Crystal Investigation

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Investigation question

How does having a saturated solution affect crystal growth and quality?

Hypothesis

If the crystals are kept in a saturated solution while growing, then the crystals will be large, transparent and have regular edges.

Research

Potassium aluminum sulphate, chemical formula $KAl(SO_4)_2.12H_2O$, is a fairly non-toxic chemical compound. Its crystals usually form in an octahedral shape and are clear if grown correctly. Among other uses, it is commonly used for purifying water, a styptic for minor wounds, and tanning and dyeing textiles.

Crystallization happens in a cooling saturated solution when the solvent is no longer able to hold the solvent molecules, so the solvent leaves the solution and forms crystals.

In order to grow one quality crystal, the alum solution needs to be cooled slowly. This allows the crystals enough time to form an organised pattern, lowers the chance of trapping impurities, and lowers the amount of nucleation points.

Alum Saturated Solution Procedure

Materials

- 200ml distilled water
- 30g alum (aluminum potassium sulphate)

Equipment

- volumetric flask
- thermometer
- hot plate
- magnetic stirrer
- two beakers
- filter paper

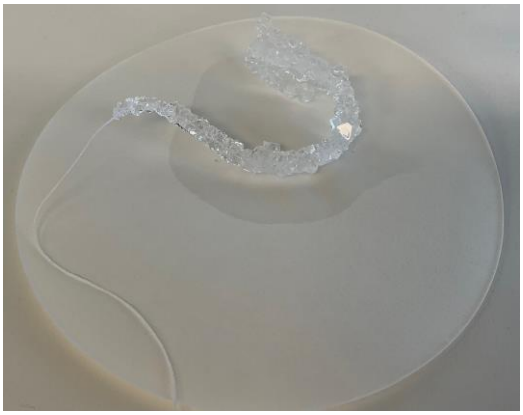
1. Add 200ml of distilled water into a volumetric flask.
2. Use a funnel to carefully pour the alum into the volumetric flask
3. Place a magnetic stirrer in the volumetric flask and heat it on a hot plate. Let it stir until it reaches 60°C, checking with a thermometer.
4. Once it has reached 60°C and all the alum is dissolved, turn off the hot plate and let it cool to 25°C.
5. Filter the solution into a beaker using filter paper until there are no impurities left.

6. Tie a string around a popstick, and submerge under 1 cm of the string into solution. Leave it in the solution for 1 week, covering the beaker with paper to stop dirt particles from getting in.
7. Check the solution, find good seed crystals on the string, and remove the rest. If there are no quality crystals on the string, transfer the solution into a clean beaker and tie or superglue the chosen crystals onto the string. An ideal crystal should be regular in shape, clear, have sharp edges and smooth faces.
8. Filter solution again and transfer all the seed crystals at the bottom of the beaker to the new beaker. Measure the size of the seed crystal you are growing and suspend it in the filtered solution.
9. Repeat steps 8-9 each week. Fresh solution may be added.

Observations

22/5/24 (9:32 - 9:56 am)
A good seed crystal needed to be found from the crystal string (fig 1). To achieve this, a magnifying glass was used to inspect the crystals for quality and tweezers for breaking off other unneeded crystals. Filter paper was then folded and inserted into a funnel, and alum solution was poured through and filtered into a beaker. Additionally, I found a clear, uniform seed crystal at the bottom of the beaker, which I attached to a string using glue. The crystals were then suspended in solution.

Figure 1, crystal clusters on a string



29/5/24

The bigger crystal was slightly foggy and had developed a growth which needed to be removed with tweezers. Due to having applied too much force, when removing the growth the crystal cracked. Alternately, the smaller crystal remained clear with smooth faces and relatively sharp edges. Regular process of filtering solution and transferring crystals into a new beaker.

5/6/24

The crystals were similar to last week in shape, clarity and uniformity, except they were slightly bigger. The cracked edge of the bigger crystal smoothed over slightly. For an unknown reason, the alum solution was contaminated with dirt particles floating on the solution surface. This could potentially cause unwanted crystal growths due to additional nucleation points. It was filtered with filter paper two additional times, and the crystals at the bottom of the beaker were replaced. An additional amount of fresh solution was also added.

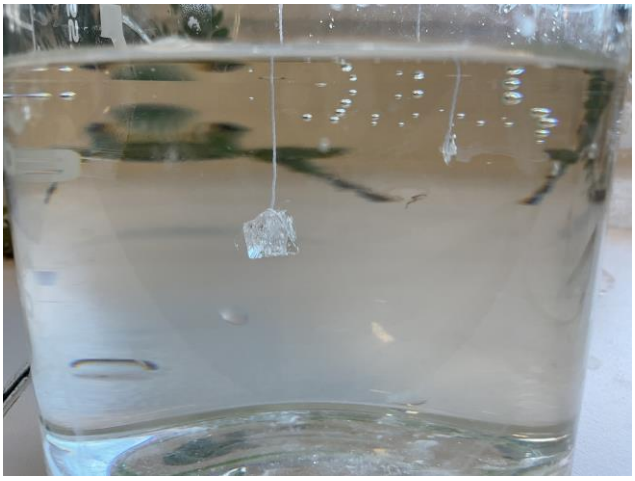
12/6/24

Unfortunately, both crystals fell off because they were attached with weak glue. The solution was filtered as usual, and I was given 2 new seed crystals by Melna, this time attached with a stronger glue to ensure it wouldn't happen again. One seed crystal was small but clear, while the larger one appeared to have air bubbles inside.

19/6/24

Crystals were similar to last week in appearance, except for the size increase in both crystals. The solution was filtered and the seed crystals at the bottom were checked for good crystals. I found 2 new crystals that were slightly misshapen but clear, so another beaker was filled with filtered solution so these additional crystals could be suspended.

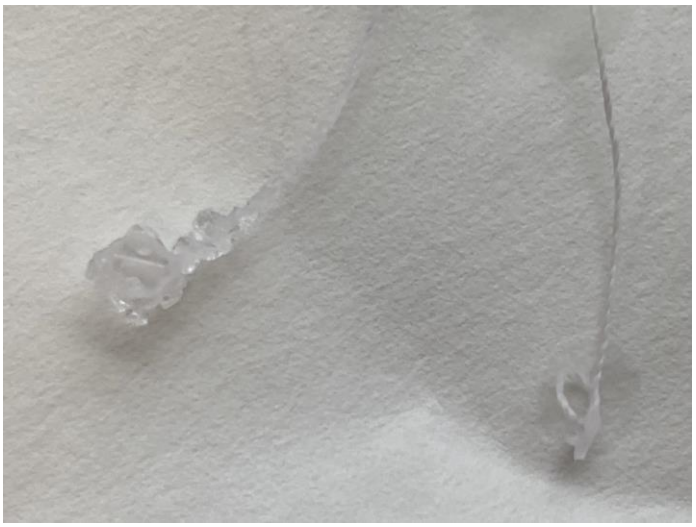
Figure 2, crystals suspended in solution



26/6/24

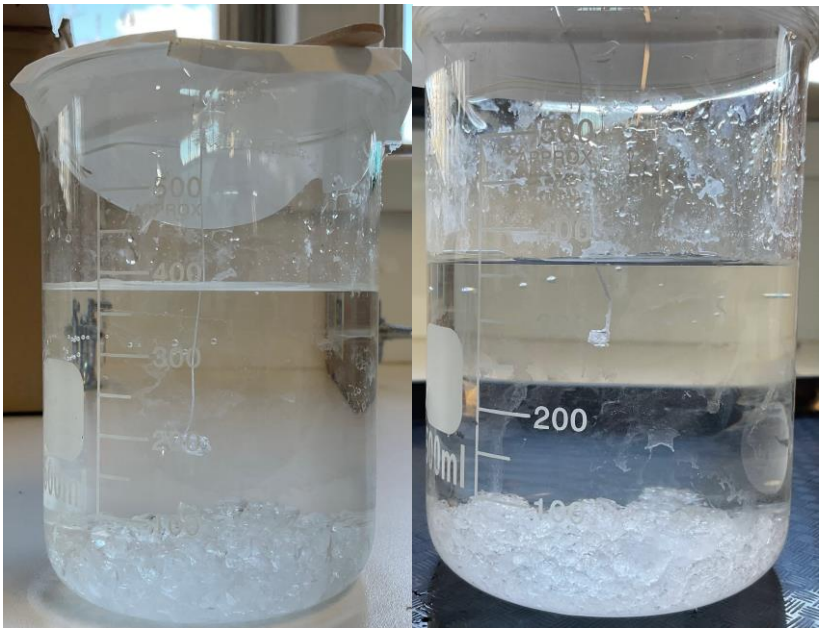
Out of the four initial crystals, two crystals fell out of the loop, leaving one tiny crystal and one crystal with lots of growths (fig 3). The first solution was filtered and the crystals were transferred to a new beaker. However, the second solution had developed a murky green tint, and needed to be replaced. A new saturated solution was filtered into the second beaker and one crystal was placed in each beaker.

Figure 3, the left crystal has developed growths while the right string's crystal has fallen out.



3/7/24 (9:02 - 9:57am)
The crystals had smooth faces, sharp edges, clarity, and almost a regular octahedral shape. They are estimated to have increased by approximately 1 mm in thickness. Both solutions were filtered and a new quality seed crystal was found from the crystals at the bottom of the second beaker. It was attached to a string and suspended inside the solution with another crystal, while the best quality crystal was given a separate beaker.

Figure 4



10/7/24
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17/7/24
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24/7/24 (9:00-9:54)
One crystal fell off and the other almost fully dissolved into the solution. This may have been because the solution was old and had become less saturated. This could be prevented from happening by adding fresh solution regularly. A new seed crystal was found from the beaker with sharp edges, smooth faces, and regularity of shape. However, it was also foggy, had some chipped edges, and another crystal attached to one of its faces. Tweezers were used to remove the additional crystal, and allowing the crystal to grow for one more week will possibly fill in the chips and make it clearer. The solution was filtered and the crystal was suspended in the beaker.

Figure 5, the new seed crystal found at the bottom of the beaker

Discussion
When the crystals were placed in solutions that were less saturated, they would have negligible size increase, stay the same size, or dissolve. crystal and delayed growth because it wasn't saturated. This supports my original hypothesis of saturated solutions being important in growing large, quality crystals. Saturated solutions ensure there is more solute than solution, allowing solute particles to separate and form crystals. Therefore saturated solutions are important in maintaining crystal growth.

Conclusion
Saturated solutions are crucial in maintaining crystal size increase, so it is advisable to add fresh solution or replace old solution periodically in order to grow a large, quality crystal.

Acknowledgement of Help/Resources
Melna Puthiyedathu - provided seed crystals, saturated solution, supervison, and guidance.