Experiment 2: common-ion effect and buffers

Science, Chemistry

EXPERIMENT 2: COMMON-ION EFFECT AND BUFFERS MARVILE REA R. FERRER1 1DEPARTMENT OF MINING, METALLURGICAL & MATERIALS ENGINEERING, COLLEGE OF ENGINEERING UNIVERSITY OF THE PHILIPPINES, DILIMAN, QUEZON CITY 1101, PHILIPPINES DATE SUBMITTED: DECEMBER 13, 2012 DATE PERFORMED: DECEMBER 07, 2012

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__________________________________ INTRODUCTION Monitoring the pH range of a laboratory reaction or a process is very important. It is important to keep the pH almost constant even when addition of acids or bases takes place. One can easily know if a solution is an acid or a base using a visual indicator. Indicators are organic dye added to a solution that changes color base on the concentration of H3O ions in the solution. Each color change corresponds into a pH value. Common indicators used in the laboratory are methyl orange, methyl red, bromthymol blue, neutral red and phenolphthalein. In this experiment, methyl orange and phenolphthalein are used. To keep the pH within the narrow range we used a process called buffer system. It resists changes in pH using conjugate acid-base pair. In doing this, concept of Le Chatelier’s Principle is used specifically the concept of common-ion effect. Common-ion effect is a behavior where the ionization of the weal electrolyte is prevented. There are common encountered type of solution that showed this behavior: a weak acid solution plus a soluble ionic salt of the weak acid or base. These are the solutions that are used in the experiment. In calculating the pH of the solution the experimenters used the following equations: Initial pH [pic] [pic] [pic] [pic] Buffer Solution (Henderson — Hasselbach Equation) [pic] [pic] Buffer Solution after the Addition of Acid or

Base [pic] [pic] [pic] [pic] In this experiment, the experimenters prepared solutions of HOAc, NaHOAc, NH3, NH4Cl, NaOH and HCl. When the needed solutions are already prepared the experimenters used visual indicators and observed their colors. After that the experimenters used the pH meter in each solution to know the solution's pH value. Next, buffer solutions are made and approximations of pH are made through their color then they used the pH meter and lastly they calculated the value using the equations above. In the second part of the experiment the solutions are divided into three equal parts, the experimenters didn't add anything in the third beaker; therefore the third beaker became the controlled set-up in the experiment while the other two became the experimental set-up. The activity aimed to understand and know more about the common-ion effect and buffers by doing calculations, observing the effects and distinguishing. DATA, RESULTS AND DISCUSSION In the first part of the experiment the experimenters used visual indicators and pH meter to know the pH of each solution. The experimenters used methyl orange and phenolphthalein as indicators in the experiment. The experimenters dropped the indicators in the solution and the color of the solution immediately changes. This change let us know the pH value of the solution. The methyl orange indicator is red when the solution's pH is 1 to 3. It is slightly red slightly yellow when the solution's pH is 3 to 4. 5 and yellow when the solution's pH is 5 or above. In the experiment solution 1's pH is 3 to 4. 5 and solution 2's is 5 or above. Phenolphthalein indicator is colorless when the solution's pH is 1 to 8 and 13. 0 beyond. It is faint pink when the solution's pH is 8 to 10 and bright pink when the solutions pH is 10 to 13. In the experiment solution 3's pH is 10-13 and solution 2’s is also the same. Table 1: pH using Visual Indicators and pH meter | Solution | Color of Solution | pH reading | | |+ Methyl Orange |+ Phenolphthalein | | | 1 | clear light pink | | 3. 04 | | 2 | Light yellow | | 4. 83 | | 3 | | clear violet | 10. 16 | | 4 | | clear violet | 8. 75 | In the second part of the experiment the solutions in the first part are used and divided into three equal parts. The experimenters added 3 drops of HCl in the first beaker and added 3 drops of NaOH in the second one. In the third beaker the experimenters didn’t add or do anything. Table 2: Effect of Strong Acid and Strong Base on Buffers | Solution | Estimated pH range | pH | | |+ Methyl Orange |+ Phenolphthalein | pH meter | Calculated | | 1 | A (+HCl) | 1 < x < 3. 04 | | 2. 47 | 2. 86 | | | B (+NaOH) | 3. 04 < x < 7 | | 3. 72 | 2. 88 | | | C | 3. 04 | | 3. 04 | 2. 87 | | 2 | A (+HCl) | 1 < x < 4. 83 | | 4. 45 | 4. 70 | | | B (+NaOH) | 4. 83 < x < 7 | | 4. 69 | 4. 78 | | | C | 4. 83 | | 4. 83 | 4. 74 | | 3 | A (+HCl) | | 7 < x < 10. 16 | 9. 45 | 11. 12 | | | B (+NaOH) | | 10. 16 < x < 14 | 10. 98 | 11. 14 | | | C | | 10. 16 | 10. 16 | 11. 13 | | 4 | A (+HCl) | | 7 < x < 8. 75 | 8. 53 | 9. 23 | | | B (+NaOH) | | 8. 75 < x < 14 | 8. 79 | 9. 30 | | | C | | 8. 75 | 8. 75 | 9. 26 | In the second part of the experiment the experimenters deal with buffer solution. They added drops of strong acid(HCl) and storing base(NaOH). Based on the recorded value the solution 2 and 4 causes a smaller change in pH than the solution 1 and 3. Solution 1 and 3 are composed of HOAc and NH3 alone while the solutions 2 and 4 are composed with salts of HOAc and NH3. Solutions 2 and 4 are already buffered solutions. Based on the definition of buffered solutions, they resist the change of the H+ ions causing the change in pH value. In the experiment we used different method to determine the pH of the solution. First we used visual indicators, colors are used in this method change in color is very significant. The method uses the perspective of the experimenters color and uses color range as their guide. This method is most probably has the tendency to have a human error or operative errors or personal errors. Second, we used the pH meter; the most delicate part of the pH meter is the tip where there is a glass part. The pH meter uses combination electrode that are used to measure pH, it incorporates both glass and reference electrodes in one body. It is important that the pH meter is properly calibrated to have a more accurate data. In using the pH meter it is unavoidable to have some errors a common error that happens in pH meter is acid errors. In acid errors, if it is a strong acid the measured pH is higher than the actual because the glass is saturated with H+ ions. These errors affect the data and it is best to do the last method, the calculation of the theoretical results where the error is minimal. SUMMARY AND CONCLUSIONS Always remember that the pH change is lower with a buffered solution than the original solution. It can be called a buffered solution if you add a salt of a base or acid and it resists the change of H+ ions. Calculations in the buffer solutions require different equations the Henderson — Hasselbach Equation is the commonly used equation. There are also different methods in determining the pH of a solution but it is still best to find it through calculations where fewer errors are present. The experiment done was a success, because they have shown that the pH change in buffered solution is smaller than the solution that isn’t buffered. REFERENCES 1Whitten, Kenneth W. 2007. Chemistry. 8/e. Thomson Brooks/Cole 2Harris, Daniel C. 2001. Quantitative Chemical Analysis. 7/e. W. H. Freeman and Company 3Quantitative Inorganic Analysis Laboratory

Manual 2007 edition. 2006. Institute of Chemistry. QC. 4Skoog, West, Holler. 2004. Fundamentals of Analytical Chemistry. 8/e. Thomson Learning Asia 5General Chemistry II Laboratory Manual 2007 edition. Institute of Chemistry. Q. C. APPENDIX A. Sample Calculations Solution 1 a. [pic] [pic] pH = 2. 86 b. [pic] [pic] pH = 2. 88 c. [pic] [pic] pH = 2. 87 Solution 2 (Buffered) a.(+HCl) [pic] pH = 4. 70 b.(+NaOH) [pic] pH = 4. 78 c. [pic] pH = 4. 74