SASTA OLIPHANT SCIENCE AWARDS

South Australian Science Teachers Association

Prize Winner

Crystal Investigation

Year 11-12

Alexandra Morrison
Maddison Fenton
Emily Zou

Seymour College

ROWE SCIENTIFIC PTY. LTD. www.rowe.com.au

Australian Government Department of Defence

Government of South Australia Department for Education

SASTA South Australian Science Teachers Association

Potassium aluminium sulphate crystal investigation

Emily Zou, Maddie Fenton, and Alexandra Morrison (Seymour College Yr. 11)

Investigation question

How does the concentration of potassium aluminium sulphate (potash alum) impact the clarity and formation of crystals and what is the optimum concentration for growing crystals?

Hypothesis

As the concentration of potassium aluminium sulphate solution increases from 20-40 grams, the rate of growth of the crystal increases rapidly, and consequently the quality of the crystal will decrease.

Apparatus

- 12 × 200 ml measuring beakers
- 1 × 250 measuring cylinder
- 1 L of boiling water
- 6 × funnels
- 6 × filtering paper
- 6 × retort stands
- 150 g of potash alum
- Stirring rod
- Thread
- Scissors
- Tweezers
- 1 × popsicle stick
- Parafilm
- 1 × scale
- 4 × petri dishes
- 1 × cupcake liner
- 1 × metal spoon
- Labels

Procedure

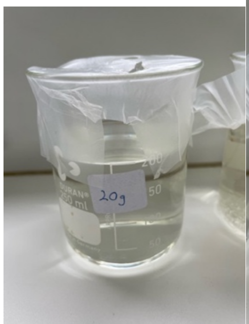
Part a: Growing seed crystals

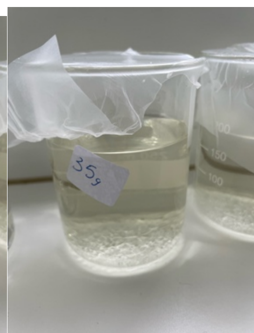
1. Place a paper cupcake liner on the scale, which is then zeroed.
2. Using a spoon, carefully weigh 20 grams of potassium aluminium sulphate into the cupcake liner
3. Place the measured potassium aluminium sulphate into a 200 ml measuring beaker.
4. Using the 250 ml measuring cylinder, measure 200 ml of boiling water and pour into the beaker with the potassium aluminium sulphate
5. Write a label reading ‘20g’ and stick it on the 200 ml beaker.
6. Stir the solution with a stirring rod until all potassium aluminium sulphate is dissolved.

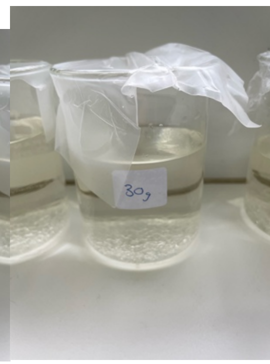
7. Place a funnel on a retort stand, then place an empty 200 ml measuring beaker underneath
8. Fold and place a sheet of filtering paper into the funnel
9. Carefully and slowly pour the solution through the funnel, allowing the solution to filter.
10. Repeat steps 1-9 using 25 grams of potassium aluminium sulphate
11. Repeat steps 1-9 using 30 grams of potassium aluminium sulphate
12. Repeat steps 1-9 using 35 grams of potassium aluminium sulphate
13. Repeat steps 1-9 using 40 grams of potassium aluminium sulphate

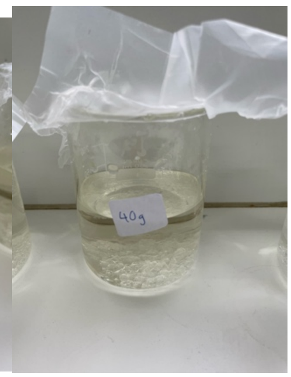
Observations:

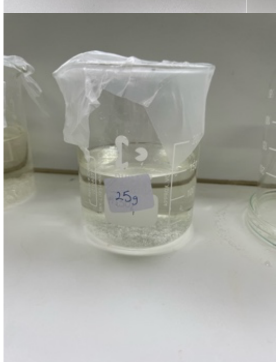
- **05/05/2023:**











After 3 days, it can be seen that all the solutions with more than 30g of potassium aluminium sulphate have formed large quantities of solids whereas the two remaining trials, each being 20g and 25g, have formed little quantities of solids. It can be seen that as the concentration of potassium aluminium sulphate increases, the growth and formation of crystals would be much more rapid, and therefore, leads to the formation of larger quantities of crystals. Examining all the solids formed for each concentration, it was evident that all crystals formed in the solutions with more than 30g of potassium aluminium sulphate were compacted and exhibited many fractures and cracks within. As a result, these solids cannot be used as seed crystals as this would lead to the final crystals being distorted, limited in size and of low optical clarity. Therefore, in order to determine the optimum concentration for the formation of the best seed crystals, part A

of the experiment is repeated using 20g, 21g, 22g, 23g, 24g and 25g of potassium aluminium sulphate.
After a further 3 days, it was concluded that the trial involving 23g of potassium aluminium sulphate was the optimum concentration for the formation of seed crystals as crystal formation in the solutions with 20g, 21g and 22g were minimal and in solutions with 24g and 25g were slightly too rapid. Figure 1 displays the nature of crystal solids formed from the solution with 25g of potassium aluminium sulphate. And it can be seen that the rapid growth of crystal has led to the crystals being overcrowded and none can be isolated.

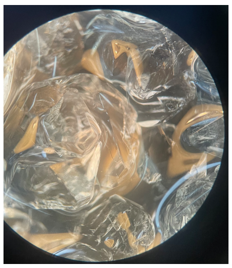
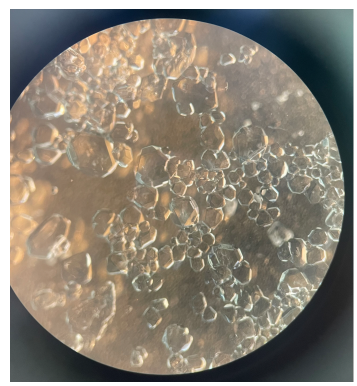


Figure 1

Part B: Picking seed crystals

1. After 3 days, carefully drain the remaining liquid within each measuring beaker, leaving the solids formed at the bottom of the measuring beaker
2. Use a light microscope to choose and pick seed crystals that are of the best shape and quality, with no other smaller crystals attached on the side, and as little fracture or streak marks within the crystals (Figure 2).
3. Place the chosen seed crystals into a petri dish and fill the petri dish with solution containing 23g of potassium aluminium sulphate so that the seed crystals are submerged.

Figure 2



Observations

Figure 3

Figure 4

Figure 5

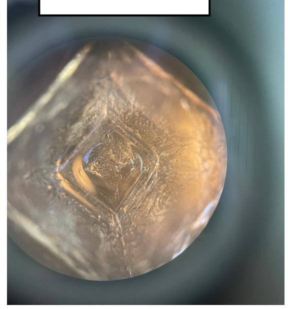
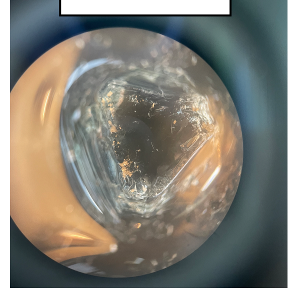


Figure 6



Similar observations to part A were recorded, and that was with increased quantity of potassium aluminium sulphate, the more solids will form and as a result, the lower the quality of the crystals will be. This is once again due to increased concentration leading to increased rate of crystallization. Above, figure 3 and figure 4 were two seed crystals that were able to be isolated from solutions, however, due to the inner fractures and the irregular edges, these two seed crystals were later discarded and not used for the growing of larger crystals. Figures 5 and 6 were two other individual seed crystals that were able to be separated from the solution; and as these two solids are of high clarity and regular shape, they were selected to be used to grow larger crystals.

Part C: Growing the selected seed crystals

1. After 3 days, examine the growth of the seed crystals in the petri dish and assess if the size and clarity are still good.
2. Place the selected crystals on a ceramic tile and use tweezers to carefully tie cotton thread around them (Figure 7).
3. Fill a 200ml beaker with 23g potash alum solution.
4. Tie the cotton thread which secures the crystals around a wooden pop stick and use this to suspend the crystals in the liquid (Figure 8). Ensure that the crystals are not touching the base of the beaker. This prevents the growth of seed crystals on the edges of the crystals.
5. Monitor the growth of the crystals over several days and any changes in clarity or shape.

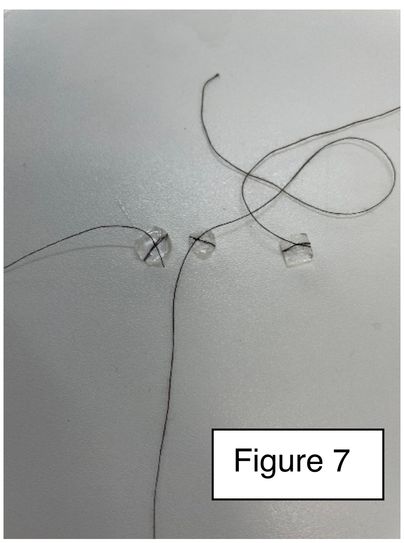


Figure 7

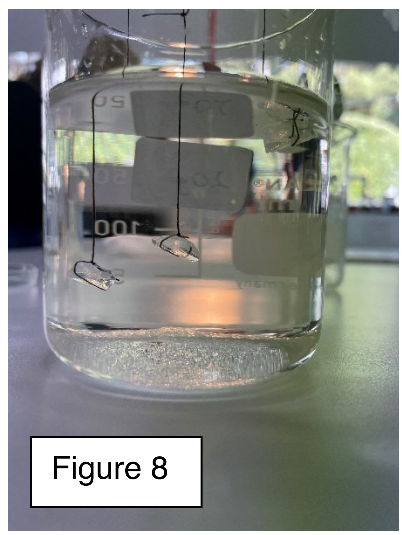


Figure 8

Observations:

During the crystal suspension the crystals were given the chance to grow without attaching to each other hence the separation within the beaker. If the crystals were to attach to each other or come into contact with the beaker, then it would result in further crystallisation. During their time in suspension, the crystal had become bigger and clearer as the risk of attachment was taken away due to the isolation of the best crystal options chosen from each trial.

Discussion and Summary

Overall, throughout the duration of the investigation, it was ultimately discovered that an increase in the mass of potassium aluminium sulphate used resulted in a greater quantity of crystals being produced. However, an increased mass of potassium aluminium sulphate also resulted in decreased clarity and a greater number of imperfections present in the seed crystals produced. Therefore, the hypothesis made at the beginning of the experiment was supported. A major issue that was encountered while growing the crystals was that if they were left lying at the bottom of the beaker, small seed crystal offshoots would develop on their edges. To prevent this, the crystals were suspended using cotton thread and pop sticks (as seen in Part C of the investigation) to ensure that they had space to grow in the solution without the interference of any other crystals that were developing. To improve the experiment, the temperature could be monitored more closely, as cold winter temperatures and temperature fluctuations likely resulted in ununiform crystal growth. In the end, two crystals produced in the 23-gram solution (found to be the optimum) were selected. The smaller of the two was very clear with sharp edges but had a few streaks and fractures in the centre. The other crystal chosen was very large and had a reasonable degree of symmetry and clarity, very sharp edges, and large reflective faces.