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Use Of Aluminium Waste To Obtain Alum: A Practical Proposal For The Circular Economy

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Summary
The purpose of this work is the recycling of aluminum, where it is demonstrated that we can give it several uses, that society and the environment are the beneficiaries, in this case we will see the process of the manufacture of alum (aluminum sulfate salt and potassium). From recycled aluminium from the laboratories located in the u-block. For this practice, laboratory materials, equipment and reagents were used, throughout this report we present the detailed steps and results of our project, it should be noted that it began by cutting small pieces of aluminum foil, where Al aluminum sulfate was obtained $_2(SO_4)_3$ thanks to the reaction of potassium hydroxide (KOH), then with sulfuric acid (H_2SO_4) to extract the crystals with pure methanol and then filter with the vacuum pump equipment. In this paper we also present several failed attempts and explain the correct quantities of our reagents and formulas used, to successfully obtain alum from recycled aluminum. To give us an idea of the help that this project of recycling aluminum, whether from cans or on paper, is capable of generating, we are contributing greatly to the environment, since an aluminum can has a useful life of 100 years. Aluminum sulfate has many applications, and one of the most important is its involvement in wastewater treatment.
Keywords: *Alum, aluminum sulfate, potassium hydroxide, sulfuric acid, recycling, aluminum*

INTRODUCTION

Aluminum is a metal that is abundantly found in the earth and accounts for more than 8% of the mass of the Earth's crust. It is the third most abundant chemical element after silicon and oxygen. Aluminium does not usually occur in nature in its pure form due to its high chemical activity, but it is found as alum. However, these are minerals that are mixed with two types of sulfuric acid salts: first, based on an alkali metal (potassium, sodium, lithium, cesium, or rubidium) second, with a metal from the third group of the periodic table, especially aluminum.

However, for the development of this proposed experiment was the synthesis of an inorganic compound, starting from elements such as aluminum foil, they cut out minimal pieces, in order to obtain alum; which is a compound formed by aluminum sulfate and potassium (KA1(SO4)2), and for this we use the pieces of aluminum foil to make them react with potassium hydroxide and later with sulfuric acid.

In other words, for the study of this research, discarded aluminum foil from the laboratories of the University's U block was used, in order to develop a new use for this material. However, in this case, it was considered to handle the materials necessary for the development of this experimental practice, managing to convert aluminum foil into crystals and in the same way converting the final objective as recycled aluminum alum.

Experimental

Aluminum foil in this project is very necessary to make aluminum sulfate, so we use the remains of this material, which are a waste in the laboratory, we take it to the autoclave to eliminate any type of residue that may alter our experiment and we proceed:

A significant amount of used aluminum foil is collected. Make sure it's clean and free of food debris or other contaminants. Unfold the used foil and cut it into small pieces to increase the reaction surface. Place the pieces of aluminum foil in a heatproof container, such as a glass flask.

Carry out the necessary concentrations to be able to pour into the aluminium so that it can carry out its bubbling and ionisation process.

Place the flask with the concentration of sodium hydroxide on a stove over low heat, to gradually pour in the aluminum foil, waiting for it to disintegrate.

When it stops efferving, it means that the aluminum foil is ready, to pour the sulfuric acid.

However, keep in mind that sulfuric acid is corrosive and should be handled with caution. Wear gloves and goggles. The result will be the formation of aluminum sulfate and the release of gaseous hydrogen.
Once the reaction is complete, filter the mixture to separate the liquid (which will contain the aluminum sulfate) from the unreacted pieces of aluminum foil.
You can heat the filtered liquid to evaporate some of the water and obtain a more concentrated solution of aluminum sulfate, you can use a vacuum pump with filter paper to be able to separate the water from the crystals. Finally, let the filtered liquid evaporate at room temperature until the crystals form. Then, you can pick them up and dry them. Performing several tests without obtaining the desired results, in total doing 4 tests with different solutions of the chemicals to obtain the crystals.

METHODOLOGY

For the present research work, a non-invasive experimental methodology is considered, it focuses on the observation and collection of data of a system or phenomenon without altering its natural state. It differs from traditional experimental methodology, which involves manipulating variables to observe their effects.
Being for the effect according to (Cabrera-Tenecela, P. 2023). In this case, there are two research designs: observational or experimental (Campbell & Stanley, 2015). In both cases, there are research designs that are subject to certain rules such as validity, reliability, randomization of the samples, replicability, among others, which demand specialized knowledge to avoid statistical dishonesty (April and April, 2021). Functionalist authors such as Durkheim, based on these rules of the game, considered that the findings of this type of research are susceptible to generalization.

RESULTS AND DISCUSSION

The following table presents the attempts made to obtain alum from aluminum foil, with their respective amounts of reagents, distilled water and grams of aluminum foil.

Table 1. Attempts made / Alum filling

Attempt	Aluminum Foil (g)	Sodium Hydroxide (g) (1.4 molar)	Distilled Water (ml)	Sulfuric Acid (ml) (9 molar)	Distilled Water (ml)	Failures	Alum Obtained
1	15	2.8	50	x	x	The aluminum foil dried together with the sodium hydroxide.	No
2	7.5	1.4	25	12.34	12.66	Too much sulfuric acid in the mixture, the crystals disappeared.	No
3	7.5	2.8	50	9.87	10.13	Crystals formed, but when neutralizing	Yes

						the sulfuric acid, some disappeared .	
4	7.5	2.8	50	4.94	5.06	Mixture too liquid, better cooking of aluminum foil with sodium hydroxide and distilled water was needed.	No

Own elaboration

The results obtained in this study revealed that there is a certain complexity in obtaining alum from reused aluminum foil, due to different variables that its formation with this method is not yet successful.

Comparing the current findings with the already known results of alum from "recycled cans", he indicates that in this case there were some unforeseen events either in the methodology, materials or even in the techniques themselves to achieve the proposed objective.

Therefore, some preliminary limitations to take into account; Aluminum foil requires different compounds essential for its manufacture, which can be obstruction in the relevant reactions, as well as some sheets used were not previously self-nailed, which can influence the result.

Similarly, in the filtration process, the Buchner funnel that needs to be used in the vacuum pump was not used; weighing grams of aluminum in different scales due to their absence, another factor to consider is the variability of temperature in the course of the process since if it is not adequate it influences the crystallization of the alum.

Something that was noticed very clearly is that the movements to dilute, move, homogenize the concentrations have a lot to do with the sequence of the operation, since sudden movements made certain elementary visible reactions disappear in the experiment.

A factor that should not be ignored is the partial absence of knowledge at certain stages, which contributes to the experiment having a considerable margin of error.

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