Analysis of Vinegar VIA Titration
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Abstract:
Vinegar or French for sour wine is formed by aerobic bacteria oxidizing grain alcohol to acetic acid and water more generally, vinegar can be defined as a solution composed of acetic acid. Water perhaps other substances the conc. of acetic acid in vinegar may be expressed as a Molarity as a mass percent. A titration involve performing a controlled reaction between a solution of known Concentration (the titrant) and a solution of unknown concentration (the analyte) here the titration is an aqueous solution of ~0.1M sodium hydroxide and the analyte is vinegar.

Keywords: Vinegar titration molarity density

I. INTRODUCTION

Ordinary white vinegar is an aqueous solution of acetic acid which often carries the notation that the acidity has been reduced to 5% with water. Product like apple, cider vinegar Red wine vinegar and balsamic vinegar have other ingredients and flavoring, but even they are essentially acetic acid in water. In order to ensure that the acidity is at the desired level, periodic routine analyses are run. A common method for such analyses is titration, in which a strong base of known concentration is used to determine the concentration of acid by allowing the solutes of two solution to react with each other a titration solution is added at a controlled rate to known amount of solution to be analyzes addition continue until the reaction is complete. An indicator is often used to determine when all the solute of solution being tested has reacted. Signal that a reaction is complete by a changing a color. Phenolphthalein the indicator that you will use in this experiment is colorless in acidic or neutral solution but turns bright magenta with the slightest excess of base the first drop of base that causes a color to persist signals the end titration. The Equation for the reaction between the sodium hydroxide and acetic acid in the vinegar is

\[ \text{HC2H3O2(aq)} + \text{NaOH(aq)} \rightarrow \text{NaC2H3O2(aq)} + \text{H2O(l)} \]

The hydroxide ion of the base (NaOH) reacts with a hydrogen ion from acid (HC2H3O2) from water this reaction are called neutralization because the acid and base are neutralization each other, producing water. Notice that only hydrogen on the acetic acid molecule reacts with OH-. Many common organic acids contain some hydrogen atom that are acidic and other that are not.

We will prepare a sodium hydroxide solution to known concentration, and then use that solution to analyze the acid content of white vinegar. Once we determine the molar concentration of sodium hydroxide, we will convert concentration to units of moles of NaOH per gram of solution because in this experiment both the mass and concentration of this sodium hydroxide titrant are known the number of moles of NaOH reacts in a 1:1 mol ratio so we can also determine the no. of moles of Acetic acid present in the sample which can then convert to mass in grams. We carry out four trials for the analysis. The amount of two solution used in each of the titration will be determine by weighing the pipettes before and after each of the titrations.

Purpose-

In this experiment the molar concentration and mass percent concentration of acetic acid HC2H3O2 (aq), in a vinegar solution were determined via titration using a standard solution of sodium hydroxide NaOH (aq).

Material available For Use:

Vinegar
NaOH (aq)
KHP-potassium hydrogen phthalate
Phenolphthalein indicator
10-ml pipettes
Beakers
Erlenmeyer flasks
Funnel
Analytical Balances

Safety Precautions:

NaOH is corrosive It can attack the skin and cause permanent damage to eyes. If contact with skin or clothing occurs flush the affected area with water.

Getting started:

We first task to standardize the NaOH sol using solid KHP This means we need to determine its molarity to at least three trials. We will need at least three trials that agree within 1% as described in the procedure. We have two other tasks to accomplish in the lab we must determine the density of the vinegar sol and the molarity of the acetic acid in a vinegar the mass percent can be our data.

To accomplish our tasks, we will need to make very accurate volume and mass measurement. Burette and pipettes are useful in accurately measurement.
**ILPROCEDURE:**

**Preparation of Burette**

1. Check the burette by rinsing down the sides with distilled water bottle to check if water sheets down inside of the burette. If water droplets are observed, the burette should be washed before use. Be careful not to scratch the inner surface if you find it necessary to use a burette brush to clean it. Rinse the burette well with tap water including the stopcock and washers.

2. Finally rinse the burette at least twice with small portions of yours NAOH solution to ensure that all water is removed.

3. Fill the burette with NAOH sol. Using funnel.

4. To remove trapped air bubble in the trip of the burette after filling. Quickly opened and closed the stop cock several times.

**Titration technique**

1. Place a sheet of white paper beneath the receiving flasks to more easily observe the end point.

2. Use a split white top/black bottom card to aid in reading the meniscus place the card behind the burette and the black line just below the meniscus darkens the meniscus for easy reading, record the initial volume of NAOH sol. To the nearest hundred milliliter in the data table.

3. The titrant can be added fairly quickly at first but as the end point is approached the rate of addition should be slowed. If you are right handed it should be faster to add the titrant with your left hand. As the end point is approached, the pink color will persist longer and longer.

4. Near the end point, rinse the flask walls down with distilled water to ensure that the entire added NAOH base has reacted.

5. When very close to the end point, suspend a half drop of base on the trip of burette and rinse the drop into receiving flask with the distilled water wash bottle.

6. The end point occurs when the phenolphthalein changes from clear to the faintest pink color you see and persist for a minimum of 30 seconds. Record the final volume of NAOH sol to the nearest hundredths milliliter in the data table.

7. Your group must complete a minimum of three trials must agree within +1%. we cannot just cross out data because we don’t like it. we must indicate the reason for discarding. The reason may be obvious such as overran end point or you may only be able to discard value based upon statistical tests.

*Sample of vinegar was analyzed and its brand and mass percentage of acetic acid were recorded. Using a 10-ml portion of the vinegar were delivered to each of three Erlenmeyer flasks and a few drops of phenolphthalein indicator were added to each flask. About 150ml of a standard sodium hydroxide solution NaOH (aq) was obtained for the titrations. The initial and final reading were recorded as the two vinegar solution were each titration to a phenolphthalein end point. The volume of NaOH required to titrate each vinegar sample was determined and used to calculate the molar concentration of HC2H3O2(aq) in each vinegar sample. The average molar concentration of HC2H3O2 (aq) for the two trials was determine along with the average molar concentration and the percent difference. If the two trials Molarity of standard NaOH (aq): 0.2165M Vinegar brand: Smiths Reported mass percent of HC2H3O2 in a vinegar:- 5.0%**

### TABLE. 1.

<table>
<thead>
<tr>
<th>Vinegar titration</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of vinegar used</td>
<td>10.0 ml</td>
<td>10.0 ml</td>
<td>10.0 ml</td>
</tr>
<tr>
<td>Initial volume of NAOH</td>
<td>0.00 ml</td>
<td>0.15 ml</td>
<td>0.35 ml</td>
</tr>
<tr>
<td>Final volume of NAOH</td>
<td>39.30 ml</td>
<td>38.80 ml</td>
<td>39.05 ml</td>
</tr>
<tr>
<td>Volume of NAOH used</td>
<td>39.30 ml</td>
<td>38.65 ml</td>
<td>38.70 ml</td>
</tr>
</tbody>
</table>

Density of Vinegar solution:
Mass of Empty 10-ml Graduated cylinder: 15.1256g
Mass of graduated cylinder+ Vinegar: 25.1753g
Mass of Vinegar: 10.053g
Volume of vinegar used: 10.0 ml

### III.CALCULATIONS:

Molarity of HC2H3O2:

**Trial 1:**
- 0.03930L NaOH×0.2165 mol NAOH× 1 mol HC2H3O2/1 mol of NAOH ×1/0.01000L=0.8508MHC2H3O2

**Trial 2:**
- 0.03865L NaOH×0.2165 mol NAOH/L ×1 mol of HC2H3O2/1 mol of NAOH ×1/0.01000L=0.8368MHC2H3O2
  Average [HC2H3O2] for trial 1 and 2 = 0.8508 M+0.8368 M/2 =0.8438 M
  % difference for HC2H3O2 for Trial 1 and 2
  10.8509 M-0.8368 M/0.8438 M×100%=0.0140M/0.8438 M×100%
  %=1.66%

**Trial 3:**
- 0.03870LNaoH× 0.2165 mol NAOH/L×1 mol of HC2h3O2/1 mol of NAOH ×1/0.01000L=0.8379MHC2H3O2
  Average [HC2H3O2] for Trial2 and 3=
  3=0.8368M+0.8379M/0.8374M×100 %=0.8374 M
  % difference for Trial 2 and 3=
  10.8386M-0.8379 M/0.8374 M ×100 %= 0.0011M/0.8374 M×100 %=0.13 %
Density of vinegar:
density=mass/volume= 10.050/10.0ml=1.005 ml
Mass percent of HC2H2O3 in vinegar:
0.847mol HC2H2O3/1000 ml solx0.052 g HC2H2O3/mol HC2H2O3xml sol/1.005 g solx100% =5.063% difference for
Mass Percent Concentration=
5.063%-5.0 %/5.0.%×0.1 %/5%×100%= 2%

IV. RESULT:

Table 2:vineger titration result

<table>
<thead>
<tr>
<th>Trial</th>
<th>Molarity of HC2H2O2(aq) in vinegar</th>
<th>Average Molarity of HC2H2O2(aq)</th>
<th>Percent Difference</th>
<th>Mass percent concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>0.8508M</td>
<td>0.8374M (Using only two trials 2 and 3)</td>
<td>0.13% (for trial 2 and 3 only)</td>
<td>5.063%</td>
</tr>
<tr>
<td>Trial 2</td>
<td>0.8368M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td>0.8379M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. DISCUSSION:

In this experiment, a sample of Smiths brand vinegar was analyzed via titration with a standard 0.2165 M NAOH sol. Three Trials were carried out to achieve the required precision of less than 1% difference the calculate molar concentration of acetic acid for the first two trials were 0.8508 M and 0.8368 M so the percent difference was 1.66%, thus a third trial was conducted. The calculated molar concentration was of acetic acid for trial 3 was 0.8379 M, which had a 0.13 % difference compared to trial 2. Thus only the data from these trials were used to calculate the average molar concentration of acetic acid of 0.8374M and resulting mass percent of acetic acid in vinegar of 5.06% this gave 2% difference compared to 5.0% concentration reported on the bottle of the Smiths brand vinegar. One possible source of error and reason for the difference trial 1 and other trial was the addition of NAOH sol. in the continue stream near the end point, so the sol. was a dark pink at the end of trial 1. Because trial 1 required0.55-0.6 ml more NAOH sol. then trial 2 and 3, the Volume of NAOH used for the trial was too high, resulting in an incorrectly high calculated molarity for acetic acid. Another possible source of error would be recording in a initial volume of NAOH sol. such as recording the initial volume as 0.00ml if the level of sol. was actually higher then 0.00ml on the burette. The excess NAOH sol. above the 0.0mlmark will result in more NAOH sol’ delivered then is actually recorded, based on the end point. Because an recording error of sol. of NAOH delivered to be recorded, the resulting calculated molar concentration of acetic acid will be incorrectly low as well. Thus correct technique is essential for obtaining good data and accurate and precise results in this experiment. Conclusions: In this experiment, A sample of Smiths brand vinegar was analyzed via titration with a standard 0.2165 M NAOH sol. The vinegar’s molar concentration was determined to be 5.063% which give a percent difference of 2 % compared to the manufacture's reported acetic acid content of 5.0%.

V.LREFERENCES:
[7]. Compendium of Basal practise in biochemistry Aarhus University.2008.