BUFFER SOLUTIONS

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Abstract
Buffer solutions are solutions widely used in chemistry and biology to help maintain pH levels in a stable manner. Buffers are mainly composed of acidic and basic substances that provide the pH stability necessary for various chemical processes or biological systems at a given pH value. It is important to study the principle and types of operation of buffer solutions, apply them in various scientific fields, as well as develop effective approaches to training. This article will analyze in detail about the properties of buffer solutions, the mechanism of operation and pedagogical approaches.

Keywords: Buffer solutions, PH stability, chemistry, biology, pedagogical approaches, educational methodology.

Introduction:
Buffer solutions are solutions that play an important role in chemistry and biology and help keep pH levels stable. They are mainly composed of acidic and basic substances, allowing control of various chemical processes by limiting changes in pH levels. Buffer systems also play an important role in many scientific and industrial fields, as well as in biological systems, such as maintaining intracellular pH stability. Understanding the performance of buffer solutions in the fields of chemistry and biology allows students to teach many other important aspects of the sciences. The properties of buffer solutions in maintaining a stable pH level, their participation in chemical reactions and their important role in biological systems are important in introducing students to this topic. For example, the activity of enzymes and other biological substances can be better under certain pH conditions, and buffer systems provide exactly this balance. For this reason, when teaching buffer solutions, it is very important to also teach their application in practice, not limited only to theoretical knowledge.

Along with traditional approaches to teaching buffer solutions in chemistry education, the application of new pedagogical methods and technologies will help students to effectively master this topic. Through Visual aids, simulations, laboratory work, and interactive techniques, students can be explained the mechanisms by which buffer solutions work. It is necessary to teach about the role of buffer systems in chemical and biological processes, develop scientific thinking of students and develop effective approaches to providing them with practical skills. Considering the properties of buffer solutions and the problems in their training, while analyzing the techniques used in the training of buffer systems, will help improve scientific education. This article will conduct a detailed analysis of the chemical properties of buffer solutions, pedagogical approaches and methods used in their training.

Literature review

Pedagogical approaches and methodologies in the teaching of buffer solutions have been studied and improved through various studies. It is very important to apply modern teaching techniques to effectively explain to students the mechanisms of operation of buffer systems. The literature lists several approaches and practical methods for teaching buffer solutions.

M. R. Smith and B. J. Johnson (2019) States in their research the importance of applying visual aids and interactive models to improve the understanding of buffer solutions in chemistry education. In their opinion, providing readers with graphs, diagrams, and animations to understand the operation of buffer systems will help develop their conceptual understanding [1]. With interactive modes, readers better understand how buffer solutions maintain pH stability and how these systems play a role in chemical processes.

O. V. Nikitin and A. S. In contrast, research by Filippov (2017) considers the use of interactive technologies in the teaching of buffer solutions. According to their work, practical laboratory training in teaching buffer solutions, as well as interactive teaching to students through simulations and online platforms, will help students better master the subject. These approaches are effective in developing students ' scientific thinking and teaching them to solve problems independently [2]. C. M. Richards and L. B. Williams (2021) studies the role of buffer systems in biological processes, arguing that buffer solutions are important not only in chemistry, but also in biology. According to their study, explaining the importance of buffer systems in maintaining pH stability in biological organisms through examples in teaching will help students better understand the complexities of biological processes. The use of

real-life examples in teaching buffer systems ' interactions with biological systems increases student interest and allows for deeper mastery of the subject [3].

Also, A. T. A study by Novak (2020) showed the effectiveness of using laboratory experiments and simulations in teaching buffer systems. In their opinion, the role of practical laboratory work in teaching the pH stability of buffer systems is incomparable. Showing readers the performance of buffer systems not only in theory but also in practice makes it easier to understand how pH systems work [4]. In addition, S. R. Franklin (2018) emphasizes in his study the need to apply customized and individual approaches to teaching students buffer systems. According to his work, each student has specific learning needs, so teachers need to adapt interactive techniques and individual activities to the specific characteristics of the student. This, in turn, increases the level of student assimilation [5].

Analyses and Results

Most analytic reactions are conducted in aqueous solutions at an exact pH value without changing the environment of the solution. For this, most analytical reactions are carried out in a buffer solution environment. If a solution of 0.01 n acid is formed in 1 L of pure water, the concentration of H+ ions in this solution is 10^{-2} g mol/L ($-lg0,01=2$), in which the pH of the solution is reduced from 7 to 5.

If similarly 0.01 N NaOH is dissolved in 1 l of water the pH of the solution increases from 7 to 12.

Many reactions, when carried out in water, may result in changes in its pH not going all the way to the end of the reactions, or in cases of precipitate formation as a result of the reaction. Therefore, in the conducting system, the change in the pH of the reaction medium is of great importance.

To do this, it is necessary to add such a substance to the reaction environment, as a result of which, if the pH of the solution changes in a very small amount, these additives are called regulators or buffer solutions.

An example of a buffer solution is the following mixtures of solutions:

1. A mixture of a salt solution consisting of a strong alkali with weak acid and weak acid:

$CH_3COOH \qquad CH_3COONa \left\{ \begin{array}{l} CH_3COONa \rightarrow CH_3COO^- + Na^+ \\ CH_3COOH \quad CH_3COO^- + H^+ \end{array} \right.$

A mixture of such solutions forms an acidic environment (pH<7). A mixture of a salt solution made up of weak alkali and weak Alkali as well as strong acid due to the increase in H+ ions in the solution:

NH_4Cl NH_4OH $NH_4Cl \rightarrow NH_4^+ + Cl^-$

$NH_4OH \rightarrow NH_4^+ + OH^-$

In such solutions, the mixture forms an alkaline environment (pH>7). Since solutions increase OH-ions, different pH can be organized according to the concentration and added volumes of these solutions.

Calculation of the pH of buffer solutions. For example

$$\begin{cases} CH_3COOH \\ CH_3COONa \end{cases}$$
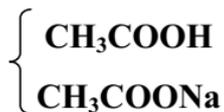
we take the solution. The acidic environment in this solution depends on the dissociation of CH3COOH:

$CH_3COOH \quad CH_3COO^- + H^+$

By applying the law of effect of masses we find it the dissociation constant:

$$K_{CH_3COOH} = \frac{[CH_3COO^-] \cdot [H^+]}{[CH_3COOH]}$$

From this we find the concentration of the volorode ion:

$$[H^+] = K_{CH_3COOH} \cdot \frac{[CH_3COOH]}{[CH_3COO^-]} \quad (1)$$

Since acetic acid is weak, it dissociates very little, CH3COONa is completely dissociated as a strong electrolyte, and at its expense, CH3COO - ions are abundant in the solution, further interfering with the dissociation of acetic acid. The dissociation chromagen CH3COOH is practically equal to its total concentration [CH3COOH] = C acid. For this reason [CH3COO -] = Csalt

We put the value of these in Equation (1) :

□

$$[H^+] = K_{кислота} = \frac{C_{кислота}}{C_{туз}}$$

туз

When we convert the logarithm of this equation into a negative gesture

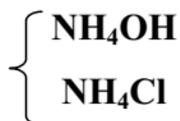$$- \lg[H^+] = - \lg K_{кислота} - \lg \frac{C_{кислота}}{C_{туз}}$$

□

туз

$$\begin{cases} -\lg [H^+] = pH \\ -\lg [K_{kislota}] = rK_{kislota} \end{cases}$$

$$pH = pK_{\text{кислота}} - \lg \frac{C_{\text{кислота}}}{C_{\text{туз}}}$$

From this:

Through the same formula, Buffer solutions with an acidic environment are pH ni.

PHi calculation of buffer solutions with an alkaline environment.

As an example, let's consider the following buffer solution –

$$\begin{cases} NH_4OH \\ NH_4Cl \end{cases}$$

This buffer is formed in solution due to the practical environment NH_4OH.

$NH_4OH \ NH_4^+ + OH^-$

We apply the law of the effect of masses on the dissociation of alkali and find the dissociation constant:

$$K_{\text{ишкор}} = \frac{[NH_4^+] \cdot [OH^-]}{[NH_4OH]}$$

From this equation we find [OH -]:

$$[OH^-] = K_{\text{ишкор}} \cdot \frac{[NH_4OH]}{[NH^+]}$$

NH4OH is weakly alkaline and poorly dissociated, NH4Cl is completely dissociated as a strong electrolyte. Noting that

[NH4OH] =Cishq.

$[NH_4^+]$ =C$_{tuz}$ it can be written as.

From this:

$$[OH^-] = K_{\text{ишкор}} \cdot \frac{C_{\text{ишкор}}}{C_{\text{туз}}}$$

Moving the logarithm of the equation to the negative.

$$-\lg[OH^-] = -\lg K_{\text{ИШК}} + (-\lg \frac{C_{\text{ишкор}}}{C_{\text{Туз}}})$$

$$pOH = pK_{\text{ишкор}} - \lg \frac{C_{\text{ишкор}}}{C_{\text{туз}}}$$

$$pH = pK+1$$

But pH = 14-pOH, using this we find the PH:

$$pH = 14 - pK_{ишкор} + \lg \frac{C_{ишкор}}{C_{туз}}$$

туз

Through this formula is pHi of buffer solutions that have an alkaline environment.

Conclusion

Buffer solutions are systems that play an important role in keeping pH levels stable in chemistry and biology. Their distinctive features and mechanism of Operation help ensure the correct and effective implementation of scientific processes. The fact that buffer solutions provide pH stability is of great importance not only in chemical reactions, but also in biological systems. Therefore, effective pedagogical methods and approaches in the teaching of buffer systems allow students to better understand the functioning of these systems. Literature analysis suggests that visual, interactive, and practical approaches can be successful in teaching buffer systems. Graphs, diagrams, online simulations and laboratory work are effective tools in explaining the properties of buffer systems to students, helping to develop their scientific thinking. Also, explaining the importance of buffer systems in biological systems, such as maintaining intracellular pH stability, leads to students ' deeper mastery of the subject. The application of modern pedagogical technologies in the teaching of buffer solutions allows students to master scientific knowledge not only at a theoretical, but also at a practical level. At the same time, interactive and personalized approaches increase the effectiveness of education in accordance with the individual needs of each student. In general, improving pedagogical techniques in the process of teaching buffer systems increases the effectiveness of students ' scientific reading and encourages them to gain more in-depth knowledge in the fields of chemistry and biology.

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