IDENTIFICATION OF ALKALIMETRIC LEVELS USING ACID-BASE REACTION PRINCIPLES

Dianingsi Hipi[1)], Eka Paramita Daud[2)], and Gayatri D. Soga[3)]
[1,2,3)] Bina Mandiri University Gorontalo
Email: dianhipi1703@gmail.com

ABSTRACT

One way to determine the concentration of an acid-base solution is through an acid-alkalimetric titration process. This method is quite profitable because the implementation is easy and fast, the accuracy and accuracy are also quite high. Acidi-alkalimetric titration is divided into two major parts, namely acidimetry and alkalimetry. Acidimetry is a titration using a standard solution of an acid to determine a base. The acids that are usually used are HCl, vinegar, oxalic acid, boric acid. While alkalimetry is the opposite of acidimetry, which is a titration that uses a standard solution of a base to determine acid.This study aims to identify the substance in a sample and determine the level is the principle of acid-base reactions. Acidi-alkalimetric titration is a volumetric titration using NaOH as the secondary standard solution and potassium hydrogen phthalate as the primary standard solution and added pp indicator. The end point of the titration is indicated by a change in the color of the solution to a pink color. Alkalimetry is a quantitative determination of the levels of compounds that are acidic by using a standard base.

The method used is the experimental method through a quantitative approach. The research method is used to determine the effect of the independent variable or treatment on the dependent or the results under controlled conditions.

The results of the study obtained the calculation of the volume of NaOH 28.7 then performed in duplicate to obtain the calculation of the volume of NaOH 29.7. So the calculation of the concentration of Salicylic Acid is0,584 M.

Keywords: salicylic acid, NaOH, titration

INTRODUCTION

Acidi-alkalimetric titration is a volumetric titration using NaOH as the secondary standard solution and potassium hydrogen phthalate as the primary standard solution and added pp indicator. The end point of the titration is indicated by a change in the color of the solution to a pink color.

Alkalimetry is a quantitative determination of the levels of compounds that are acidic by using a standard base. Therefore, research was carried outIdentifying substances in a sample and determining their levels is the principle of an acid-base reaction.

In titration research, a solution whose concentration is known with certainty is called a standard solution. The standard solution was added until the reaction was complete. Some titrations must be assisted by an indicator to reach the end point of the reaction titration which is indicated by a change in the color of the solution [2].

Standard Solution, the analytical process for determining an unknown amount of a substance, by measuring the volume of the reactant solution required for a complete reaction is called volumetric analysis. This analysis also concerns the measurement of gas volume.

The process of measuring the volume of a solution in a burette that is added to another solution of known volume until the reaction is complete is called titration. The solution whose concentration is known is called the standard solution. The process of determining the concentration of a solution of known concentration, which will be used in volumetric analysis. There are ways to standardize a solution, namely:

1. Direct preparation of a solution by dissolving a pure substance with a certain weight, then diluting it to obtain a certain volume precisely. This solution is called the primary standard solution, while the substance used is called the primary standard.
2. A solution whose concentration cannot be determined by weighing the substance and then dissolving it to obtain a certain volume, but can be standardized with a primary standard solution, is called a secondary standard solution.

Primary Standard Solution

The titrant solution must be known in its composition and concentration. Ideally we should start with a primary standard solution. Primary standard solutions are prepared by dissolving a substance of high purity (primary standard) of known exact weight in a solution of precisely known volume. If the titrant is not pure enough, it needs to be standardized with a primary standard.

Material requirements to make a primary standard solution:

1. High purity,
2. Stable to air,
3. Not a hydrate group,
4. Easily available,
5. Quite easy to dissolve,
6. Molecular weight is quite large,

Primary standard solutions must be prepared by:

1. Accurate weighing using analytical balance.
2. Dissolved in a volumetric flask
   An example of a solution that can be used as a primary standard solution is C2H2O4 .2H2O (oxalic acid). Oxalic acid is a solid, fine, white, water soluble substance. Oxalic acid is a divalent acid and is always titrated until the normal salt is formed. The equivalent weight of oxalic acid is 63 [8].

Secondary Standard Solution:

Secondary standard solution is a solution whose concentration is obtained by titrating with a primary standard solution. NaOH cannot be used for primary standards because NaOH is hygroscopic, therefore NaOH must be titrated first with KHP so that it can be used as a primary standard. Sodium hydroxide (NaOH) also known as caustic soda is a kind of caustic metallic base. Sodium hydroxide forms a strong alkaline solution when dissolved in water. Pure sodium hydroxide is a white solid and is available in the form of pellets, flakes, granules or 50% saturated solution.

NaOH is an inert liquid and spontaneously absorbs carbon dioxide from the air, it is very soluble in water and will release heat when dissolved. NaOH is also soluble in ethanol and methanol. although the solution of NaOH in these two liquids is smaller than the solubility of KOH. NaOh is insoluble in ether and other non-polar solvents. Likewise, H2SO4 and HCl cannot be used as primary standards. In order to become a secondary standard, this solution can be titrated with a primary standard solution of NaCO3.

Tertiary Standard Solution

Tertiary standard solution is a solution whose concentration is obtained by titrating with a secondary standard solution which has previously been standardized with a primary standard solution.

Indicators are an important part of titrimetric analysis because of their ability to show the end point of the titration. In an acid-base titration, an indicator is a substance that has a sharp color change in an acid and a base medium. There are various synthetic indicators with their respective pH ranges commonly used in acid-base titrations, including: phenolphthalein, methyl red, methyl orange, and bromothymol blue [2].

In a titration, a solution to be neutralized is added to a container or tube. Another solution, which is a base, is put into the burette and then put into the acid, first rapidly, then dropwise, until the equilibrium point of the titration is reached. The point during the titration at which the indicator changes color is called the end point of the indicator. What is needed is to match the endpoint of the indicator whose changes occur in the pH range which includes the pH according to the equivalent point [11].

The substance to be determined is called the titration (titrant) and is usually placed in an Elenmeyer tube while the substance whose concentration is known is called the (titer) and is usually placed in a burette, either the titer or the titrant, usually in the form of a solution.

Volumetric Calculation

Calculations in volumetric analysis are based on simple stoichiometric relationships of chemical reactions. aA + tT→ product

Where a molecule of analyte A, reacts with molecule of reagent T. Reagent T, called the titrant (titer solution), is added little by little, usually from the burette. The solution in the burette can be a standard solution whose concentration is known by standardization or a solution of the substance whose concentration will be determined. The addition of the titrant is continued until the amount of T is chemically equivalent or equivalent to A, then the state is said to have reached the equivalence point of the titration [13].

The basis of this reaction is used to determine the equivalence of the test substance with the titer solution listed in the monograph of each drug compound in the Indonesian Pharmacopoeia.

But when exactly is reached an equivalence point can not be seen with the naked eye.

To find out when the addition of the titrant must be stopped, an indicator solution is used which can indicate the occurrence of excess titrant with a color change. The point in the titration at which the indicator changes color is called the end point of the titration, ideally it is the end point of the titration as close as possible to the equivalence point. Therefore, when you carry out the titration, the addition of the titer solution must be stopped immediately if the first color change has occurred. And remember, if you use excessive titer solution (you didn't pay close attention to the first color change), then there is an excess of titer solution which causes the analysis results to be no longer accurate. The concentration units that are widely used in volumetric analysis are molarity (M) and normality (N) [1].

For that we need to re-learn about the molarity and normality.

As you already know that:

1. Molar (M) is the number of grams' mole or moles of solute in 1 liter of solution.
2. Normal (N) is the number of grams equivalent or gram of solute in 1 liter of solution.

For the purpose of calculating the amount of material to be weighed for concentration
molar or normal, one thing to pay attention to is the unit equivalence:

1. Liters are equivalent to moles and grams while milliliter is equivalent to mmol and Mg.
2. The same applies to normality (liters equivalent to grams and grams and milliliters equivalent to magnesium and grams).

The equivalent units in the calculation of molarity and normality, are:

1. If the weight is in grams, then the volume is in liters.
2. If the weight is in mg, then the volume is in milliliters.

In carrying out the titration, several requirements must be considered, such as;

1. The reaction must proceed stoichiometrically and not.
2. There was a side reaction.
3. The reaction must be fast.
4. Reaction must be quantitative
5. At the equivalence point, the end point of the reaction must be known
6. Sharply (obviously the change).
7. There must be indicators, either direct or indirect.

Based on the type of reaction, the titration is grouped into four types of titrations, namely:

1. Acid base titration.
2. Precipitation titration.
3. Complexometric titration.
4. Oxidation reduction titration.

The first step that must be done before carrying out the titration is the preparation of a standard solution. A solution can be used as a standard solution if it meets the following requirements:

1. Has a high purity
2. Has a definite molecular formula
3. Not hygroscopic and easy to weigh
4. The solution must be stable
5. Has a high equivalent weight (be)

A solution that satisfies the above requirements is called a primary standard solution. While the secondary standard solution is a standard solution which, when used to standardization must be standardized first with a primary standard solution.

Solution Concentration

There are several ways to express the concentration of a solution, namely as follows:

1. Molarity (M) is the number of moles of solute dissolved in 1000 ml of solution.
2. Normality (N) is the number of gram equivalents of solute dissolved in 1000 ml of solution.
3. Molality (M): is the number of moles of solute dissolved in 1000 mg of solvent.

Normality (N) is determined by the number of gram equivalents of solute in 1000 ml of solution. The equivalent weight (BE) can be determined based on the type of reaction, as follows:

1. Acid base reaction (neutralization).
2. Precipitation reaction.
3. Reactions to form complex compounds.
4. Oxidation reduction reaction.

Acid-Base Indicator

An acid-base indicator as an indicator of the degree of acidity of a solution is an organic compound with a complex structure that changes color when the pH of the solution changes. The indicator can be a weak acid or a weak base which has a fairly sharp color, with just a few drops the indicator can be used to determine the equivalence point in an acid-base titration or to determine the level of acidity of the solution [5].

How to Find the Equivalent Point

Acid-base titrations involve an acid or a base as the titre or titrant. Acid-base titration by neutralization reaction. The concentration of an acid solution is determined by using a basic solution and

vice versa. The titrant is added little by little until it reaches an equivalent state (meaning that the titrant and titer have completely reacted stoichiometrically). This state is known as the "equivalence point". At this equivalence point, the titration process is stopped, then we record the volume of titer needed to reach that state. By using the data of titrant volume, titer volume and concentration, we can calculate the titrant content.

There are two general ways to determine the equivalence point in an acid-base titration.

1. Use a pH meter to monitor changes in pH during the titration, then make a plot between pH and titrant volume to obtain a titration curve. The midpoint of the titration curve is the “equivalence point”.
2. Use an acid-base indicator. The indicator is added to the titrant before the titration process is carried out. This indicator will change color when the equivalence point occurs, this is when we stop the titration. In general, the second method was chosen due to the ease of observation, no additional tools needed, and very practical. The indicator used in the acid-base titration is the right indicator and in accordance with the titration to be carried out [16].

The state where the titration is stopped by looking at the color change of the indicator is called the "end point of the titration".

Factors Affecting Titration

1. Concentration of analyte and titrant, the greater the concentration, the greater the change in pH in the equivalent point region, making it easier to determine the appropriate indicator.
2. Strength of weak acid or weak base, the completeness of the reaction on a weak acid/base with a strong base/acid is determined by the value of Ka or Kb of the analyte. The greater the value of Ka or Kb, the greater the area of the change in pH at the equivalent point, thus determining the appropriate indicator.
3. Indicator selection, the indicator used to change the pH must be in the pH equivalence point region.

Determination of Salicylic Acid Levels

To determine the levels of Salicylic Acid, the Indonesian Pharmacopoeia states that the analysis of levels is carried out by indicator using a 0.1 N sodium hydroxide titer solution. The titration method using a sodium hydroxide titer solution is known as the alkalimetry method, this method is based on the neutralization reaction between the acid test substance and the solution. base as the titer solution.

Based on the solubility of salicylic acid which is difficult to dissolve in water but more soluble in ethanol, so in the analysis salicylic acid is dissolved with ethanol so that a perfect reaction occurs. Because ethanol reacts slightly acidic, the solvent must be neutralized first so that in the titration process the titer solution only neutralizes the sample solution. To determine the completion of the reaction, an indicator is used, the indicator used is phenolphthalein (pp) which is a base indicator. The pH interval of phenolphthalein was 8.0-10.0, a color change was observed from colorless to pink [15].

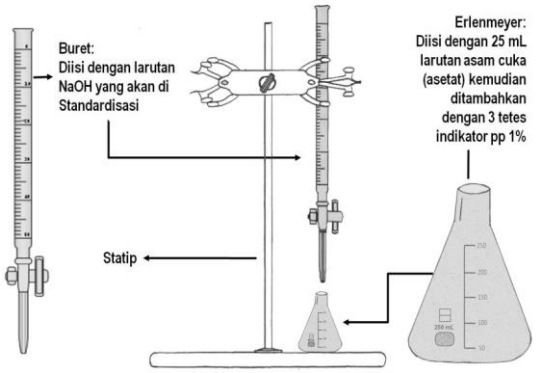

Figure 1. Titration apparatus circuit

RESEARCH METHODS

The method used is the experimental method. The experimental method is part of quantitative research, and has its own characteristics, especially in the presence of a control group. The essence of experimental research (experimental research) is to examine the effect of treatment on behavior that arises as a result of treatment. Definition of experimental research according to experts:

1. Experimental research is research conducted to determine the consequences of a treatment given intentionally by researchers [13].
2. Experimental research is research conducted by manipulating which aims to determine the effect of manipulation on observed individual behavior [11].
3. Experimental research is a systematic method to build relationships that contain causal-effect relationships [9].
4. Experimental research is a research method used to find the effect of certain treatments on others under controlled conditions [16].

The definition of some of these experts, it can be concluded that experimental research is research that is based on knowing the effect of giving a treatment or treatment to research subjects. So experimental research in education is a research activity that aims to assess the effect of an educational treatment/action/treamen on student behavior or to test hypotheses about the effect of that action when compared to other actions.

Tools used

1. Burette 1 piece → Its function is to drop liquid reagents in experiments that require precession such as titration.
2. Statives and clamps → the function is to uphold the burette, funnel, separating funnel and other glassware when in use and also to hold the burette used for titration.
3. 1 spray bottle → function as a container to store aquadest.
4. Funnel 1 piece → Its function is to filter a chemical mixture/a solution.
5. Erlenmeyer glasses 250 ml 2 pieces→ its function is for the titrant container (the solution being titrated) in the titration process
6. 1 cup 250 ml beaker→ its function is to measure the volume of the solution or as a container/place for the solution.
7. Dropper 1 piece→ Its function is to take the liquid that is still in the container.

Materials used:

1. NaOH 1 M**,** Physical properties: Colorless, brittle (breakable) hygroscopic liquid, salty, soluble in water. Chemical properties: Very easy to absorb CO2 gas, the pH is neutral, and bonds strong ionic.
2. Phenoftalein, Physical properties: It is in solution form and is a weak acid. Chemical properties: Cannot react with the reacted solution only as an indicator.
3. Salicylic acid, Physical properties: It is a colorless gas with a pungent odor and an electrolyte strong, strong acid. Chemical properties: Will smoke thickly in humid air, and the boiling point, point melting, density, pH.
4. Aquadest, Physical properties: Colorless and odorless liquid. Chemical properties: A good solvent, has a pH of 7 (neutral).
5. Filter paper/Tissue; used for filtering.

RESEARCH RESULT

Table 1 is a table of observations of acid-base reactions. First, clean the burette and rinse with NaOH 3 times (± 5 ml) so that the burette becomes clean, transfer 50 ml of NaOH into the burette, Measure 10 mlC6H8O7into the Erlenmeyer flask, then Add 3 drops of pp indicator so that the solution becomes a clear yellow color, do the titration by dripping NaOH solution

and rotate the burette slowly so that the solution reaches the equivalence point or pink, calculates the volume of NaOH which is 28.7 ml and is carried out in duplicate so that the calculation of both volumes of NaOH is 29.7 ml. After calculating the concentration, the concentration obtained forC6H8O7 is 0.584 M.

Table 1. The results of the observation of acid-base reactions

No	Treatment	Observation result
1	Clean the burette and rinse with NaOH 3 times (± 5 ml)	Burette to be clean
2	Transfer 50 ml of NaOH into the burette	Clear solution color
3	Measuring 10 ml C6H8O7into the Erlenmeyer flask	Clear solution color
4	Added 3 drops of pp indicator	The color of the solution is clear yellow
5	Perform titration by dripping NaOH solution and rotating the burette slowly	The color of the solution is pink
6	Calculating the volume of NaOH	28,7 ml
7	Duplo	29,7 ml
8	Calculating concentration C6H8O7	0,584 M

In the process of the occurrence of pink color in the titration, the standard solution or titrant used is a base. Why is that? because in this process the titer (the titrated solution) is an acidic solution and the titrant (the titrated solution) is an alkaline solution. For the titer, we give a little pp indicator to find out whether the compound has acidic or basic properties. after the addition of the pp indicator in the acid solution is still clear, then we will titrate it with a titrant that has alkaline properties. when the initial mixing occurs, between an acid solution and a basic solution, the color of the solution is still clear, but when the moles of acid are used up because they are used to react with moles of bases (the name is the equivalence point), the alkaline solution will bind to the pp indicator, resulting in color change from clear to pink (the name is the end point of the titration, it is indicated by the color change). because the alkaline solution will prefer to bind with the acid solution first than with the pp indicator.

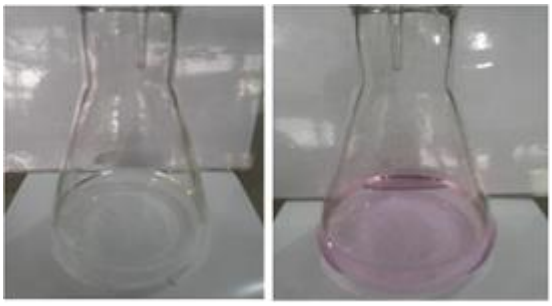

Figure 2. Before and After titration

Chemical reaction is a natural process that always produces interchanges of chemical compounds. The initial compounds or compounds involved in the reaction are called reactants. Chemical reactions are usually characterized by chemical change, and will return one or more product which usually have different properties from the reactants. Classically, chemical reactions involve changes that involve the movement ofelectron in the formation and termination chemical bond, although basically the general concept of chemical reactions can also be applied to transformation of elemental particles as in nuclear reaction. Different chemical reactions are used together inchemical synthesisto produce the desired compound product. Inbiochemistry, a series of chemical reactions that catalyzed by enzyme shape metabolic pathway, where synthesis and decomposition normally not possible in the cell is carried out.

$3NaOH + C_6H_8O_7 \rightarrow Na_3C_6H_5O_7 + 3H_2O$

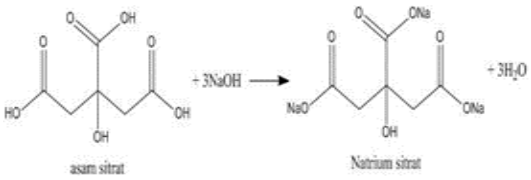

Figure 3. Reaction of Salicylic Acid + NaOH

DISCUSSION

The research carried out is Alkalimetry experiments with its application, namely the determination of

the levels of C6H8O7. The purpose of this research is to make and determine the standardization of acid solutions. Neutralization reactions in titrimetric analysis are better known as acid-base reactions. The basis of the reaction in this neutralization titration is the reaction between hydrogen ions (H+) which are acidic and hydroxide ions (OH) which are basic and form neutral water, this reaction includes a neutralization reaction.

This reaction can also be said to be a reaction between a proton donor (acid) and a proton acceptor (base). In this experiment, including the type of acidimetric neutralization titration, because the experiment involved an alkaline solution with an acid whose concentration was known (acid standard solution). The base used in this study is NaOH to determine the concentration ofC6H8O7 done as follows:

Previously, the first step was to clean the tools to be used using water and then dried, this was done so that there were no previous impurities or residual substances that might interfere and affect the reaction so that the reaction results did not match the theory. However, for the burette, the cleaning method is by rinsing the burette using 1 M NaOH. The NaOH solution is inserted into the burette through the top hole that has been given a funnel and with the faucet position on the burette open and there is a beaker underneath so that the 1 M NaOH can come out and be accommodated in the burette. the beaker. This is intended so that the burette is truly a 1 M NaOH solution, not a solution or other residual or impurity substances that may later interfere with the titration process. Then the filling is made beyond the zero scale and expelled through the end of the burette so that there is absolutely no air in the burette. The discharge was stopped until the NaOH solution was exactly on the 1 M scale.

After the tool is completely clean, first transfer 50 ml of NaOH into the burette using a funnel. After that the solution C6H8O7 plus 3 drops of pp indicator. The purpose of using indicators is to make it easier to determine the end point of the titration. AfterC6H8O7 given indicator,

Then the solution is titrated with 1 M NaOH in a burette, with white paper at the bottom of the Erlen meyer so that the color change of the titrate solution can be clearly observed. The titrate is titrated with 1 M NaOH until the color changes from light yellow to pink. When the color changes, it indicates that the end point has been reached and indicates that the equivalence point has also been reached. The well-known acid-base indicator is the phenolphthalein (PP) indicator which is usually used in titration experiments. This PP indicator has a pH range of 8.0-9.6 with a color change from colorless to purplish red [12]

Indicator can change color? Acid-base indicators will tend to react with an excess of acid or base during the titration to produce a color. This color change is caused by the resonance of the electron isomer. Each acid-base indicator is an ion that has a different ionization constant. This ion has a conjugated system that can absorb certain color waves and transmit other color waves. The absorbed color waves are part of the color spectrum, so the ion will appear colored [9].

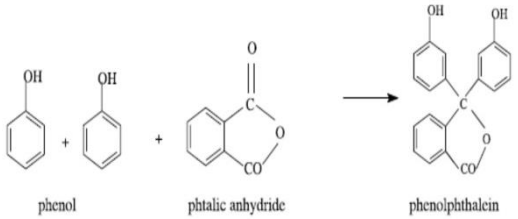

Figure 4. Phenolphthalein Manufacturing Reaction

At pH 8 and below, the structure of phenolphthalein can be abbreviated as H2P. In the pH range of 8-10, acid protons will be taken up by OH- ions from NaOH,

thus giving P2- ions which are pink in color [7].

The color given by phenolphthalein fades with increasing base concentration [10]. This research uses a synthesis indicator (phenolphthalein), because it is practical and easy to use, generally in the form of paper or liquid that you just need to put into the solution being tested. This indicator is also precise, because it is accompanied by a pH value indicator for precise measurements and has been adjusted by the manufacturer [5].

But basically the equivalence point cannot be known by conventional titration because it is influenced by the work of the indicator which can only work on excess H+ or OH-. The equivalence point is the point where the number of moles of the titrated solution is equal to the number of moles of the titrating solution. The end point is when the color change occurs. After getting the color change to pink, then the titration was stopped and the amount of 1 M NaOH required was recorded. At the time of titration, the color change is also made as faint as possible or not too concentrated in order to obtain results that are not too far from the equivalence point [13].

Record the volume of NaOH required to titrate the solution. In the initial titration, the volume of NaOH required was 28.7 ml, while in the second titration the volume of NaOH required was 29.7 ml. In order to determine the concentration of the acid solution (C6H8O7) in the experiment, the first step is to add up the two volumes of NaOH used in this experiment (first and second) divided by two so that the average volume used in the experiment will be obtained. These results are then entered into the dilution formula, namely:

VNaOH x MNaOH=VC6H8O7 x MC6H8O7

Where VNaOH is the average volume of NaOH used, MNaOH is the concentration used, which is 1 M, and VC6H8O7 is volume C6H8O7used in research. Based on the calculation results obtained that the concentration of besarnyaC6H8O7 is 0.584 M

The error factors that will cause the failure of this research include: 1) if the concentration of the standard solution used is not in accordance with existing work procedures; 2) if the titrant used is not in accordance with the theory, namely if the acid solution you want to titrate is the titrant is basic standard solution and vice versa; 3) in addition if there are other particles attached to the research tools; 4) the speed at which the solution is shaken when titrated is also a factor in the success of the titration or not.

CONCLUSION

Titration is a method of determining the concentration of a solution with a certain volume by using a solution of known concentration and measuring the volume with certainty. When the titration involves an acid-base titration, it is called an addition-alkalimetric titration. The solution whose concentration is known is called the titrant. If an acid is added to a base, the pH of the solution will increase, and if an acid is added to a base solution, the pH will decrease.

A standard solution is a solution prepared by accurately weighing a substance of high purity and dissolving it with a certain amount of solvent in a volumetric flask. A standard solution prepared in this way is called a primary standard solution, while a standard solution whose molarity is determined by a primary standard solution is called a secondary standard solution. Before being used in the experiment, the burette must be rinsed with the solution to be added so that there are no liquid/other substances remaining in the burette, so that the burette is neutral [14].

The equivalence point is the state at which the number of moles of acid reacts exactly with the number of moles of base. The end point of the titration is the point in the titration marked by a change in the color of the indicator. The change in pH in an acid-base titration is called the titration curve [6].

Factors Affecting Titration are: 1) concentration of analyte and titrant,The greater the concentration, the greater the change in pH in the equivalent point region, making it easier to determine the appropriate indicator; 2) the strength of a weak acid or weak base,The perfection of the reaction on a weak acid/base with a strong base/acid is determined by the value of Ka or Kb of the analyte. The greater the value of Ka or Kb, the greater the area of the change in pH at the equivalent point, thus determining the appropriate indicator; 3) indicator selection, the indicator used for changes in pH must be in the pH equivalence point region. Based on the calculation results obtained that the concentration of besarnya C6H8O7 is 0.584 M.

As a recommendation that future researchers should be more careful in carrying out the titration process and in paying attention to changes in indicator color.

REFERENCES

[1] Basset, J., Denney, R C., dkk., 1994, Buku Ajar Vogel Kimia Analisis Kuantitatif Anorganik, Jakarta: EGC.

[2] Chang, R. (2005). Kimi Dasar Konsep-Konsep Inti Edisi Ketiga Jilid 2. Jakarta: Erlangga

[3] Depkes RI,1979, Farmakope Indonesia Edisi III, Direktorat Jendral Pengawasan Obat dan Makanan, Jakarta.

[4] Depkes RI, 1995, *Farmakope Indonesia Edisi IV*, Direktorat Jendral Pengawasan Obat dan Makanan, Jakarta.

[5] Harjadi W. 1986. Ilmu Kimia Analitik Dasar. Jakarta: Gramedia.

[6] Hadioetomo, R. S., 1985, *Mikrobiologi Dasar-dasar Praktik*, Gramedia, Jakarta *cit* Ismiyati, 2004, Identifikasi Bakteri dari Tinja pasien diare di Rumah Sakit Islam Klaten, *Skripsi*, Fakultas Farmasi, UMS, Surakarta.

[7] Hughes, R.G (2008). Patient Safety and Quality: an evidence base handbook for nurses.Rochville MD: Agency for Healthcare Reseach and Quality Publication : http://www.ahrg.gov/qual/nurseshdbk/pdf

[8] Keenan. 1982. *Kimia Untuk Universitas*. Jakarta: Erlangga

[9] Petrucci, R. 1989. Kimia Dasar: Prinsip dan Terapan Modern. Jakarta: Penerbit Erlangga

[10] Petruševski, Vladimir M. dan Risteska, Keti. (2007). Behaviour of Phenolpthalein in Strongly Basic Media. Journal of Chemistry, 16 (4

[11] Ralph H. 2008. Kimia dasar: prinsip-prinsip & aplikasi modern jilid 2 (cet.9). Jakarta: Erlangga.

[12] Resenberg, J. 1985. Kimia Dasar. Jakarta: Penerbit Erlangga

[13] S, Syukri. 1999. Kimia Dasar Jilid 2. Bandung: Penerbit ITB

[14] Sudjadi, Abd Rohman, 2007, Analisis Kuantitatif Obat, Pustaka Pelajar Yogyakarta

[15] Sudjadi, Abd Rohman, 2012, *Analisis Farmasi*, Pustaka Pelajar Yogyakarta.

[16] Sukmariah. 1990. *Kimia Kedokteran Edisi 2*. Jakarta: Binarupa Aksara.