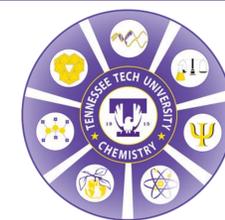




Creating Color Flame Candles as an Alternative to the Rainbow Flame Test

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Abstract

The rainbow flame test is a visually appealing chemical demonstration that showcases atomic emission spectra, but it can be very dangerous and has caused injuries due to accidents. Recently updates have been made to increase the safety of the demonstration, but it can still prove to be inaccessible to groups without access to proper safety training, certain scientific equipment, and supplies. The purpose of this research is to create easy to make candles that produce colored flames which can be used over long periods of time in a safe manner in classroom and educational settings. Cotton and wood candle wicks are soaked in salt solutions containing different metal cations that are known to produce colored flames and then sealed with wax prior to making the candles. Some wicks are sealed with wax and others are not to determine the effectiveness of sealing the salts into the wicks prior to making the candles. A portion of the sealed candles are coated with a wax containing the salt to allow the salts to soak into the wick as they burn. Other wicks are prepared by spraying the solution on the wicks and allowing them to dry between applications to build up the amount of the salt on the wicks. If successful, this work would allow a new way for the rainbow flame test to be conducted in a safe and accessible manner for a variety of audiences in scientific and non-scientific settings.

Introduction

Providing educators in K-12 and homeschool setting with the ability to safely do the rainbow flame test demonstration increases the accessibility of making complex chemistry concepts relatable to everyday life. When done in the traditional manner, this particular demonstration inherently has serious safety issues that must be considered, as well as the need for specialty chemicals and equipment. The creation of color flame candles would remove many of the safety and accessibility issues, while allowing this exciting demonstration to reach a wider audience.

Experimental

- Saturated solutions of strontium chloride, copper II sulfate, and potassium chloride were made to soak cotton and wooden wicks in.
- Wicks were soaked for two days and allowed to dry for one day.
- Salts were added to petroleum jelly and spread onto the wicks. Leftover petroleum jelly was mixed into wax paraffin in candle holders.
- Wicks were placed into the melted wax mixture and allowed to set.
- Candles were lit to see if a colored flame was produced.

Results



Figure 1. Copper (II) sulfate candle



Figure 2. Strontium chloride candle



Figure 3. Potassium chloride candle

The figures 1-3 show three candles with small portions of different colored flames. Figure 1 shows a candle with a green outline on the flame due to the presence of a copper (II) sulfate salt. Figure 2 shows a more vibrant red on the lower portion of the flame due to the strontium chloride. Figure 3 shows a faint indication of a violet outline on the left side of the flame due to the potassium chloride.

Discussion

During this research period, no significantly successful way of creating a colored flame candle was discovered. While the flames of the candles showed color, the buildup of salts would cause the inability of the wicks to stay burning or in some cases, burn at all. It was found that the cotton wicks were most effective at burning for the longest periods of time. When the wicks were successfully lit, it was found that the flame would only partially and sporadically show color. The salts that were added to the wax through the means of a petroleum jelly mixture were unable to be absorbed by the wick and built up at the base. Due to these factors, no long lasting and accessible method of creating a colored flame test candle was found.

Future Work

In order to create an effective and successful colored flamed candle, further research needs to be done. Ideas for further research include:

- Creating a hollow wick that would allow salts to be packed into the middle.
- Allowing the wicks to soak for longer periods of time.
- Sealing the salts to the wick using a wax coating method like drip candle making.
- Using a gel wax to see if absorption of salts into the wax is possible.

References

John P. Canal, Rajendra Dev Sharma, and Hamel N. Taylor, "A Convenient, Effective, and Safer Flame Demonstration", *Journal of Chemical Education*. **2019** 96 (10), 2261-2265 DOI: 10.1021/acs.jchemed.8b01010

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