

# Buffer Solutions

Created: Friday, 30 September 2011 09:27 | Published: Friday, 30 September 2011 09:27 | Written by [Super User](#) | [Print](#)

## Introduction

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buffer solutions\_01

Preservation of the solutions of particular pH is generally difficult as when they are kept open absorb atmospheric carbon dioxide and alters the pH. If they are kept in closed glass bottles, they react with the alkaline impurities present in the bottle and again alter the pH of the solution.

## buffer solutions\_02

## Buffer Solutions

A buffer solution is defined as the solution that resists changes in its pH value even when small amount of the acid or the base are added to it.

## Types of Buffer Solution

There are two types of buffer solutions. These are:

(i) **Solution containing single substances:** The solution of the salt of a weak acid and weak base, e.g., ammonium acetate ( $\text{CH}_3\text{COONH}_4$ ) acts as a buffer.

(ii) **Solution containing mixtures:** These are mixtures of acid or base with salts.

**Acidic buffer:** It is the solution of a mixture of weak acid and a salt of this weak acid and a strong base.

Example:  $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$ .

**Basic buffer:** It is a solution of a mixture of a weak base with the salt of this weak base with a strong acid.

## Buffer Action

The property by virtue of which a buffer solution resists any change in its pH value even on adding a small amount of the acid or base to it is called buffer action.

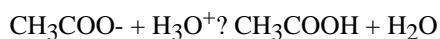
## Buffer Action of Ammonium Acetate

Ammonium acetate like all other salts is almost completely dissociated in the aqueous solutions as follows:



Thus in solutions, there is excess of  $\text{CH}_3\text{COO}^-$  ions and  $\text{NH}_4^+$  ions. On adding

few drops of HCl to this solution the  $\text{H}_3\text{O}^+$  ions produced combine with  $\text{CH}_3\text{COO}^-$  and gives  $\text{CH}_3\text{COOH}$



Since concentration of  $\text{H}_3\text{O}^+$  ions does not change practically, the pH of the solution remain almost constant.

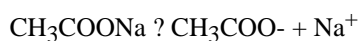
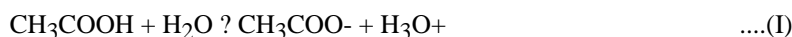
Similarly when a few drops of base like NaOH are added to the above solution, the  $\text{OH}^-$  ions given by the base combine with  $\text{NH}_4^+$  ions.



Thus  $\text{OH}^-$  ion concentration and hence  $\text{H}_3\text{O}^+$  ion concentration remains almost constant.

## Buffer Action of Acidic Buffer

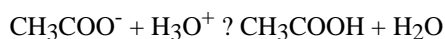
In the acidic buffer containing  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$ , acetic acid dissociates to a small extent whereas sodium acetate is almost completely dissociated in the aqueous solution as follows:



By common ion effect the ionisation of  $\text{CH}_3\text{COOH}$  is further suppressed.

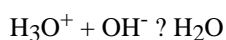
Thus in the solution, there are excess of acetate ( $\text{CH}_3\text{COO}^-$ ) and small amount of  $\text{H}_3\text{O}^+$  ions.

When a few drops of acid are added  $\text{H}_3\text{O}^+$  ions given by acid combine with  $\text{CH}_3\text{COO}^-$  ions to form weakly ionised molecules of  $\text{CH}_3\text{COOH}$ .



Similarly on addition of few drops of base

$\text{OH}^-$  ions combine with  $\text{H}_3\text{O}^+$  ions already present to form weakly ionised molecules of  $\text{H}_2\text{O}$ .



As the  $\text{H}_3\text{O}^+$  ions are used up, the equilibrium (I) shifts to right as a result more  $\text{CH}_3\text{COOH}$  dissociate. So the  $\text{H}_3\text{O}^+$  ion concentration as well as pH of the solution does not change.

## Henderson- Hasselbalch Equation

pH of an acidic or a basic buffer is calculated from Henderson - Hasselbalch equation

For acidic buffers,  $\text{pH} = \text{pK}_a + \log [\text{salt}]/[\text{acid}]$

For basic Buffers,  $\text{pOH} = \text{pK}_a + \log [\text{salt}]/[\text{base}]$

Dilution of a buffer solution does not affect its pH, but pH of a buffer changes with temperature.

## Buffer Capacity

buffer solutions\_06

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### Uses of Buffer solution

(i) Buffer solutions are used in colorimetry to determine pH of unknown solutions.

(iv) Buffer solutions are used for fermentation of alcohols, tanning of leather, electroplating, manufacture of sugar, paper manufacturing etc.

(vi) Human blood consists of a buffer system of carbonic acid + sodium bicarbonate. It maintains the constant pH (7.4) of blood in human body.

## How does human blood maintain its buffer?

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### Reference Links

- [http://en.wikipedia.org/wiki/Buffer\\_solution](http://en.wikipedia.org/wiki/Buffer_solution)
- <http://www.chem.purdue.edu/gchelp/howtosolveit/equilibrium/buffers.htm>
- <http://www.sparknotes.com/chemistry/acidsbases/buffers/section1.html>
- <http://www.chemguide.co.uk/physical/acidbaseeqia/buffers.html>

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