

ENHANCING THE EFFICIENCY OF UREA AND AMMONIUM NITRATE BY THE ADDITION OF OTHER NUTRIENTS

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1.A) Plant Nutrients

- ☞ Crops need a number of mineral elements for healthy growth.
- ☞ The generally accepted number of essential nutrients required is 20, which includes carbon, hydrogen and oxygen as well as 17 other mineral elements which are nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, boron, chlorine, copper, iron, manganese, molybdenum, zinc, silicon, sodium, cobalt, and vanadium.
- ☞ Carbon, hydrogen, and oxygen are taken from the air and the water. The other elements are divided into three groups ;
Primary Nutrients (Nitrogen, Phosphorous, and Potassium),
Secondary Nutrients (Magnesium, Calcium, and Sulphur),
and **Micro-Nutrients** (The rest). All these groups are highly important for the plant growth and are equally essential, regardless of the amounts required.

1.B) Abu Qir Production with Other Nutrients

» Abu Qir Fertilizer Company planned to produce urea and ammonium nitrate with various secondary and micronutrients aiming at:

1. Improving the chemical properties of urea and ammonium nitrate to give all the types of crops the required nutrients needed to good growth and high productivities and to avoid symptoms of nutrients deficiency.
2. Improving the physical (mechanical) properties and decreasing solubility in soil, which means avoiding losses of fertilizers and escape deeply in soil away from the plant roots.
3. Achieving fertilizers balancing in the soils by providing it with different types of nutrients.

2- Urea

Urea is the main direct fertilizer source of nitrogen, where nitrogen composes 46.5% of its contents.

2.A) Nitrogen

- » The nitrogen is taken up by plants primarily as nitrate (NO_3^-) or as ammonium ions (NH_4^+). Plants can utilize both of these forms of nitrogen in their growth process.
- » Most of the nitrogen is taken up by the plants in the nitrate form due to the following two reasons :
 - Nitrogen from nitrate is mobile in the soil and moves with soil water to plant roots.
 - All forms of nitrogen fertilizer added to soils are changed to nitrate under proper conditions of temperature, aeration and moisture by the soil organism.

Importance of Nitrogen

- A) Nitrogen is utilized by plants to synthesize amino acids , which in turn form proteins .
- B) Nitrogen is also required by plants for other vital compounds such as chlorophyll, nucleic acids, and enzymes.

2.B) Urea Plus Other Nutrients

2.B.1) Secondary Nutrients Added to Urea

1.a) Magnesium and Its Importance for the Plants

- ↳ Magnesium is one of three secondary nutrients which are calcium , magnesium, and sulphur.
- ↳ Magnesium is up taken by the plant in the form of the magnesium ions (Mg^{++}).
- ↳ Magnesium is essential for the photosynthesis process because the chlorophyll molecule contains magnesium.
- ↳ Magnesium serves as an activator for many plant enzymes required in the growth process.
- ↳ Magnesium ions are mobile within plant tissues and can be translocated from older to younger tissues under condition of deficiency.
- ↳ The most common use of magnesium fertilizer has been for celery and citrus.

1.b) Sulphur

1.b.1) Forms of Sulphur Absorbed by Plants

- ⇒ The sulphate is up taken by plants in the form of sulphate ion (SO_4^-).
- ⇒ The sulphur can be also absorbed from air through leaves in the area where the atmosphere is rich of sulphur compound.

1.b.2) Importance of the Sulphur for the Plants

- ⇒ Sulphur is a constituent of three amino-acids (cystine, methionine, and cysteine) therefore it is essential for protein synthesis.
- ⇒ It is essential for nodule formation on legume roots.
- ⇒ It is responsible for the characteristics odors of some plants such as garlic and onions

2.B.2) Micro – Nutrients Added to Urea

2.a) Zinc

2.a.1) Forms of Zinc Absorbed by Plants

- »» The more important source of zinc which can be added to urea is the zinc sulphate.
- »» Zinc is up taken by plants as zinc ion , where zinc sulphate is ionized in soils to zinc ion Zn^{++} plus sulphate ion SO_4^- .

2.a.2) Importance of the Zinc for the Plants

- »» Zinc is essential constituent of several important enzyme system in plants.
- »» It controls the synthesis of indoleacetic acid.
- »» Plant growth regulator.
- »» Many crops require zinc fertilization such as tree fruits, nuts, grapes, beans, onions, tomatoes, cotton , rice, and corn.

3- Production of Urea Ammonium Sulphate

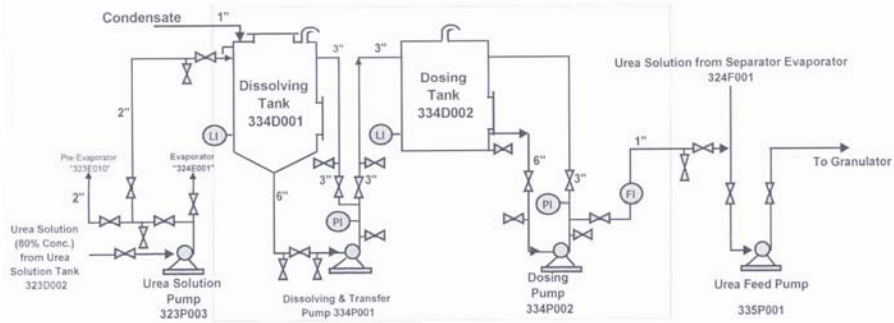
- ☞ Ammonium sulphate is present in white crystals form, dissolved in hot condensate at about 100°C.
- ☞ Urea ammonium sulphate is produced by the addition of ammonium sulphate to urea with required ratio according to the market request.
- ☞ It can be produced by addition of ammonium sulphate up to 28% which means sulphur content of about 7%.
- ☞ Due to market request AFC produced urea with ammonium sulphate between 0.8 - 1 %.

Ammonium Sulphate Preparation and Addition

↪ See Flow Sheet Number (1)

AMMONIUM SULPHATE ADDITIVES UNIT

Unit 334



Tank Specifications for both Dissolving & Dosing Tanks
Diameter: 1.90m
Height: 3m
Volume: 8.5m³
Material: Stainless Steel 304

Note

The Tanks & the Pipe Connections must be Steam-Traced & Insulated

Process Flow Diagram Number (1)

Problems During Manufacturing

Improving the Quality of the Produced Urea Sulphate

⇒ In addition to the achieved objectives from the addition of sulphur as a secondary nutrient to urea, we are also aiming to improve the physical properties of the urea – sulphate.

⇒ All problems were resolved as explained and finally the results were:

- ⇒ *Completely trouble free operation*
- ⇒ *Dust free production, which appears also from density measurement of scrubbing solution in both granulator and cooler scrubber.*
- ⇒ *Better improvements in hardness.*
- ⇒ *Moisture content (free) decrease to limit between 0.23 – 0.24 instead of limit between 2.6 – 2.8.*
- ⇒ *Sphericity of granules improved.*

Inspection Results of Evaporation Section

»» During the annual shutdown of Abu Qir plant (3) in September 2004, it was decided to inspect the tubes of the final evaporator to investigate any troubles from using ammonium sulphate with urea solution concentrated in the heater.

»» The inspection was done by the urea solution plant Licensor StamiCarbon, where the results were excellent as there was no effect of the sulphate on the tubes, the tubes thickness was the same as the new heater.

Urea Magnesium Sulphate

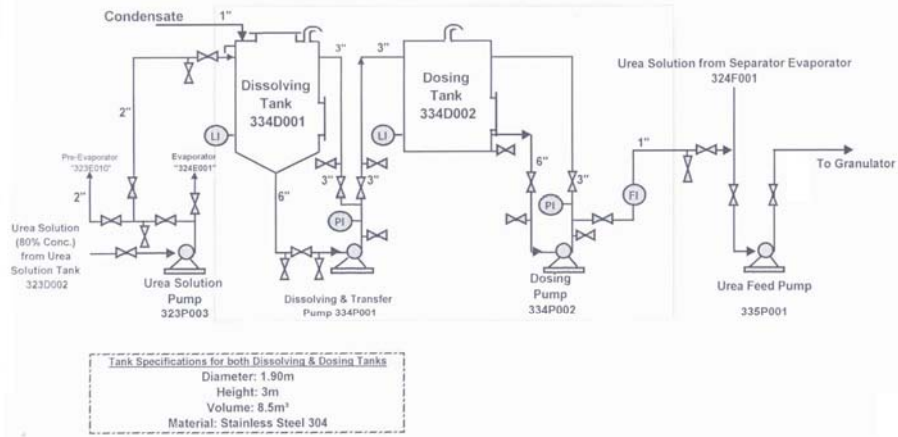
- ↳ Magnesium sulphate is white hydrous crystals containing seven molecules of water $\text{Mg} \cdot \text{SO}_4 \cdot 7\text{H}_2\text{O}$ and its molecular weight is 246.4.
- ↳ Magnesium sulphate is completely soluble in water at moderate temperature that can facilitate its use and addition to urea solution
- ↳ Magnesium sulphate itself is used as fertilizer so when it mixed with urea its added value to the plants will be very high .
- ↳ The magnesium sulphate salts is commercially known as Epsom (Epsomit).

Preparation and Addition of Magnesium Sulphate

↳ See Flow Sheet Number (2)

MAGNESIUM SULPHATE ADDITIVES UNIT

Unit 334



Note
The Tanks & the Pipe Connections must be Steam-Traced & Insulated

Process Flow Diagram Number (2)

Problems During Manufacturing

Final Improvements In the Product Quality

- In addition of increasing the fertilizer efficiency by addition of two important secondary nutrients the following improvements in physical properties are gained :
 - a) Increasing the hardness of the final product to be 5.4 kg instead of 4 kg, due to binding bond and water bridges formed between molecules of urea and magnesium sulphate.
 - b) Increasing the granules size and control its increase at required value due to attraction and binding forces between different molecules in the mixtures.
 - c) Dust disappeared completely from all the system and that was appeared on the density of scrubbing solution in both granulator and cooler scrubber.
 - d) The dust free product means no caking tendency.
 - e) Decreasing the urea formaldehyde used by about 50% which means decreasing the production cost .
 - f) Decreasing the solubility of urea – magnesium sulphate which decreases the nitrogen losses in the soil and increases its stability and its benefits for the plants over long period.
 - g) With avoiding losses of nitrogen in the soil, it also helps in decreasing the injection rate of the fertilizer needed for plants which means saving money for farmers.
 - h) The appearance of the product was excellent.
 - i) Finally all these properties mean that the urea treated with magnesium sulphate is a slow release urea fertilizer.

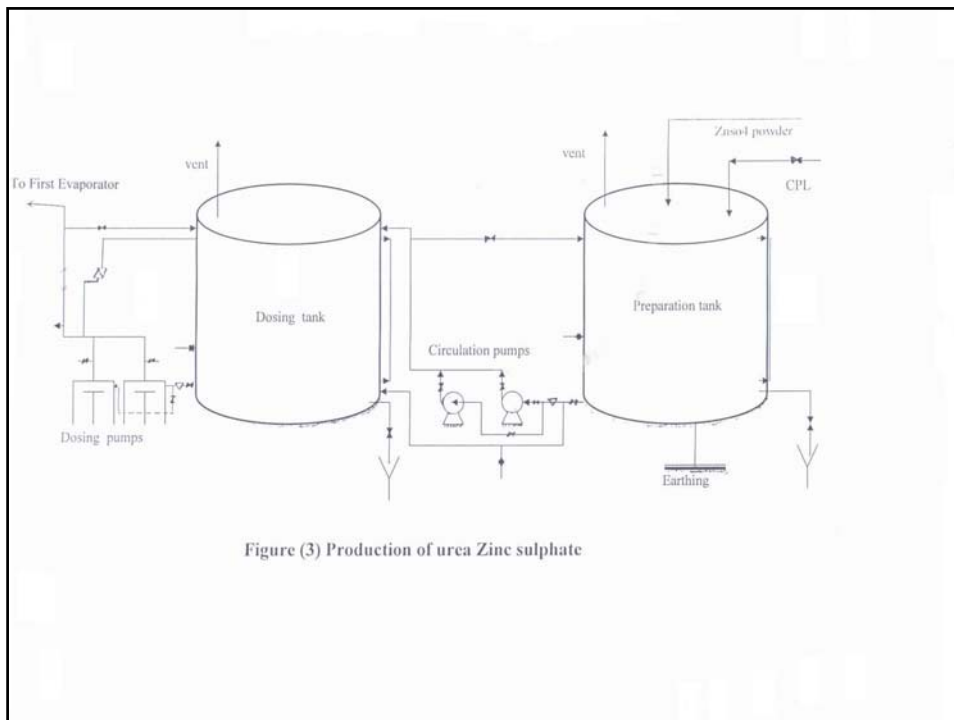
Urea Zinc Sulphate

⇒ Zinc Sulphate is hydrated white crystals containing 6 water molecules and its molecular weight is 269.54 ($\text{Zn} \cdot \text{SO}_4 \cdot 6\text{H}_2\text{O}$).

⇒ Zinc Sulphate is completely soluble in water at room temperature, thus it is suitable to use with urea prills to avoid blockage of prilling device holes (buscket).

Preparation and Addition of Zinc Sulphate

↪ See Flow Sheet Number (3)



Production of Super Quality (Multi – Nutrients Ammonium Nitrate)

- 💡 In addition to magnesium and calcium presented in high quality ammonium nitrate, iron, manganese, zinc in addition to sulphur were added to ammonium nitrate of Abu Qir to produce super quality AN enhanced by multi-nutrients.
- 💡 The importance of magnesium, sulphur, and zinc for plants are previously mentioned.

Iron

Iron is added as Iron Sulphate

Importance of Iron to Plant:

- Iron is absorbed by plants as Ferrous Ions (Fe^{++}).
- Formation of chlorophyll in plant cells.
- It serves as an activator for biochemical process such as respiration, photosynthesis and symbiotic nitrogen fixation.

Symptoms of Iron Deficiency:

- Intervinal chlorosis of young leaves.
- Twig dieback.
- In severe cases, death of the entire limbs or plants.

Reasons of Iron Deficiency:

- High levels of manganese.
- High lime content in the soil.
- High pH or aeration.

Manganese

Manganese is added as Manganese Sulphate

Importance of Manganese to Plant:

- Manganese is up taken by plants as Manganese Ions (Mn^{++}).
- Manganese is required for the plant as an activator for enzymes in growth processes.
- It assists iron in the chlorophyll formation.

Use of Manganese:

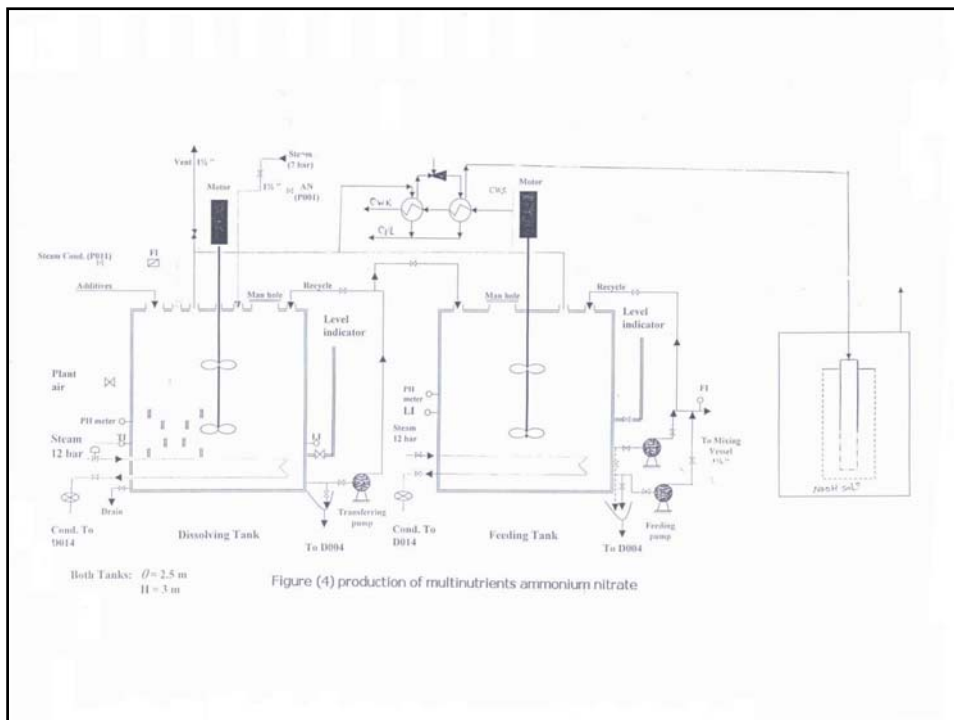
- It is used with zinc in the foliar spraying of the commercial citrus.

Symptoms of Manganese Deficiency:

- Intervinal chlorosis of young leaves.
- Gradation of pale-green coloration with darker

Preparation and Process Description

↪ See Flow Sheet Number (4)



Problems Faced and Its Resolving

Final Results

- Very excellent and multi-nutrient ammonium nitrate including 6 nutrients and micro nutrients in addition to nitrogen are in commercial production now without any problems.
- All parameters are under control and watching .
- Following up the product in the bulk store indicated no changes even good appearance was gained.
- No increase in temperature during storage.
- Dust free operation and product are obtained, that also very clear from the decrease in density of scrubbing solution for both granulator and cooler scrubbers.
- Dust free product means no caking tendency and that was very clear from storage

Conclusion

- Abu Qir Fertilizers Company succeeded to have a variety of products that sustained its original products which are urea prills, urea granules, and ammonium nitrate granules by addition of secondary and micronutrients which are very important for all plants and crops .
- All problems appeared during the test were solved chemically and physically, where now all new product are in fully commercial scale without any problems.
- Abu Qir by this way opened new fields and helped the community for improving and increasing the productivity of the crops and sustained the soils by various nutrients and micronutrients to achieve nutrient balance
- All products are registered and have its name in local market.