The Buffering Capacities and pH of Solutions when Titrated with Sodium Hydroxide

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1-18-17

Plant Physiology and Lab
Spring 2017

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Lab #1
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Introduction

The purpose of this lab was to obtain knowledge of buffers and how buffering capacity affects pH change in various solutions. The buffering capacities of four liquids will be observed when sodium hydroxide (NaOH) is titrated to each liquid. NaOH is a strong base that has the potential to change the pH value of each liquid, overcoming the buffering capacities of the solutions.

Materials and Methods

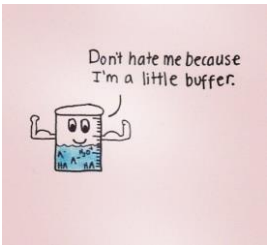
1 group of awkward students attempting to be confident on their first day of lab
1 professor to help them through the tears, sweat, pain and broken arms
Titration apparatus
pH meter
1 5000 µL pipetman
Four 100 mL beakers
200 mL of 0.25 M NaOH
20 mL of 0.25 M HCl
20 mL of 0.25 M TES
20 mL of deionized water 20 ml of Sprite soft drink
Phenolphthalein

Procedure

A burette on a titration apparatus was filled with a 0.25 M NaOH solution. 20 mL each of 0.25 M HCl, 0.25 M deionized water, 0.25 M TES, and 0.25 M Sprite, were individually titrated with the NaOH solution while connected to a pH meter probe., Each solution's pH value was individually recorded as NaOH was added in increments to observe the buffering capability. Phenolphthalein indicator was added to each solution to indicate rises in anion concentrations, and equilibrium shifts to the right, meaning alkaline conditions have been reached. Changes to the original procedure in the lab manual included adding NaOH in increments of 5 mL rather than 1 mL, and stopping the experiment for each solution at 30 mL 0.25 NaOH added, rather than stopping when a pH of 10 was reached.

Results and Discussion

Hydrochloric acid solution remained very stable until 20 mL of NaOH solution was added (Figure 1). The HCl solution pH jumped to 9.51 and remained there for a few seconds before jumping again to 11.57. At 20 mL NaOH, the buffering capacity of HCl quickly weakened, allowing a very basic solution to form. HCl showed strong buffering capabilities for solutions with high acidity.



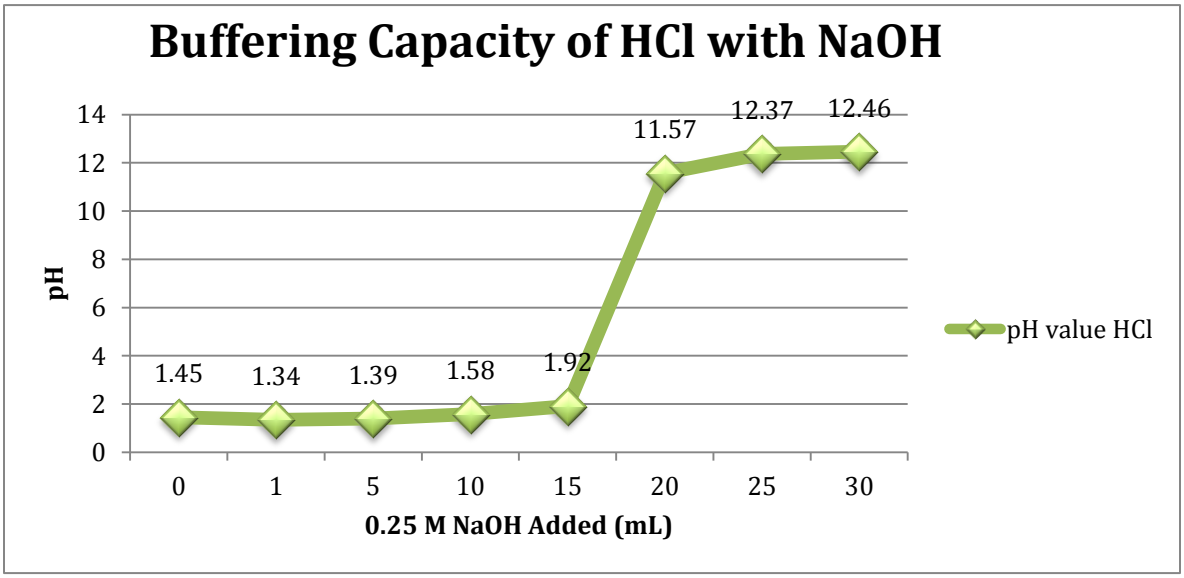


Figure 1 Response of HCl to NaOH

Deionized water was affected immediately by the addition of NaOH and stabilized in an alkaline state as early as 10 mL added (Figure 2). The buffering capacity of deionized water was less impressive than someone who does not enjoy studying plants; There is just zero capacity to be of interest, so moving on to more exciting discussion is preferable.

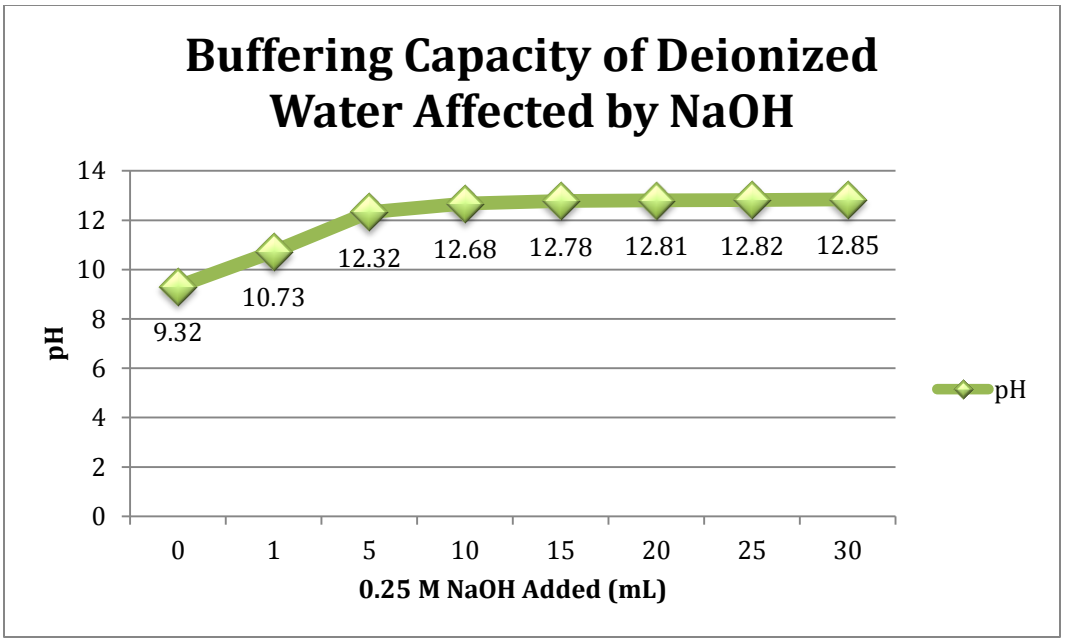


Figure 2 Response of Deionized Water to NaOH

TES held off NaOH pretty well until the 15 mL marker (Figure 3). An interlude as a middle linebacker would produce not-too-shabby results. TES would definitely be a buffering asset to any team that wishes to continue the title for slightly acidic to slightly alkaline.

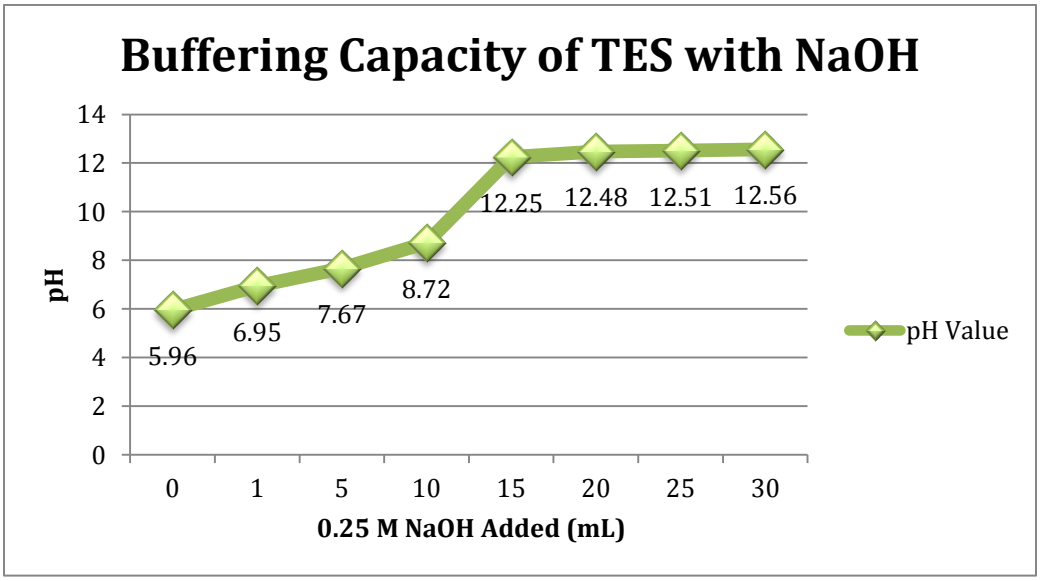


Figure 3 Response of TES to NaOH

Sprite, an acidic solution, showed a slight buffering capacity in the first 5 mL of NaOH added, but then lost is capacity to buffer further at the addition of 15 mL (Figure 4).

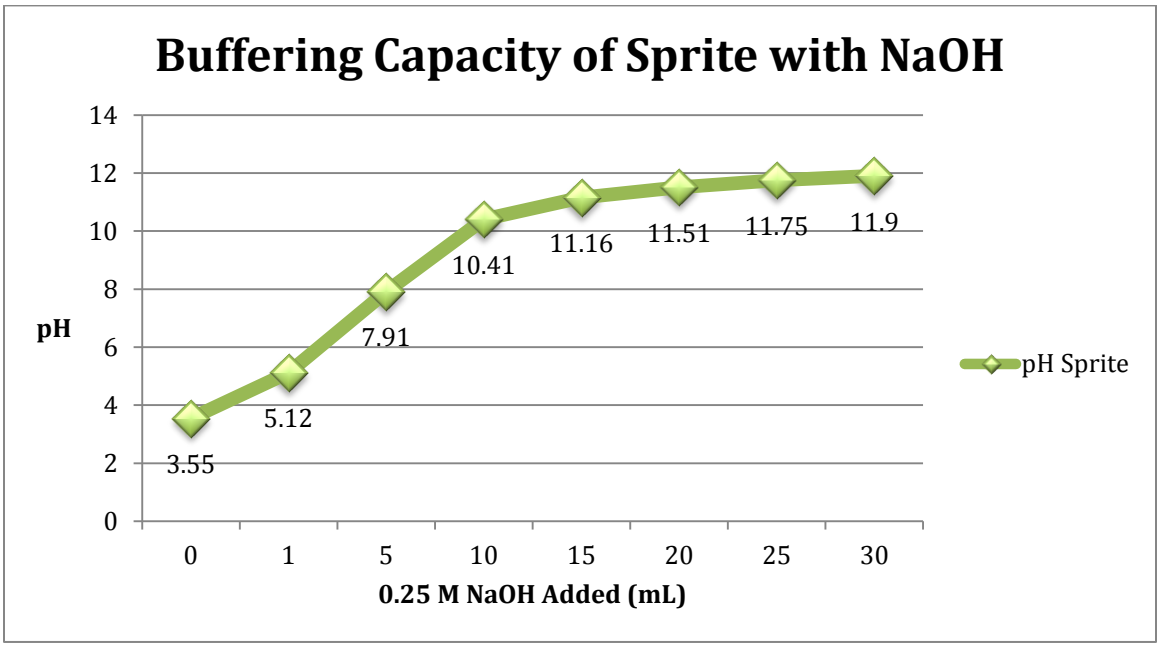


Figure 4 Response of Sprite to NaOH

Conclusion

Neither water nor Sprite would be adequate buffers for a solution to maintain its pH value. Their buffering capacities were affected quickly as each of the pH levels rose to very alkaline with small amounts of NaOH. TES and HCl were less affected than Sprite and Water by the addition of NaOH. According to this experiment TES would be a suitable buffer for a solution of pH between approximately 6 and 8. HCl appears to be an excellent choice for buffering very acidic solutions around a pH of 2 (Figure 5).

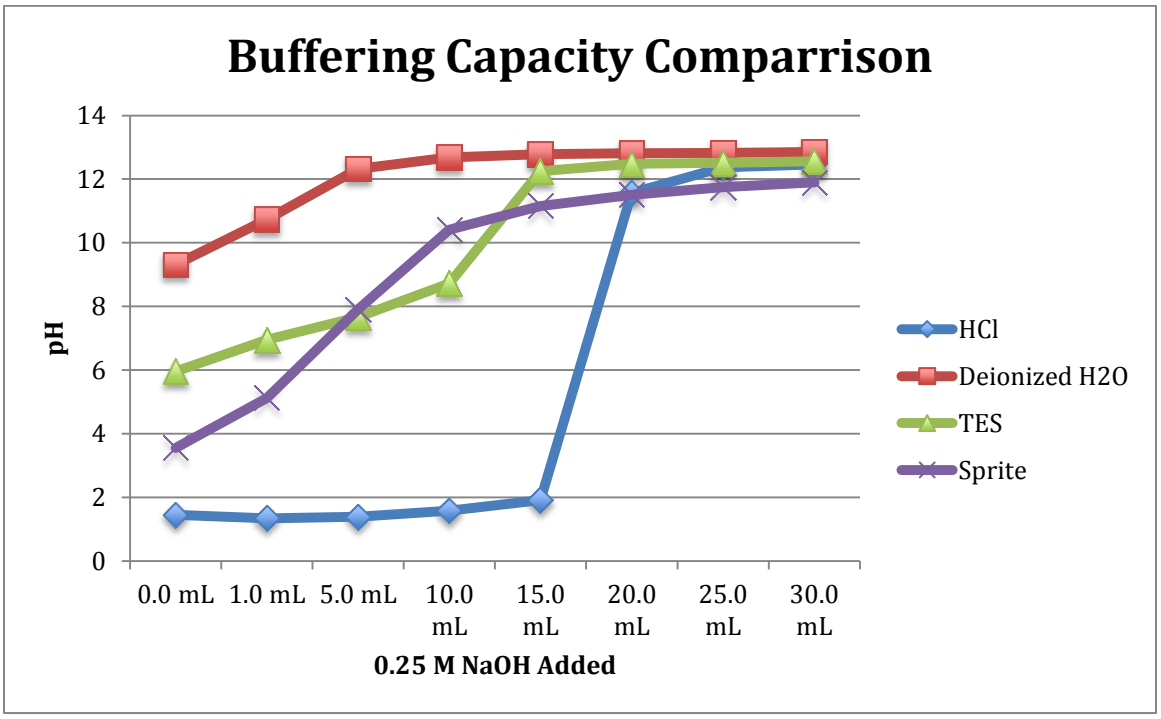


Figure 5 Comparison of Buffering Capacities of all Four Solutions Against NaOH