Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(3): 2445-2451
Received: 16-03-2018
Accepted: 22-04-2018

Sushant Bhardwaj
College of Agricultural Engineering and Technology, CCSHAU, Hisar, Haryana, India

Arvind
Vaugh Institute of Agricultural Engineering & Technology, SHUATS, Allahabad, Uttar Pradesh, India

Amandeep Singh
College of Agricultural Engineering and Technology, CCSHAU, Hisar, Haryana, India

Narender Kumar
College of Agricultural Engineering and Technology, CCSHAU, Hisar, Haryana, India

Correspondence
Sushant Bhardwaj
College of Agricultural Engineering and Technology, CCSHAU, Hisar, Haryana, India

Effect of different water quality parameters on acid requirement to lower water pH

Sushant Bhardwaj, Arvind, Amandeep Singh and Narender Kumar

Abstract
Drip irrigation system has been widely used as an efficient application method. But performance of a drip irrigation system using poor quality water is mainly limited by emitter clogging and this discourages farmers to use drip irrigation system as emitter clogging reduce irrigation efficiency. The paper gives the result of laboratory study conducted to determine the amount of acid required to lower water pH to desired level to prevent emitter clogging. Three ground samples of different pH and chemical composition were used. Three acid HCl (36.5%conc) H_2SO_4 (98.08% conc.) and H_3PO_4 (88% conc.) were used to bring the pH to 4.0. Amount of acid required depends on strength of acid used, buffering capacity of irrigation water, pH of irrigation water and on target pH of water. Functional relationships are developed to determine the amount of different acids required per 1000 litre of water.

Keywords: water quality, requirement, lower water pH

Introduction

Drip irrigation is one of the best irrigation method in comparison to other irrigation methods as drip irrigation require less amount of water over the growing season in comparison to other methods and the potential exits for significantly improving fertilizer management. Most of advantages regarding drip irrigation system are affected by emitter clogging which is directly related to water quality. Emitter clogging reduces distribution uniformity and irrigation efficiency. Emitter clogging is classified into three main categories -: (1) physical (2) chemical (3) biological clogging. Physical clogging is caused by suspended inorganic material like sand, silt, clay and plastic material Adin (1978) [1]. Physical clogging can be prevented by filtration. The main filter commonly used in drip irrigation is screen filter which are simple, economical and easy to manage. Biological clogging is caused by biological and bacterial growth. It can be prevent by chlorination. Chemical clogging is caused by mineral precipitation David *et al.* (1982). The most common deposits are calcium or magnesium carbonates and iron oxide. Precipitation occurs more readily in water with a pH above 7.0. Acidification can reduce chemical clogging of emitters. Precipitation of these compounds can be prevented by continuous injection (whenever the system is operating) of a small amount of acid to maintain water pH just below 7.0. A more popular control method is to remove deposits as they are formed by periodic injection of a greater volume to acid. Enough acid should be injected continuously for 45 to 60 minutes to reduce the water pH to 4.0or 5.0. Phosphoric acid (which also supplies phosphate to the root zone), sulphuric acid, or hydrochloric (muriatic) acids are commonly used. The selection of a specific acid depends on cost and availability, water quality, the severity of clogging, and nutrient needs of the crop Buck *et al.* (1979) [2]. The amount of acid required to treat a system depends on (1) the strength of the acid being used, (2) the buffering capacity of the irrigation water and (3) the pH of the irrigation water. The required pH of the irrigation water (target pH) depends on the severity of mineral deposits. Volume of acid required to bring pH of irrigation water to target level can be estimated by titration test. So emitter clogging problem can be reduced to some extent by acidification. The emitter clogging can be reduced by lowering water pH to a desired level acidification. The different acids needed to bring source water pH to desired level can be determined by titration test. So emitter clogging problem can be reduced by acidification and drip irrigation can be utilised by reducing emitter clogging.

The present study achieved with the following objectives i.e. Determination of amount of acid required to lower water pH to given target level and Dentification of role of different water quality parameters on acid requirement to lower water pH.

Material and Methods

Groundwater sample

Groundwater samples of different pH and chemical composition were received from Soil and Water Testing Laboratory of Department of Soil and Science. Determination of acid required for treatment of chemical clogging in drip irrigation system was achieved with the help of received samples (Appendix A).

Preparation of acid solution

To determine the amount of acid required to lower pH to a desired level. Acid solution of hydrochloric acid, sulphuric acid and phosphoric acid of 0.01N were prepared.

For preparation of 0.01 N HCl solution following methodology was adopted:

- 86.27 ml of concentrated HCl (36.5%) was taken and distilled water was added to make 1000 ml (1N HCl)
- 100 ml 1N HCl and distilled water was added to make 1000 ml (0.1N HCl)
- 100ml 0.1N HCl and distilled water was added to make 1000ml (0.01N HCl)

For preparation of 0.01N H_2S0_4 Following methodology was adopted:

- 27.17ml of concentrated H_2S0_4 (98.08%) was added in distilled water to make 1000 ml (1N H_2S0_4)
- 100 ml 1N H_2S0_4 and distilled water was added to make 1000 ml (0.1N H_2S0_4)
- 100 ml 0.1N H_2S0_4 and distilled water was added to make 1000 ml (0.01N H_2S0_4)

For preparation of 0.01N H_3PO_4 following methodology was adopted:

- 21.21ml of concentrated H_3PO_4 (88%) and distilled water was added to make 1000 ml (1N H_3PO_4)
- 100 ml 1N H_3PO_4 and distilled water was added to make 1000 ml (0.1N H_3PO_4)
- 100 ml 0.1N H_3PO_4 and distilled water was added to make 1000 ml (0.01N H_3PO_4)

Estimation of acid requirement

As different water samples have different chemical composition, pH and electric conductivity, so volume of acid used is also different. Three acids Hydrochloric (HCl), Sulphuric (H_2S0_4) and Phosphoric acid (H_3PO_4) were used to bring pH to 4.0.

Titration for pH reduction

To determine the acid required to bring the pH of ground water sample to the desired level. The following methodology was used:

- 50 ml of water sample of known pH was taken in titration flask.
- 2ml of 0.01N HCl, H_2S0_4 and H_3PO_4 solution was added to water sample and stirred to completely mix the solution in water sample.
- The sample was kept for 30 minutes, stirred and then pH determined.
- Above steps were repeated till the pH of water sample was lowered to 4.0.

Volume of acid required for pH reduction

Volume of acid required for pH reduction of ground water depends on pH, normality of acid solution used for titration and also on the initial and target pH of water. A titration curve was prepared to determine the volume of acid required to bring the pH up to target level for 1000 litre of irrigation water.

Volume of HCl (36.5% conc.) required for 1000 litre of water was estimated as:

$$V_{1000} = 86.27 \times N_p \times V_t / V_s$$

Where,

V_{1000} = Volume of HCl required for lowering pH of 1000 litre of irrigation water to desired level, ml

N_p = Normality of HCl solution

V_t = Volume of HCl solution used in titration, ml

V_s = Volume of Volume of acid required for pH reduction of irrigation water depends on pH, water sample used, ml

Volume of H_2SO_4 (98.08% conc.) required for 1000 litre of water was estimated as:

$$V_{1000} = 27.17 \times N_p \times V_t / Vs$$

Where,

V_{1000} = Volume of H_2SO_4 required for lowering pH of 1000 litre of irrigation water to the desired level, ml

N_p = Normality of H_2SO_4 solution

V_t = Volume of H_2SO_4 solution used in titration, ml

V_s = Volume of water sample used, ml

Volume of H_3PO_4 (88% conc.) required for 1000 litre of water was estimated as:

$$V_{1000} = 21.21 \times N_p \times V_t / V_s$$

Where,

V_{1000} = Volume of H_3PO_4 required for lowering pH of 1000 litre of irrigation water to the desired level, ml

N_p = Normality of H_3PO_4 solution

V_t = Volume of H_3PO_4 solution used in titration, ml

V_s = Volume of water sample used, ml

Results and Discussion

Quality of water samples

Chemical analysis of the 15 water samples was performed in the laboratory. The pH values of sample ranged from 7.92 to 8.91.

Acid requirement

The amount of acid required to lower the pH of water samples to the desired level (pH = 4) was estimated with the help of HCl (36.5% conc.), H_2SO_4 (98.08% conc.) and H_3PO_4 (88% conc.).

Amount of HCl

The amount of HCl (35.5% conc.) required to lower the pH of three sample (having different pH) is shown in fig.1. The values are given in Appendix A1. The total amount of HCl required to lower the pH to 4.0 of different samples has been presented in Table.1. The volume of HCl acid added varied from 14 ml for sample having pH 8.6 to 3.6 ml for water having pH 7.62. The empirical relationship fitted between initial pH of water and amount of acid HCl (35.5% conc.) required to lower pH to 4.0 has been plotted (fig.2).

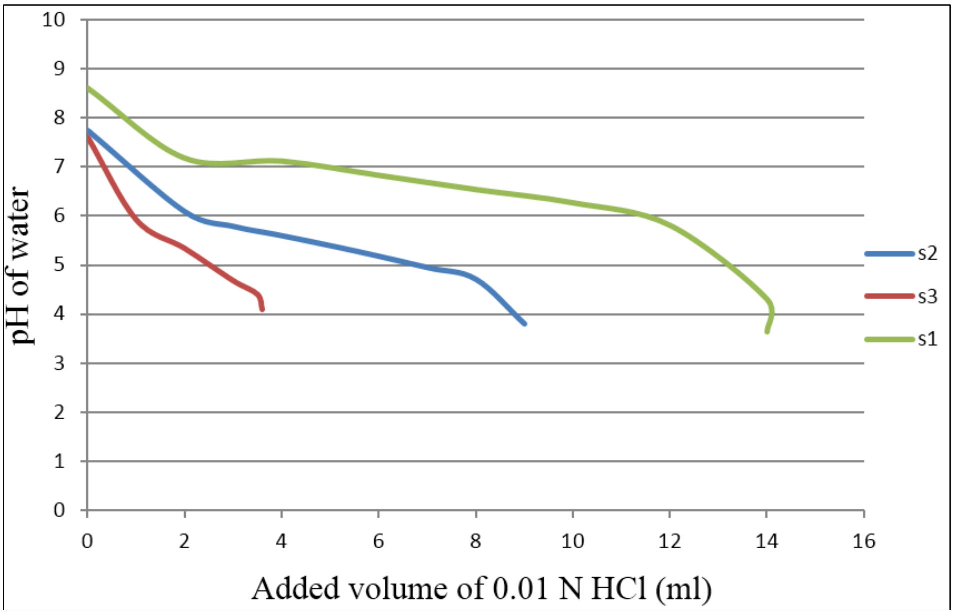

Fig 1: Reduction in pH of 50 ml water sample on addition of HCl (0.01N)

The estimated volume of HCl (36.5% conc.) required to lower pH of 1000 litre of water is given in table 1.

Table 1: Volume of HCL required for lower pH

Sample No.	Initial pH	Volume of acid used for 50 ml to bring pH to 4.0 (ml)	Acid requirement for 1000 litre(litre)
1	8.6	14	144.90
2	7.75	9	127.30
3	7.62	3.6	

The polynomial equation fitted between amount of HCl (36.5% conc.) required for 1000 litre of water (y) and initial pH (x) of water sample is:

$$Y = 2.6275x^2 - 42.227x + 169.99$$
$$R^2 = 0.9645$$

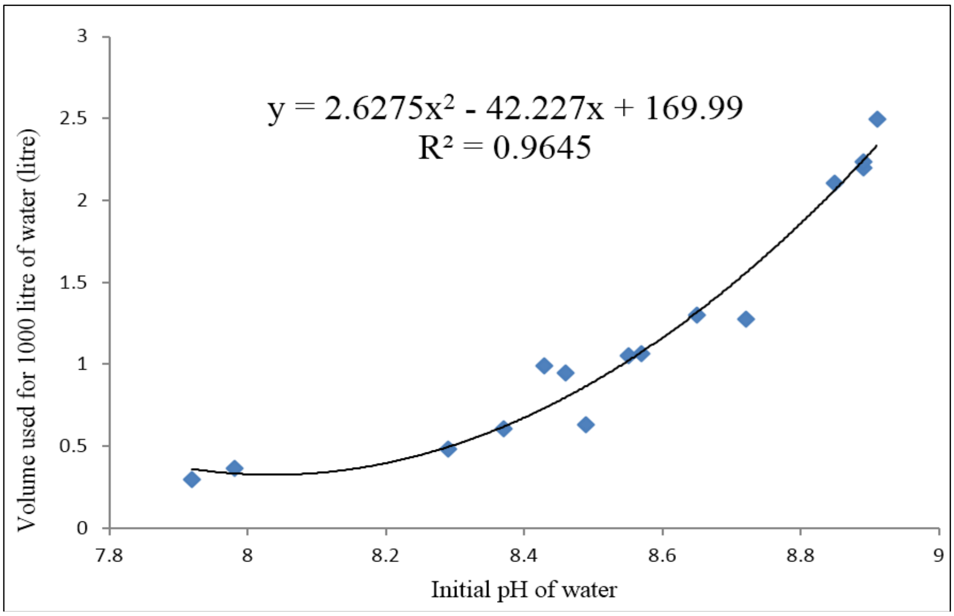

Fig 2: Relationship of HCl requirement for 1000 litre of water with initial pH of water

The equation derived shows that there is a strong polynomial relation between initial pH and volume of acid required lowering down pH of 1000 litre of water. The effect of different water quality parameters on HCl requirement is found to be negligible.

Amount of H_2SO_4

The amount of H_2SO_4 (98.8% conc.) required to lower the pH of three sample (having different pH) has been presented in fig. 3. The values are given in Appendix B1. The total amount of H_2SO_4 required to lower the pH to 4.0 of different sample has been presented in table 4.The volume of HCl acid added varied from 109 ml for sample having pH 8.8 to 110ml for sample having pH 7.62. The empirical relationship fitted between initial pH of water and amount of H_2SO_4 (98.8% conc.) required to lower pH to 4.0 has been plotted (fig. 2).

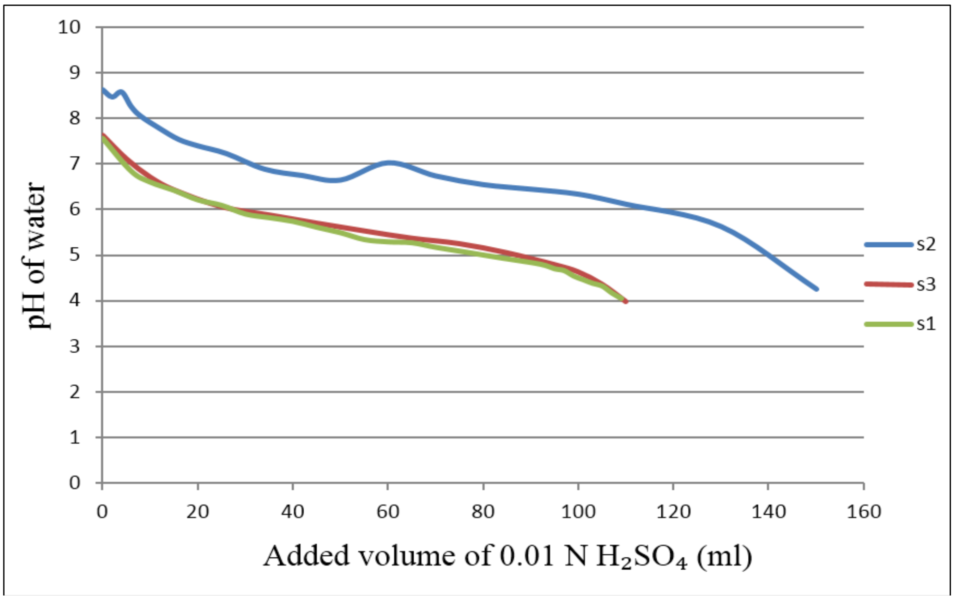

Fig 3: Reduction of pH of 50 ml sample on addition of H_2SO_4 (0.01N)

The estimated volume of H_2SO_4 (98.8% conc.) required to lower pH of 1000 litre of water is given in table 4

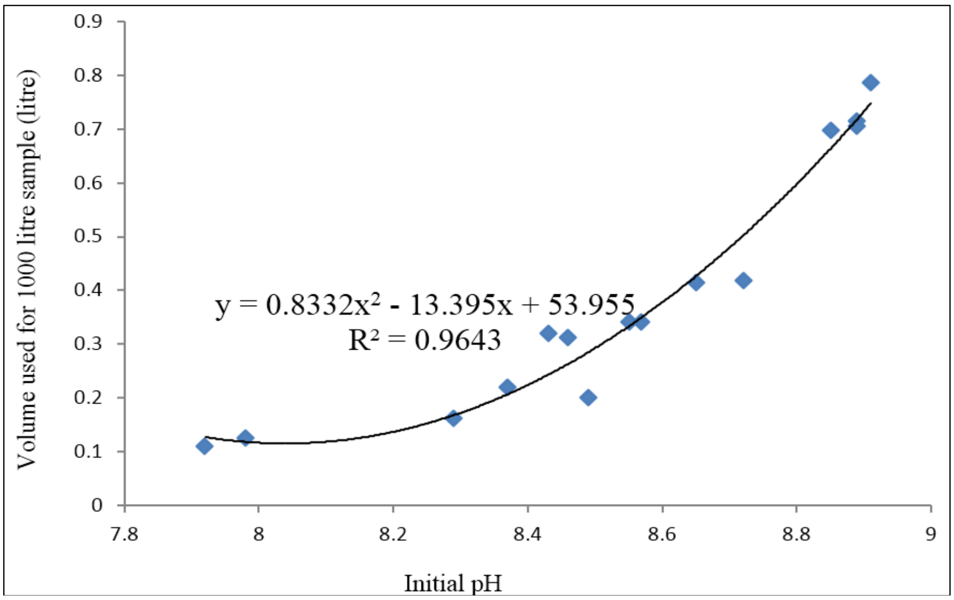

Fig 4: Relationship of H_2SO_4 requirement for 1000 litre of water with initial pH

Table 2: H_2SO_4 requirement to lower the pH (=4) of water sample

Sample no.	Initial pH	Volume of acid used for 50 ml sample to bring pH to 4.0 (ml)	Acid requirement for 1000 litre (litre
1	8.6	109	0.79
2	7.75	150	0.71
3	7.62	110	0.71

The estimated volume of H_3PO_4 (88% conc.) required to lower pH of 1000litre of water sample is given in table 3 and shown in fig.6.

Table 3: H_3PO_4 acid required to lower the pH (=4) of water samples

Sample.no.	Initial pH	Volume of Acid used for 50 ml to bring pH to 4.0 (ml)	Acid requirement for 1000 litre (litre)
1	8.8	93	
2	7.75	133	
3	7.62	91	

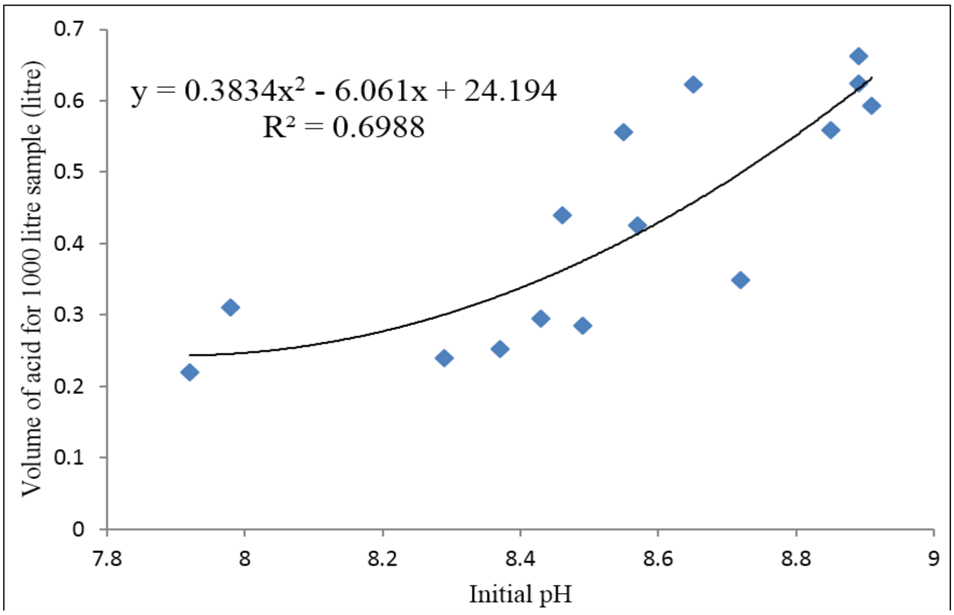

Fig 6: Relationship of H_3PO_4 requirement for 1000litre of water with initial pH of water

The polynomial equation fitted between amount of H_3PO_4 (88% conc.) required for 1000 litre of water(y) and initial pH (x) of water sample is:

$$y = 0.3834x^2 - 6.061x + 24.194$$
$$R^2 = 0.6988$$

The low value of correlation factor suggests that there are factors other than initial pH which effect the acid requirement to lower the pH of sample with H_3PO_4.

Conclusions

Drip irrigation system is affected by emitter clogging which is directly related to water quality clogging occurs more readily in water with pH more than 7.0. Acidification can reduce chemical clogging of emitters as it reduces pH of water. Fifteen number of water samples were collected from the Soil and Water Laboratory of Department of Soil Science having pH range was 7.98 to 8.91.Three acid HCl (35.5% conc.) H_2SO_4 (98.8% conc.) and H_3PO_4 (88% conc.) were used to lower down the pH of 50 ml of water sample to the desired level (=4). Acid solution of 0.01N were prepared to determine the amount of acid require to lower down the pH. The following conclusions were drawn from the experimental analysis:

1. The amount of HCl (35.5% conc.) required to bring down the pH of water sample has a strong correlation coefficient with initial pH.
2. The amount of H_2SO_4 (98.8% conc.) required to bring down pH of water sample also depends upon the initial pH. The effect of other water quality parameters on acid requirement is found to be negligible.
3. The amount of H_3PO_4 (88% conc.) required to bring down the pH of water sample depends upon initial pH and as well as on other water quality parameters.
4. In HCl (35.5% conc.), H_2SO_4 (98.8% conc.) and H_3PO_4 (88% conc.) phosphoric acid is most economical to use

References

1. Adin A. Clogging in irrigation system reusing pond effluents and and its prevention. Water science and technology. 1987; 19(12):323-331
2. Bucks DA, Nakayama FS, Gilbert RG. Trickle irrigation, water quality and preventive maintenance. Agric Water Manage. 1979; 2(2):149-162.
3. Cararo DC, Botrel TA, Hills DJ, Leverenz HL. Analysis of clogging in drip emitters during wastewater irrigation. Appl. Eng. Agric. 2006; 22(2):251-257.
4. David J, Fakher MH, Peter MWN. Effect 0f chemical clogging on drip tape irrigation uniformity. Transactions of ASAE. 1989; 32(4):1202-1205.
5. Gilbert RG, Nakayama FS; Bucks DA. Trickle irrigation prevention of clogging. Transactions of ASAE. 1979; 24(2):1279-1282.
6. Hossain E, Golkarhamzee H, Tavasoli AF, Nazarjani M. Evaluation of emitter clogging in trickle irrigation with wastewater. J, of basic appl. Science. Res. 2012; 2(5):5288-5291.
7. Joseph Mustin T. Treatment of SDI emitter clogged with manganese compounds. Texas Agrilite Reaserch. 823W US Hwy 70, Plainview, Texas 79092, 2000.
8. Ribeiro P, Assuncao T, Paterniani S, Euclides J, Charistiane C. Chemical treatment to unclog dripper irrigation system due to biological problems. Sci. Agric. 2008; 65(1):1-9.
9. Trooien TP, Lamn FR; Stone LR, Alam M, Roger D, Clark GA, Schlegel AJ. Subsurface drip irrigation using livestock wastewater: dripline flow rate. J of Appl. Engg. Agric. 2000; 16(5):505-508.
10. Trooien TP, Lamn FR, Stone LR, Alam M, Roger D, Clark GA *et al*. Using livestock waste water with SDI-A status report after four seasons. Proceeding of the central plain irrigation short course, Lanar, CO. Available from CPIA, 760N Thompson Colby, KS 67701, 2000.

Appendix A

App A: Chemical composition of ground water samples

Sample No.	Ec	pH	CO3	HCO3	Cl	SO4	NO3	ca^{+2}	Mg^{+2}	Na	K
1	2.48	8.91	1.56	3.25	15.60	3.10	0.02	2.10	4.60	16.20	0.76
2	2.29	8.89	1.80	5.70	10.90	3.56	0.00	0.75	2.36	17.80	0.06
3	4.04	8.89	2.20	6.80	26.50	4.10	0.02	1.89	6.31	30.20	0.21

Appendix A1

A1: Volume of HCl (0.01 N) required to lower pH to 4.0 for 50 ml of water samples

HCl acid added	pH of S1	HCl acid added	pH of S2	HCl acid added	pH of S3
0.00	8.91	0.00	8.89	0.00	8.89
2.00	8.84	2.00	8.74	2.00	8.84
4.00	8.76	4.00	8.68	4.00	8.80
9.00	8.50	6.00	8.62	9.00	8.61
14.00	8.05	8.00	8.30	14.00	8.38
19.00	7.28	13.00	7.87	19.00	7.94
24.00	6.97	18.00	7.38	24.00	7.35
29.00	6.76	23.00	7.06	29.00	7.05
34.00	6.61	28.00	6.88	34.00	6.86
39.00	6.48	33.00	6.74	39.00	6.75
44.00	6.36	38.00	6.62	44.00	6.66
49.00	6.26	43.00	6.52	49.00	6.60
54.00	6.16	48.00	6.45	54.00	6.56
64.00	6.07	53.00	6.39	64.00	6.39
74.00	5.98	58.00	6.33	74.00	6.24
84.00	5.88	68.00	6.22	84.00	6.08
94.00	5.77	78.00	6.03	94.00	5.91
104.00	5.65	88.00	5.87	104.00	5.71
114.00	5.49	98.00	5.74	114.00	5.42
124.00	5.28	108.00	5.44	124.00	4.78
143.00	4.96	118.00	5.05	127.70	4.24
144.00	4.20	127.30	4.00	128.90	4.11
144.50	4.13			129.70	4.00
144.90	4.00				

Appendix B1

B1: Volume of H_2SO_4 (0.01 N) required to lower pH to 4.0 for 50 ml of water samples

H_2SO_4 acid added (ml)	pH of S1	H_2SO_4 acid added (ml)	pH of S2	H_2SO_4 acid added (ml)	pH of S3
0.00	8.91	0.00	8.89	0.00	8.89
2.00	8.71	2.00	8.77	2.00	8.75
4.00	8.56	4.00	8.65	4.00	8.65
9.00	8.05	9.00	8.37	9.00	8.39
14.00	7.65	14.00	8.06	14.00	8.01
19.00	7.21	19.00	7.81	19.00	7.83
24.00	7.01	24.00	7.59	24.00	7.59
29.00	6.85	29.00	7.42	29.00	7.40
34.00	6.73	34.00	7.26	34.00	7.26
39.00	6.57	39.00	7.05	39.00	7.05
44.00	6.46	44.00	6.83	44.00	6.77
54.00	6.27	54.00	6.46	54.00	6.45
64.00	6.13	64.00	6.19	64.00	6.22
74.00	5.97	74.00	5.93	74.00	5.96
84.00	5.83	84.00	5.78	84.00	5.79
94.00	5.67	94.00	5.57	94.00	5.55
104.00	5.55	104.00	5.28	104.00	5.23
114.00	5.24	114.00	4.91	114.00	4.87
124.00	5.03	124.00	4.59	124.00	4.43
134.00	4.72	131.00	4.08	129.00	4.15
144.00	4.17	131.40	4.00	129.90	4.00
144.60	4.00				
39.00	6.15	39.00	5.86	39.00	5.55
44.00	5.96	44.00	5.27	44.00	5.31
54.00	5.56	54.00	4.69	54.00	4.80
64.00	5.07	62.00	4.16	62.00	4.14

74.00	4.36	62.80	4.00	62.70	4.00
76.40	4.00				

Appendix C1

C1: Volume of H_3PO_4 (0.01 N) required to lower pH to 4.0 for 50 ml sample

H_3PO_4 acid added (ml)	pH of S1	H_3PO_4 acid added (ml)	pH of S2	H_3PO_4 acid added (ml)	pH of S3
0.00	8.91	0.00	8.89	0.00	8.89
5.00	8.57	5.00	8.75	5.00	8.68
10.00	7.99	10.00	8.45	10.00	8.42
15.00	7.34	15.00	7.91	15.00	7.98
20.00	7.03	20.00	7.38	20.00	7.76
25.00	6.85	25.00	7.11	25.00	7.48
30.00	6.75	30.00	6.94	30.00	7.12
35.00	6.63	35.00	6.82	35.00	6.98
40.00	6.55	40.00	6.74	40.00	6.87
50.00	6.47	50.00	6.60	50.00	6.71
60.00	6.36	60.00	6.47	60.00	6.63
70.00	6.23	70.00	6.35	70.00	6.51
80.00	6.17	80.00	6.12	80.00	6.34
90.00	6.04	90.00	5.96	90.00	6.12
100.00	5.92	100.00	5.78	100.00	5.99
110.00	5.63	110.00	5.63	110.00	5.84
120.00	5.03	120.00	5.51	120.00	5.67
130.00	4.63	130.00	5.13	130.00	5.41
139.00	4.19	140.00	4.76	140.00	5.08
139.90	4.00	145.00	4.21	150.00	4.66
		147.10	4.00	155.00	4.18
				156.00	4.03
				156.10	4.00
				131.00	4.07
				131.10	4.00