Ammonium Phosphate Crystals

Background:
During chemical processing phosphate and phosphate pebble are reacted with sulfuric acid to create the phosphoric acid needed to make fertilizer. The principal fertilizer product of the industry is diammonium phosphate (DAP), made by reacting ammonia with the phosphoric acid. DAP is not the only product of phosphoric acid reactions. Another product is ammonium dihydrogen phosphate also known as monoammonium phosphate, ADP or MAP. MAP is formed with phosphoric acid is added to ammonia until the solution is clearly acidic. The solution crystallizes and has many uses.
Often MAP is used in the blending of dry agriculture fertilizers provided soil with nutrients useable by plants. MAP can also be found in fire extinguishers. In crystal form ADP is widely used in the field of optics . Another popular use of MAP is in crystal growing kits used for many levels from home kits for children to laboratory use.

Grades:
9-12 (Physical Science and Chemistry)

Standards:
SC.912.P.8.8 SC.912.P.10.7

Objectives:
The student should be able to…
-Characterize types of chemical reactions
-Identify the components of a solution (solute, solvent, solution). Identify factors that affect the rate of solubility.
-Describe the impact of acids and bases as they relate to environmental concerns and industry.
-Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

Vocabulary:
Phosphate
Ammonia
Product
Reactant
Reaction
Solution
Acid
Base

Materials:

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6 tablespoons monoammonium phosphate ($NH_4H_2PO_4$)
½ cup hot water (or 100 mL)
Clear container, plastic or glass

Procedure:
Note: Be careful when handling hot liquids. Wear gloves when handling ADP. If you get any on your skin wash immediately.

1. Pour approximately ½ cup or 100 mL of hot water (at least 80 degrees Celsius) into a clear container.
2. Stir six tablespoons of monoammonim phosphate (ADP) intothe cup of hot water.
3. Stir until completely dissolved.
4. Add 5 drops of food coloring if desired.
5. Stir again until the powder is completely dissolved and the food coloring is thoroughly mixed.
6. Set the container in a location where it will not be disturbed. Try to let the solution cool slowly.
7. By the next day you should have a bed of long, thin crystals at the bottom of your container.
8. Remove the crystals from the solution. Save the solution if you continue to step 9.
9. To get one large crystal, take a small single crystal and place in the old solution. Leave over night and this "seed" crystal will grow into a large crystal in a few days.

Data/Observations: Draw your crystals

Analysis/Conclusion:

1. Characterize the type of chemical reaction in this activity.
2. Why is it important for the ADP to completely dissolve?
3. How do solutes and solvents interact to form solutions?
4. Identify the solute and solvent in this activity.

5. How do concentration, temperature, and the addition of a catalyst impact chemical equation?
6. How would you differentiate between a physical and a chemical change in a chemical reaction?

Extension:

1. The FIPR Institute's Colorimetric Lab demonstration can be done before or after this activity.
2. Student can research the different uses of the products of chemical processing beyond fertilizer use.
3. Students can work in teams on creating a working crystal growing kit that they have to market and advertise.
4. Students can research careers related to chemical processing, fertilizer production and use, crystals, and careers that are affected by these products.

Adapted from Mike Bogan and Pete Puchstein's Colorimetric Lab Demonstration and Anne Marie Helmenstine, Ph. D's How to Grow Ammonium Phosphate Crystals