Status: Currently Official on 14-Feb-2025
Official Date: Official as of 01-May-2018
Document Type: Reagents
DocId: GUID-0E4CE941-0762-456C-94B0-9209A58834FC_3_en-US
DOI: https://doi.org/10.31003/USPNF_R2999_03_01
DOI Ref: l3wvn

BUFFER SOLUTIONS

1. DEFINITION

A solution is said to be buffered if it resists changes in the activity of an ion on the addition of substances that are expected to change the activity of that ion. Buffers are substances or combinations of substances that impart this resistance to a solution. Buffered solutions are systems in which the ion is in equilibrium with substances capable of removing or releasing the ion.

2. BUFFER CAPACITY

It refers to the amount of material that may be added to a solution without causing a significant change in ion activity. It is defined as the ratio of acid or base added (in gram-equivalents/L) to the change in pH units. The capacity of a buffered solution is adjusted to the conditions of use, usually by adjustment of the concentrations of buffer substances.

3. USES

Buffers are used to establish and maintain an ion activity within narrow limits. The most common systems are used for the following:

1. To establish hydrogen-ion activity for the standardization of pH meters
2. In the preparation of dosage forms
3. In analytical procedures
4. To maintain stability of various dosage forms

Buffers used in physiological systems are carefully chosen so as not to interfere with pharmacological activity of the medicament or normal function of the organism.

4. STANDARD BUFFER SOLUTIONS

Standard solutions of definite pH are readily available in buffer solutions prepared from the appropriate reagents.

Buffer solutions, buffer tablets, and buffer solids may be obtained from commercial sources in convenient prepackaged form.

4.1 Preparation

Previously dry the crystalline reagents at 110°–120° for 1 h, except for boric acid and sodium acetate trihydrate.

Where water is specified for solution or dilution of test substances in pH determinations, use carbon dioxide-free water.

Store the prepared solutions in chemically resistant, tight containers such as Type 1 glass bottles. Use the solutions within 3 months.

Standard buffer solutions for various ranges between pH 1.2 and 10.0 may be prepared by appropriate combinations of the solutions described herein, used in the proportions shown in the table below.

The volumes shown in the table below are for 200 mL of buffer solution, except for *Acetate Buffer* where the volumes are for 1000 mL of buffer solution and for *Citrate Buffer* where the volumes are for 100 mL of buffer solution.

1. *Hydrochloric Acid, 0.2 M and Sodium Hydroxide, 0.2 M*: Prepare and standardize as directed in *Volumetric Solutions*.
2. *Potassium Biphthalate, 0.2 M*: 40.85 g/L of potassium biphthalate in water
3. *Potassium Phosphate, Monobasic 0.2 M*: 27.22 g/L of monobasic potassium phosphate in water
4. *Boric Acid and Potassium Chloride, 0.2 M*: 12.37 g/L of boric acid and 14.91 g/L of potassium chloride in water
5. *Potassium Chloride, 0.2 M*: 14.91 g/L of potassium chloride in water
6. *Acetic Acid, 2 N*: Prepare and standardize as directed in *Volumetric Solutions*.
7. *Citric Acid, 0.1 M*: 21.01 g/L of citric acid in water
8. *Sodium Citrate, 0.1 M*: 29.41 g/L of sodium citrate dihydrate in water

Composition of Standard Buffer Solutions

Hydrochloric Acid Buffer

Place 50 mL of the potassium chloride solution in a 200-mL volumetric flask, add the specified volume of the hydrochloric acid solution, then add water to volume.

pH	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2
0.2 M HCl, mL	85.0	67.2	53.2	41.4	32.4	26.0	20.4	16.2	13.0	10.2	7.8

Acid Phthalate Buffer

Place 50 mL of the potassium biphthalate solution in a 200-mL volumetric flask, add the specified volume of the hydrochloric acid solution, then add water to volume.

pH	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
0.2 M HCl, mL	49.5	42.2	35.4	28.9	22.3	15.7	10.4	6.3	2.9	0.1

Neutralized Phthalate Buffer

Place 50 mL of the potassium biphthalate solution in a 200-mL volumetric flask, add the specified volume of the sodium hydroxide solution, then add water to volume.

pH	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8
0.2 M NaOH, mL	3.0	6.6	11.1	16.5	22.6	28.8	34.1	38.8	42.3

Phosphate Buffer

Place 50 mL of the monobasic potassium phosphate solution in a 200-mL volumetric flask, add the specified volume of the sodium hydroxide solution, then add water to volume.

pH	5.8	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0
0.2 M NaOH, mL	3.6	5.6	8.1	11.6	16.4	22.4	29.1	34.7	39.1	42.4	44.5	46.1

Alkaline Borate Buffer

Place 50 mL of the boric acid and potassium chloride solution in a 200-mL volumetric flask, add the specified volume of the sodium hydroxide solution, then add water to volume.

pH	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0
0.2 M NaOH, mL	3.9	6.0	8.6	11.8	15.8	20.8	26.4	32.1	36.9	40.6	43.7

Acetate Buffer

Place the specified amount of sodium acetate ($NaC_2H_3O_2 \cdot 3H_2O$) in a 1000-mL volumetric flask, add the specified volume of the acetic acid solution, then add water to volume, and mix.

pH	4.1	4.3	4.5	4.7	4.9	5.1	5.2	5.3	5.4	5.5
pH (measured)	4.10	4.29	4.51	4.70	4.90	5.11	5.18	5.30	5.40	5.48
$NaC_2H_3O_2 \cdot 3H_2O$, g	1.5	1.99	2.99	3.59	4.34	5.08	5.23	5.61	5.76	5.98
2 N CH_3COOH, mL	19.5	17.7	14.0	11.8	9.1	6.3	5.8	4.4	3.8	3.0

Citrate Buffer																
Mix *0.1 M Citric Acid* with *0.1 M Sodium Citrate* in the proportions given below.																
pH	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2
0.1 M Citric Acid, mL	82.0	77.5	73.0	68.5	63.5	59.0	54.0	49.5	44.5	40.0	35.0	30.5	25.5	21.0	16.0	11.5	8.0
0.1 M Sodium Citrate, mL	18.0	22.5	27.0	31.5	36.5	41.0	46.0	50.5	55.5	60.0	65.0	69.5	74.5	79.0	84.0	88.5	92.0

Auxiliary Information - Please check for your question in the FAQs before contacting USP.

Topic/Question	Contact	Expert Committee
BUFFER SOLUTIONS	Margareth R.C. Marques Principal Scientific Liaison	HDQ Headquarters

Most Recently Appeared In:
Pharmacopeial Forum: Volume No. PF 43(1)

Current DocID: GUID-0E4CE941-0762-456C-94B0-9209A58834FC_3_en-US
Previous DocID: GUID-0E4CE941-0762-456C-94B0-9209A58834FC_1_en-US
DOI: https://doi.org/10.31003/USPNF_R2999_03_01
DOI ref: l3wvn