Hard water in chemistry

Science, Chemistry

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(A) Experiment

Name: Titration

Required items:

A beaker

A burette

Phenolphthalein

HCL solution

calcium hydroxide solution

Procedure

20 ml of a solution of HCl is to be placed in a beaker.

Add a couple of drops, 3 to be precise of phenolphthalein to the beaker. It is to be noted that phenolphthalein has a pink colouring in bases but a transparent/ clear colour in acids.

Fill a burette with calcium hydroxide.

Calcium hydroxide is slowly added drop by drop to the acid, HCL until the solutions starts turning pink. This shows that the acid is being neutralised, that is, a neutral pH of 7 is being achieved.

The reading of the burette is recorded. That is the amount of Calcium hydroxide required to neutralise 20ml of 0. 05M HCL

All the steps are to be repeater at least three times to achieve a more accurate reading. The more number of times the experiment is performed the more the accurate the reading.

(B) Laboratory sheet

Readings

Volume of HCL

Volume of calcium hydroxide

1

20

48

2

20

53

3

20

51

4

20

52

5

20

52

6

20

49

7

20

50

8

20

51

9

20

50

10

20

48

11

20

52

12

20

53

13

20

48

14

20

48

15

20

51

average

20

50. 4

(C) How to calculate the concentration of calcium hydroxide

If 50. 4 ml (average) of unknown Ca (OH)2 neutralized 25. 0ml of 0. 05M HCl.

How to determine the concentration of Ca (OH)2

Firstly, write the chemical equation of the reaction

Ca(OH)2(aq)+ HCl(aq)------CaCl2+H2O

Secondly, balance the equation

Ca(OH)2(aq)+2HCl(aq)------CaCl2+2H2O

Thirdly, extract information that is relevant from the experiment performed

$Ca(OH)_2$ V = 50mL (average reading) M = ?

HCl V = 20. 0 mL, M = 0. 05 M

Fourthly, convert millilitres to litres

$Ca(OH)_2$ V = 0. 05 L , M = ?

HCl V = 0. 020 L, M = 0. 05 M

Fifthly, Calculate moles HCL

n(HCL) = M x V = 0. 05 moles/L x 0. 020L = 1 x 10^{-3} moles

sixthly, From the balanced chemical equation find the molar ratio

$Ca(OH)_2$: HCl = 1: 2

Seventhly, find the number of moles of $Ca(OH)_2$ that were titrated.

$Ca(OH)_2$: HCl is 1: 2,

so number of moles $Ca(OH)_2$ = n(HCl)/2 = 0. 0005 moles at neutralization.

Lastly, Calculate the concentration of $Ca(OH)_2$:

M = n ÷ V n = 0. 0005 mol, V = 0. 05L

Molarity $Ca(OH)_2$ = 0. 0005 moles ÷ 0. 0504 L = 0. 00992 moles/L or 0. 0992 M

Describe the preparation of 100mL phosphate buffer at pH 7. 4, starting from H_3PO_4 solution (1M) and KH_2PO_4 (FW 136 g/mol).

Preparation

Buffer strength of 1M at 7. 4 pH is achieved by mixing 3. 12 grams of monosodium phosphate monohydrate and 20. 74 g of disodium phosphate hepta hydrate to 100 ml water.

Calculation

Below is the initial ionization

H_3PO_4 --------> H^+ + $H_2PO_4^-$

K1 =

Calculations of relative amounts are obtained through their normalization.

Molarities are found through the following equation.

H_3PO_4 + $H_2PO_4^-$ (monosodium phosphate monohydrate)

PO_4^{3-} + HPO_4^{2-} (disodium phosphate hepta hydrate)

The pKs that were used are as follows

2. 15

6. 87

12. 32.

By using the pH and all the above pKs of phosphoric acid, the ratios of each of the phosphoric pairs are calculated. By using their molecular weights along with the buffer strength the required amount of each is calculated.

What is the pH of a solution resulting from mixing 100 mL 0. 5M NaOH with 500 mL 0. 3M HCl?

HCl + NaOH --> H_2O + NaCl

If HCl is mixed with NaOH it neutralises at a ratio of 1: 1 . Hence, find mmol mixed of each to check which one is more

HCl = 0. 3 x 0. 5 = 0. 15 mmol

NaOH = 0. 5 x 0. 1 = 0. 05 mmol

HCL excess = 0. 15 – 0. 05 = 0. 1 mmol

Total volume of solution= 0. 6 L

Number on M of Hcl= 0. 1/0. 6= 0. 167

pH = -log[H_3O^+] = -log[HCl]

hence

pH = -log(0. 167) = 0. 77 really acidic

SHORT ESSAY ON HARDWATER

Introduction

Water with quite a high content of mineral is known as hard water. We sometime do experience soap solutions forming a white scum rather than lather, this is due to the water being high in mineral content. This occurs mainly due to 2+ ions change the properties of the soap and performs a white scum. Hence one may define hardness as the capacity of water that doesn’t allow the formation of the any lather of the soap.

Hard water is also responsible for the formation of deposits that effect plumbing. The clog formation may include many compounds but the main reason that causes its formation is hard water.

Hardness is expressed in terms of calcium carbonate.

Soft water is usually contains 75 milligrams per litter (mg/l)

Hard water above 150 mg/l

76-150 mg/l is considered as moderately hard

Origin

C02 and water reacts with each other carbonic acid. Carbonic acid usually exists as a bicarbonate ion at a normal environmental pH. (figure 1) . Extensive limestone deposits have been built up over the years by microorganism by taking up of this carbonic acid. Groundwater acquires calcium and bicarbonate ions and hence becomes " hard". If the bicarbonate ions are a lot then they may form a precipitate like that in pipes. (Figure 2)

Temporary hardness

Temporary hardness is referred to such water that can lose its hardness by simply boiling it. Boiling water gives rise to the following reaction

$2 HCO_3^- \rightarrow CO_3^{2-} + CO_2$

CO_3^{2-} reacts with Calcium or Magnesium ions. This leads to the formation of a precipitate. This precipitate is actually calcium and magnesium carbonates which are insoluble in nature.

Permanent hardness

Water that doesn't lose it hardness by boiling is known to be permanently hard. This is mainly due to the presence of chloride or sulphate, that is, it contains anions.

Traditional water softening

Traditional water softening is usually carried out through a process that is known as ion exchange. Ion exchange refers to the process in which chloride and sodium ions exchange places. These ions are fixed comparatively loosely to something called a zeolite. Zeolite may be understood referring to figure 3 in the appendix,

Alternative methods

Although they is quite some proof that electromagnetic devices may be useful in preventing the formation of scale but due to lack of testing and scientific proof one may not be able to give an assuredly claim it.

As softening of water is of high importance many companies and organisations have claimed to come up with really good and effective solutions and have also claimed to be chemical free. In actual most of them are just claiming economic advantage by selling their product or process without actually carrying on an in depth research and coming out with an effective solution.

Health Concerns and issue

Some researchers believe that hard water may lead to potential cardiac risk but there is no such evidence to actually prove this aspect. Hard water has not so far been termed as unhealthy but it has always been emphasized that soft water is more preferable to drink.

Negative aspect

They are as such no health concerns but they surely are a few negative aspects of hard water. Some are as follows:

A grey staining may occur when clothes are washed

A scum may appear on water after using soap. This also reduces the lathering of soap as mentioned above.

Due to hard water, you may seem a formation of scale on heating elements along with heating boilers (usually the electric ones). You may also experience a white precipitate (scale) formation in kettles and all things used to boil water in.

Hard water may also lead to the reduction of water supply in houses especially hot water due the formation of scale.

Conclusion

Although hard water doesn’t have much health concerns its negative aspects are of great concern and an effort should be made for the softening of water which is not only effective but also cheap along with having no unhealthy impact.

APPENDIX

Figure 1

Figure 2

Figure 3

References

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