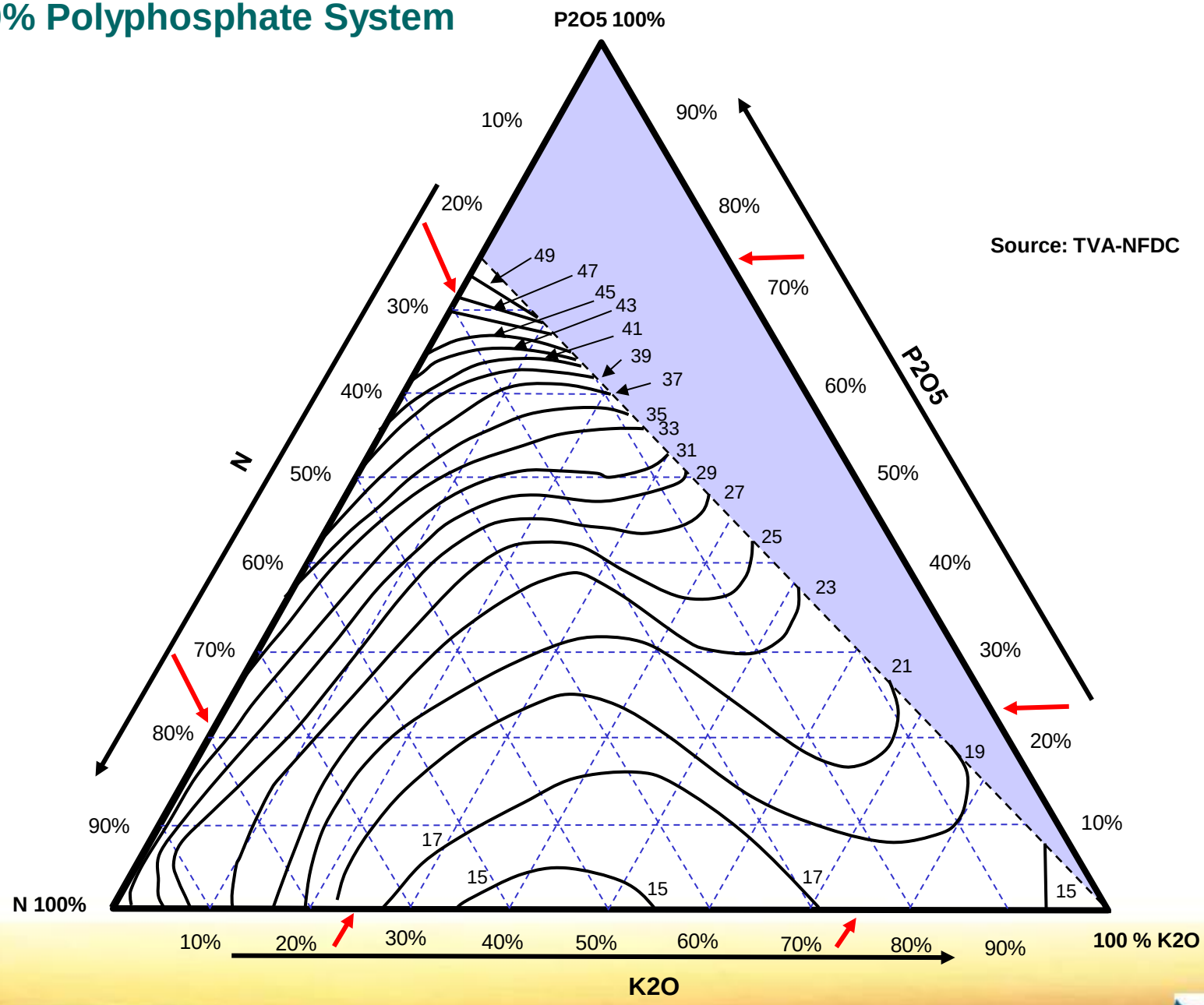
Always do a jar test before making large quantities. *When blending KTS and UAN 32 always have as much water in the blend as either one of these products.*

Source: Tessenderlo Kerley

Formulating Grades

APP, UAN and KCl Formulation

70% Polyphosphate System



Solution Grades For UAN Solution (28-32% N), Potassium Chloride (0-0-62) and Ammonium Polyphosphate (10-34-0, 11-37-0) System

$N:P_2O_5:K_2O$ Ratio	Solution Analysis (32° F Salt-out)
3–0–1	13.5–0–4.5
3–0–2	8.4–0–5.6
3–0–4	6.6–0–8.8
3–1–0	24.6–8.2–0
3–1–1	12.6–4.2–4.2
3–1–2	8.7–2.9–5.8
3–1–3	6.9–2.3–6.9
3–1–4	6–2–8
3–2–0	21.6–14.4–0
3–2–1	12–8–4
3–2–2	8.7–5.8–5.8
3–2–3	6.9–4.6–6.9
3–2–4	6.3–4.2–8.4
3–2–5	5.7–3.8–9.5
3–3–1	11.7–11.7–3.9
3–3–2	8.4–8.4–5.6
3–3–4	6.3–6.3–8.4
3–3–5	5.7–5.7–9.5
3–4–1	11.4–15.2–3.8
3–4–2	9–12–6

$N:P_2O_5:K_2O$ Ratio	Solution Analysis (32° F Salt-out)
6–1–0	27–4.5–0
6–1–1	18–3–3
6–1–2	12.6–2.1–4.2
6–1–3	10.2–1.7–5.1
6–1–4	8.4–1.4–5.6
6–1–5	7.8–1.3–6.5
6–1–6	7.2–1.2–7.2
6–2–1	16.2–5.4–2.7
6–2–3	10.2–3.4–5.1
6–2–5	7.8–2.6–6.5
6–3–1	16.2–8.1–2.7
6–3–2	12–6–4
6–3–4	8.4–4.2–5.6
6–3–5	7.8–3.9–6.5
6–4–1	15–10–2.5
6–4–3	10.2–6.8–5.1
6–4–5	7.8–5.2–6.5

Fluid Fertilizer Foundation

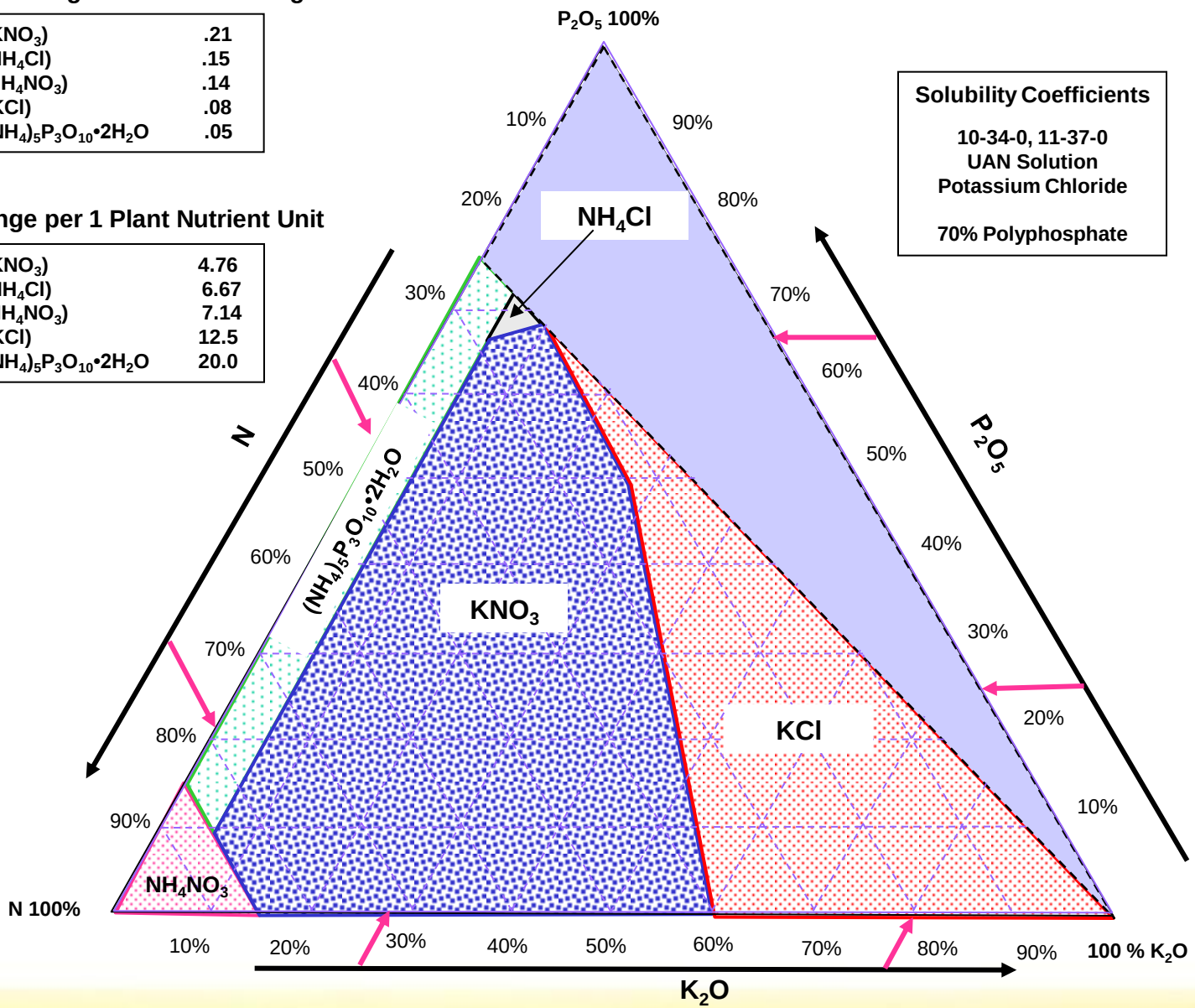
Estimating Salt-Out Temperatures

Plant Nutrient Units per 1 Degree Salt-Out Change

Potassium Nitrate	(KNO_3)	.21
Ammonium Chloride	(NH_4Cl)	.15
Ammonium Nitrate	(NH_4NO_3)	.14
Potassium Chloride	(KCl)	.08
Pent Amm. Tripoly.	$(NH_4)_5P_3O_{10}•2H_2O$	.05

1 Degree Salt-Out Change per 1 Plant Nutrient Unit

Potassium Nitrate	(KNO_3)	4.76
Ammonium Chloride	(NH_4Cl)	6.67
Ammonium Nitrate	(NH_4NO_3)	7.14
Potassium Chloride	(KCl)	12.5
Pent Amm. Tripoly.	$(NH_4)_5P_3O_{10}•2H_2O$	20.0



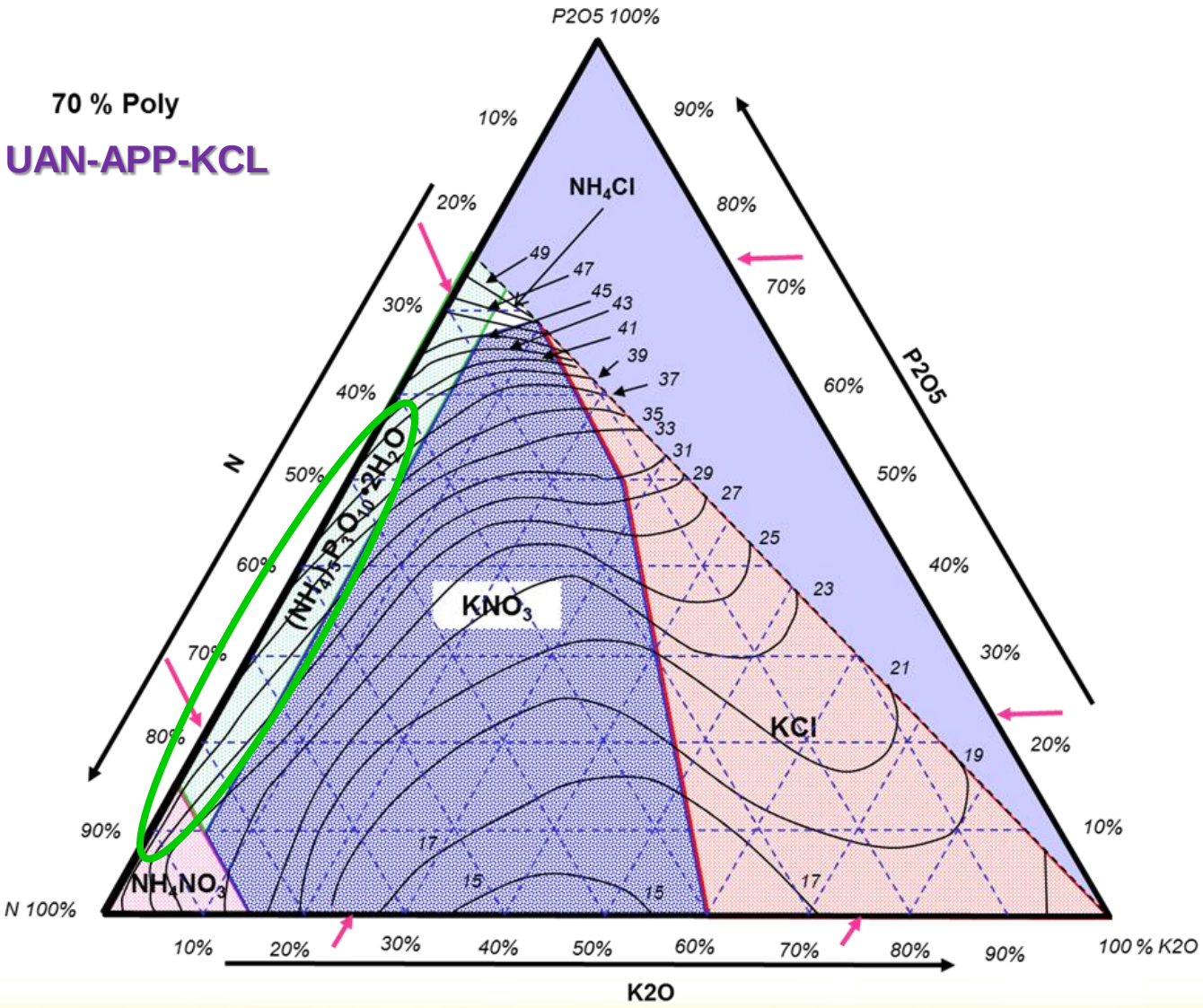
Solubility Coefficients

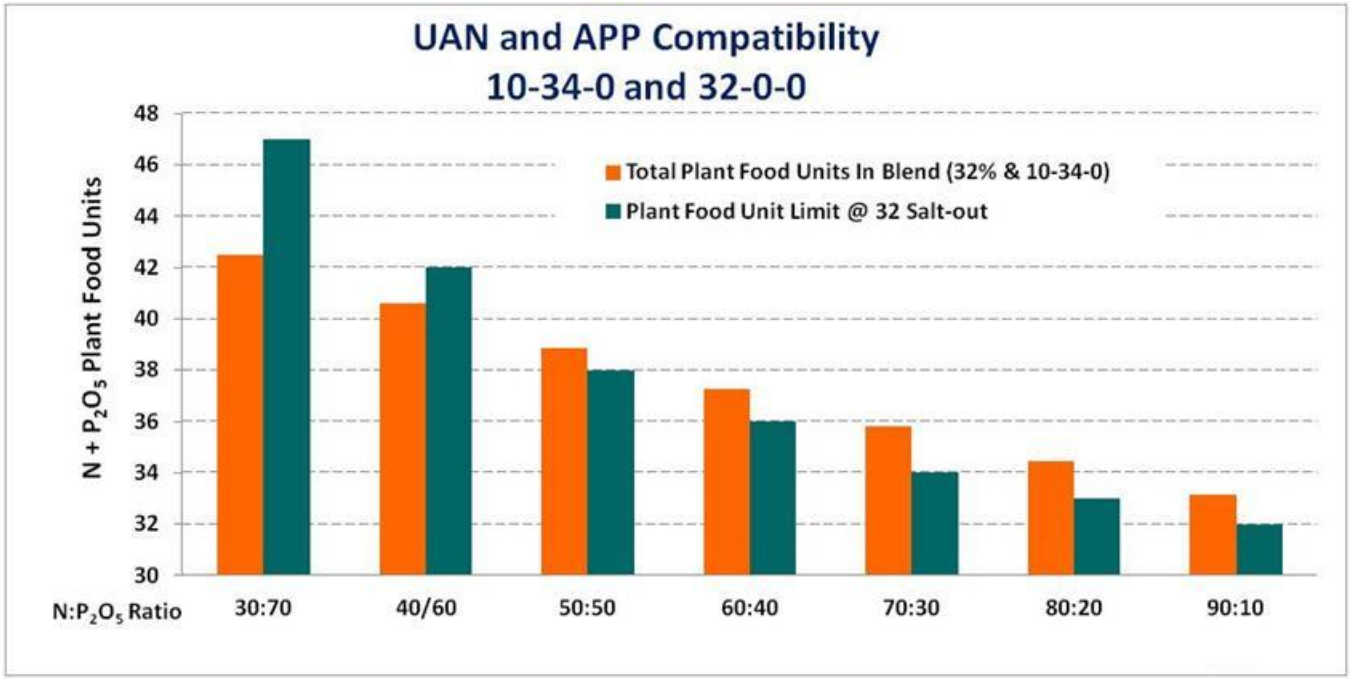
10-34-0, 11-37-0
UAN Solution
Potassium Chloride

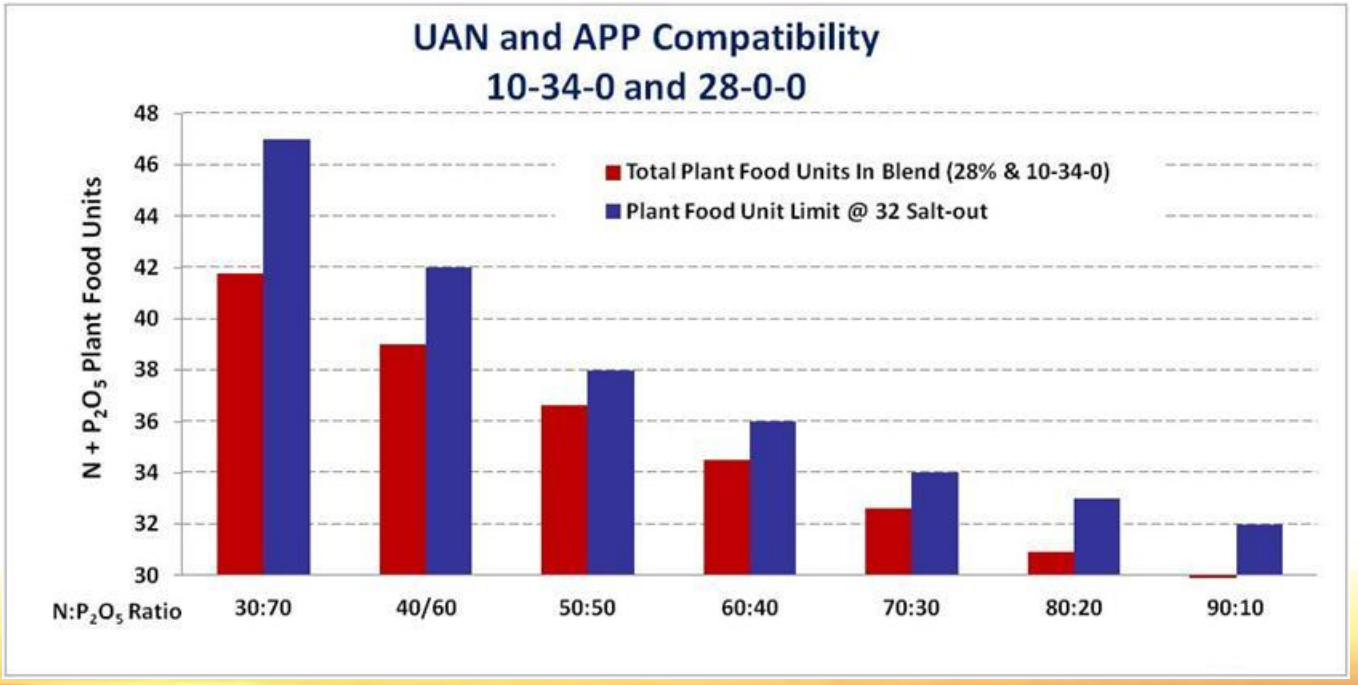
70% Polyphosphate

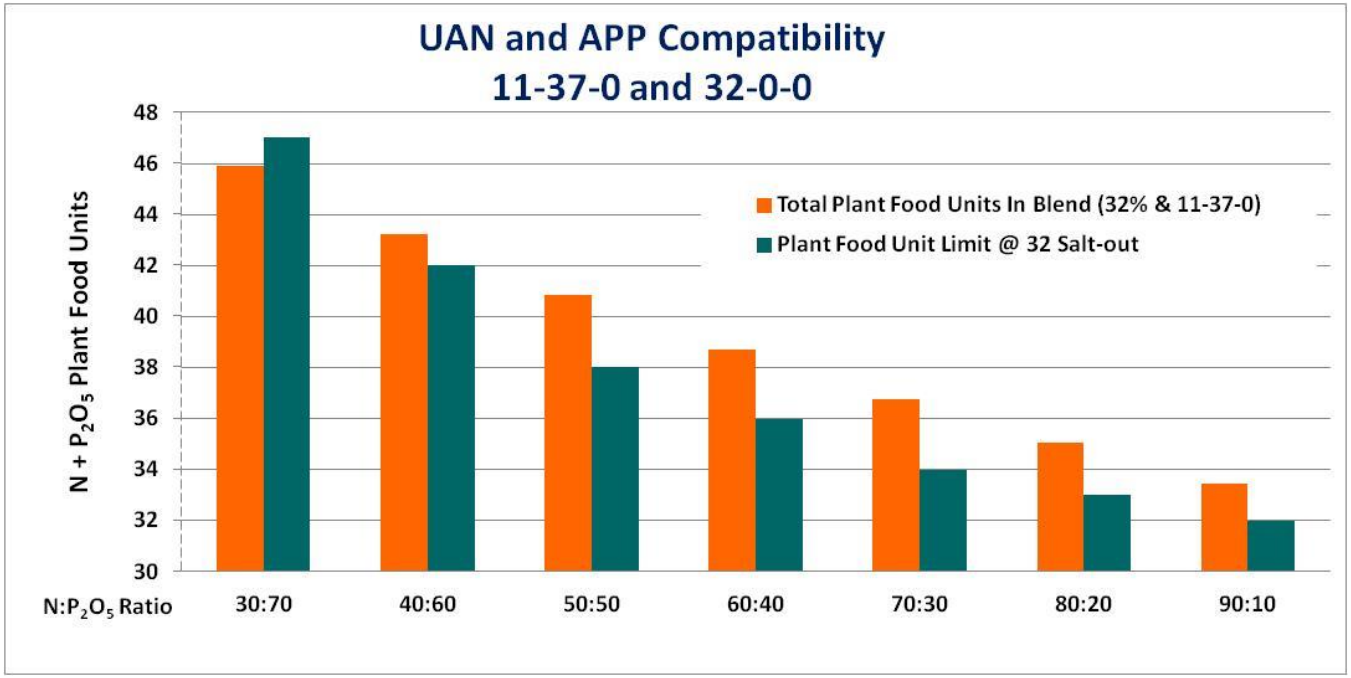
Source: TVA-NFDC

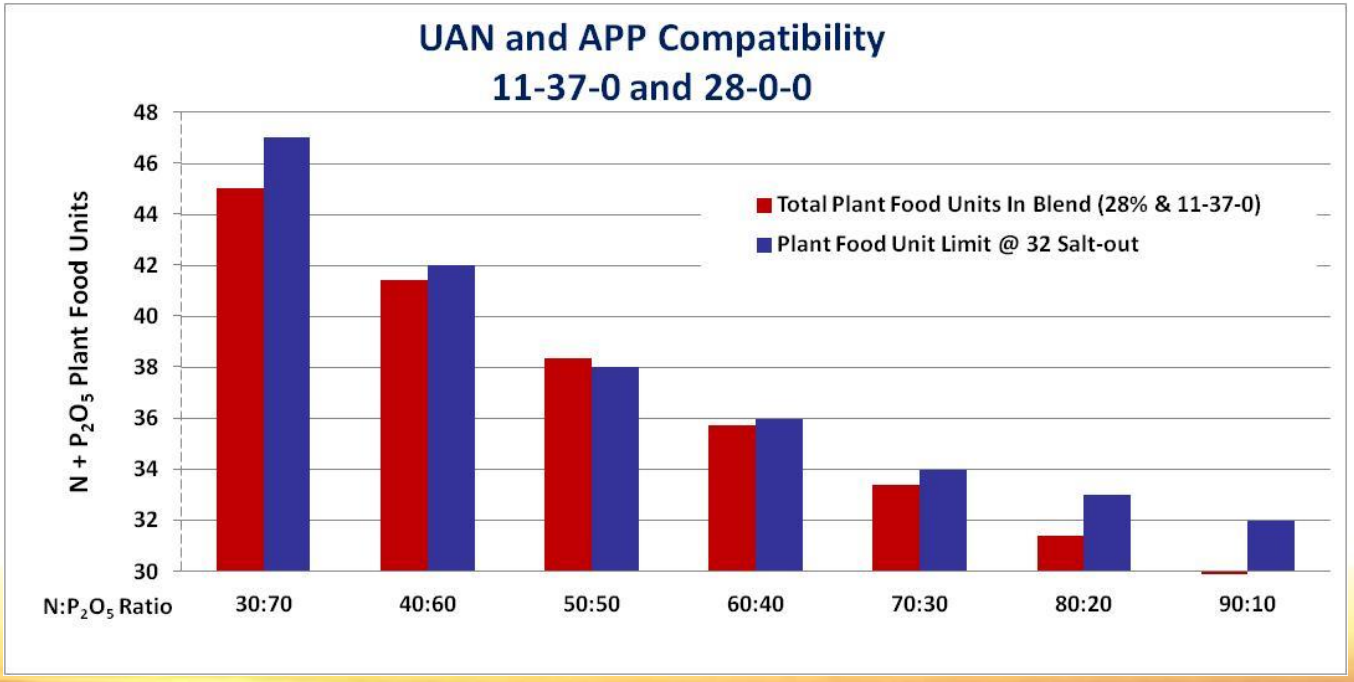
UAN, APP & KCl Compatibility







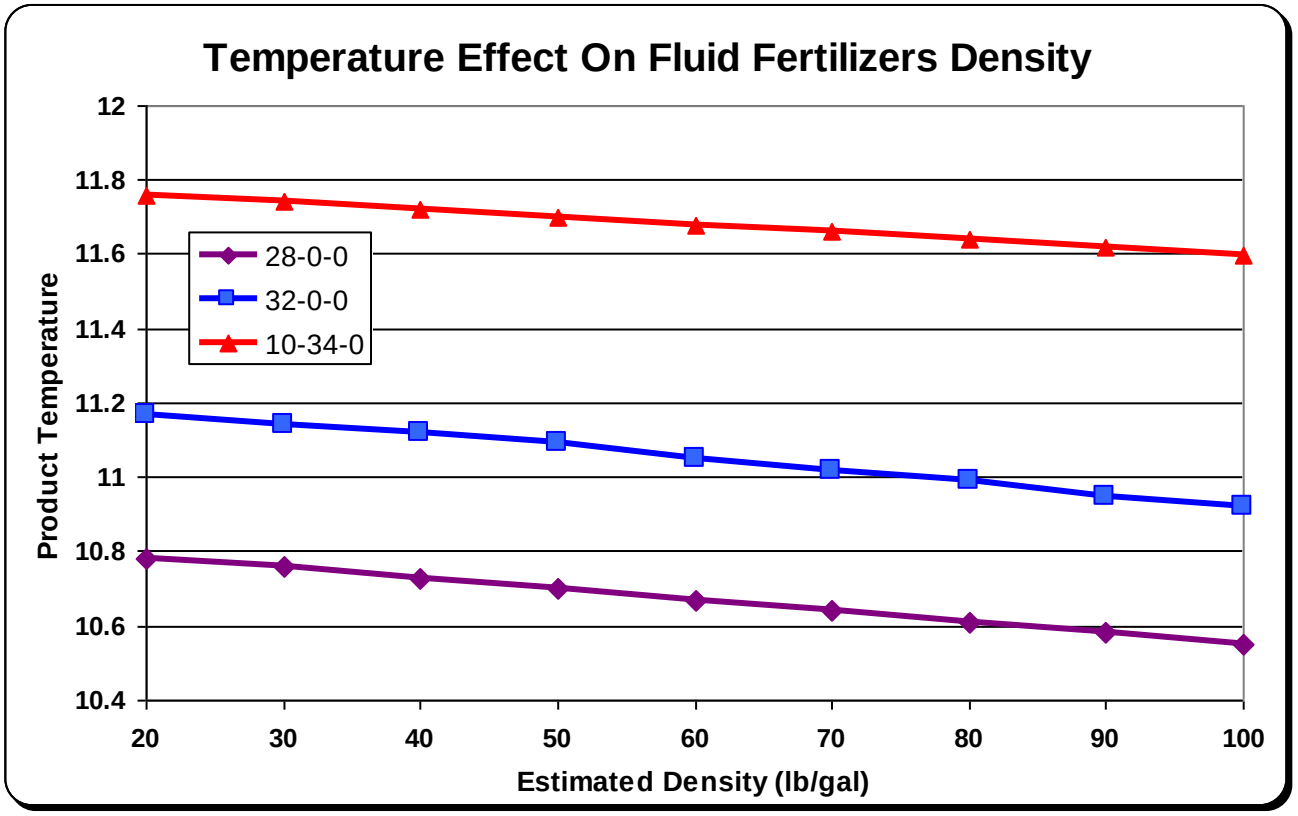




Fluid Fertilizer Foundation

Typical Characteristics Of Several Common Fluid Fertilizer Products

Source	Analysis	Density	Salt-Out	General Comments
	N-P_2O_5-K_2O	*Lbs/gal*	*º F*	
UAN	28-0-0	10.67	~ 0	~ 30% water
UAN	32-0-0	11.06	~ 32	~ 20% water
ATS	12-0-0-26S	11.04	<20?	Common Fluid S Source
KTS	0-0-25-17S	12.18	< 5	Becoming More Common
APP	10-34-0	11.65	<10	11-37-0 grade also



Estimated Density Of Fluid Products

Product Temperature	28-0-0	32-0-0	10-34-0
	- - - lb / gal - - -		
20	10.78	11.17	11.76
30	10.76	11.14	11.74
40	10.73	11.12	11.72
50	10.7	11.09	11.7
60	10.67	11.05	11.68
70	10.64	11.02	11.66
80	10.61	10.99	11.64
90	10.58	10.95	11.62
100	10.55	10.92	11.6

Salt-out – Crystals form as solution cools; goes back in solution as product is warmed. Example; UAN Solution.

Precipitate formation – Non-crystalline mass forms which has much lower solubility than original ingredients in solution. Example; Improperly stored fluid phosphates

Heat generator – Generates chemical heat when producing solutions. Examples; ammonia + phosphoric acid; dilution of sulfuric acid)

Fume generator – Generates fumes which can be safety hazard. Example; UAN solution + Potassium carbonate → ammonia fumes.

$$2NH_4NO_3 + K_2CO_3 \rightarrow 2KNO_3 + (NH_4)_2CO_3$$

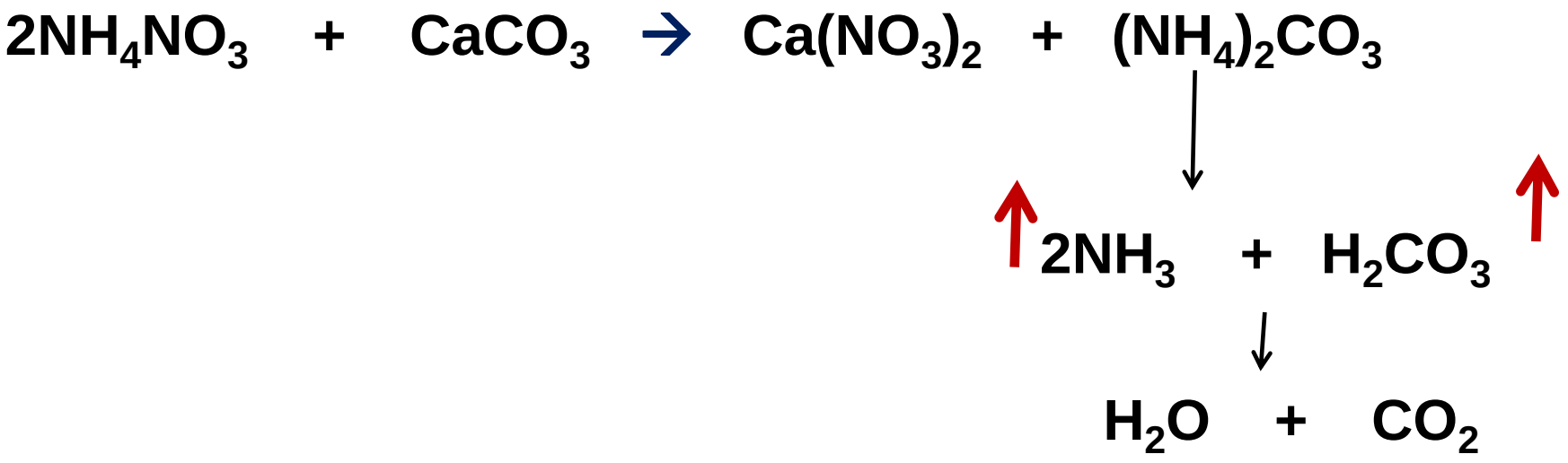
$$(NH_4)_2CO_3 \rightarrow 2NH_3\uparrow + H_2CO_3$$

$$H_2CO_3 \rightarrow H_2O + CO_2\uparrow$$

UAN in Irrigation Water ?

UAN in Irrigation Water ?

Urea N Volatilization ?



Fluid Fertilizer Foundation

Solutions for AGRICULTURE

FluidFertilizer.com

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.

- 'Compatible', results in generally acceptable mixture.
- 'Limited Compatibility', generally compatible within solubility limits.
- Very Limited Compatibility', generally unsuitable mixtures.
- 'Incompatible', unsuitable mixture and/or hazardous combination.
- △ Significant heat generated.

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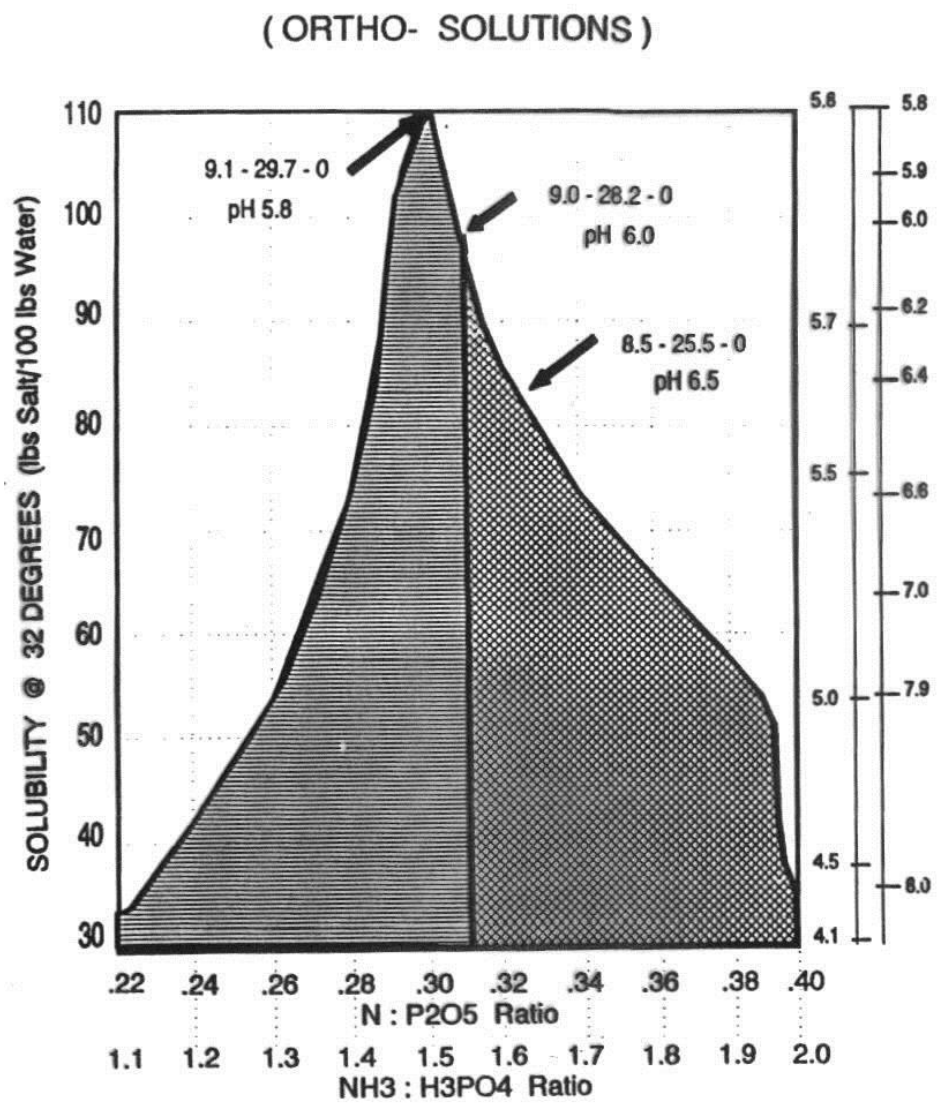
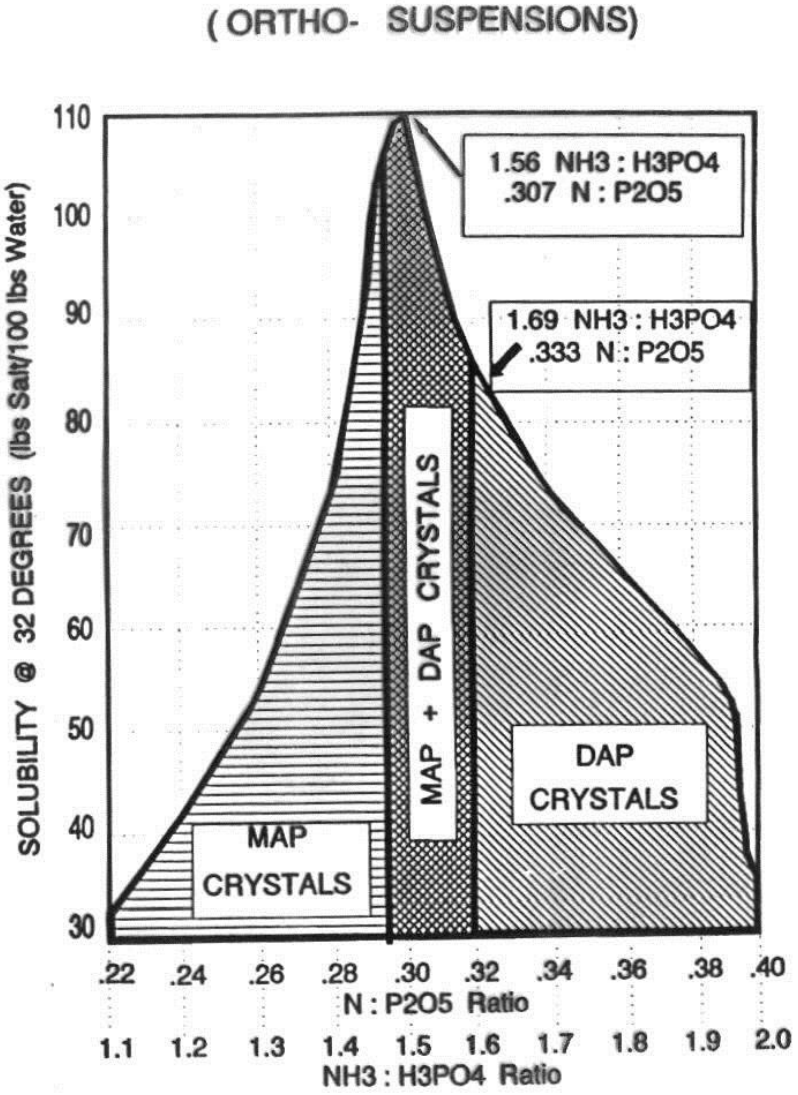
3/1/09

	Anhydrous Ammonia	Aqua Ammonia	Urea Solution	Ammonium Nitrate Solution	UAN Solution	Ammonium Sulfate Solution	Ammonium Polyphosphate Solution	Ammonium Chloride Solution	Ammonium Thiosulfate	Potassium Thiosulfate	Calcium Thiosulfate	Magnesium Thiosulfate	Calcium-Ammonium Nitrate Solution	Calcium Nitrate Solution	Potassium Carbonate Solution	N-pHuric 28/27	N-pHuric 15/49	N-pHuric 10/55	Water	Nitric Acid	Phosphoric Acid (white)	Phosphoric Acid (gr	Sulfuric Acid	Urea	Ammonium Nitrate	Calcium Nitrate	Potassium Chloride	Potassium Nitrate	Magnesium Nitrate	Technical Grade MAP	Monopotassium Phosphate	PeKacid
Anhydrous Ammonia ; 82-0-0		△																														
Aqua Ammonia; 20-0-0	△																															
Urea Solution; 23-0-0	△																															
Ammonium Nitrate Solution; 20-0-0	△																															
Urea Ammonium Nitrate Solution; UAN 28/32-0-0	△																															
Ammonium Sulfate Solution; 8-0-0-9S	△	△																														
Ammonium Polyphosphate Solution; 10-34-0	△	△																														
Ammonium Chloride Solution; 6-0-0-16Cl	△																															
Ammonium Thiosulfate Solution; ATS, 12-0-0-26S	△																															
Potassium Thiosulfate Solution; KTS, 0-0-25-17S																																
Calcium Thiosulfate; CaTS, 6%Ca 10% S								?																								
Magnesium Thiosulfate; MgTS, 10% S 4%Mg								?																								
Calcium-Ammonium Nitrate Solution; 17-0-0 8.8Ca																																
Calcium Nitrate Solution; 8-0-0-11Ca								?																								
Potassium Carbonate Solution; 0-0-32								?																								
N-pHuric 28/27; 28-0-0-9S		△																														
N-pHuric 15/49; 15-0-0-16S		△																														
N-pHuric 10/55; 10-0-0-18S		△																														
Water	△																															
Nitric Acid	△	△	△	△		△	△												△					△	△	△	△						
Phosphoric Acid (white)	△	△	△			△	△							△					△													
Phosphoric Acid (green)	△	△	△			△	△							△					△													
Sulfuric Acid	△	△	△			△	△												△													
Urea; 46-0-0																				△	△	△	△									
Ammonium Nitrate; 34-0-0																								Dry								
Calcium Nitrate; 15.5-0-0-19Ca																								Dry	Dry							
Potassium Chloride; 0-0-62																								Dry	Dry	Dry						
Potassium Nitrate; 13-0-46								?																Dry	Dry	Dry	Dry					
Magnesium Nitrate; 10-0-0-9Mg								?																Dry	Dry	Dry	Dry	Dry				
Monoammonium Phosphate (Technical, 12-61-0)								?							?									Dry	Dry	Dry	Dry	Dry	Dry			
Monopotassium Phosphate (0-52-34)								?							?									Dry	Dry	Dry	Dry	Dry	Dry	Dry		
PeKacid (0-60-20)								?												△	△			Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	

Fluid Fertilizer Foundation

SOLUBILITY OF AMMONIUM PHOSPHATES





Fluid Basics:

Thank You!

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