

Journal of Advanced Scientific Research

ISSN

Available online through http://www.sciensage.info/jasr

83

Measurement Uncertainty in the Analysis of Ground Water Chloride of Beed City Using Mohr's Method

Abdul Rahim^a, Vidya Pradhan^b, Sayyed Husain^c, Mazahar Farooqui^{b, d}

^{*a}Milliya* College Beed,</sup> ^bDr Rafiq Zakaria College for Women, Aurangabad ^cSir Sayed College, Aurangabad ^dPost graduate and research centre, Maulana Azad College, Aurangabad *Corresponding Author: mazahar_64@rediffmail.com

ABSTRACT

The chloride estimation from the ground water of Beed City (Maharashtra, India) was determined using Mohr's method. All volumetric apparatus used were calibrated using weighing method. The AgNO3 solution was standardized and uncertainty associated with preparation of solution, standardization of solution and estimation of chloride is calculated. It was observed that the contribution of uncertainty from standardization is maximum. Hence the estimation of chloride from ground water is mostly depending on the standard solution of AgNO₃.

Keywords: Uncertainty in measurement, ground water analysis, chloride estimation

1. INTRODUCTION

Each quantitative estimation associated with uncertainty. Evaluation of uncertainty is essential since it provide the valuable information about the quality and reliability of result. Generally uncertainty is carried out in analytical laboratories which work in the field of forensic, technological environmental, agricultural and food analysis. Regardless of the type of method scope and application, laboratories must be able to provide reliable data when performing analytical test for client or for regulatory purposes [1]. Beed city is a district place, belonging to the backward region of Marathwada of Maharashtra State. The major source of water pollution is due to domestic waste. Therefore we decided to estimate chloride of ground water of Beed city and uncertainty associated with it.

2. EXPERIMENTAL

All solutions used in this experiment were prepared in double distilled water. The sodium chloride used was of analytical grade of purity of 99.9 %. The other chemicals were of laboratory reagent. Solution of AgNO3 was prepared in double distilled water and standardized using NaCl solution. Standardized AgNO3 was used to determine chloride from ground water collected from different regions of Beed. The pipette, burette and volumetric flask were calibrated and uncertainty associated with each of these was calculated.

3. RESULT AND DISCUSSION

The AgNO₃ solution used were standardized with NaCl and then chloride content of ground water was determined. A set of 20 replicate measurements were taken for each determination. An equation for the analyze was formulated by expressing mathematical

relationship between the measurement and all the input quantities upon which the measurement depends. These are equation 1 & 2

 $C_{AaNO3} = Concentration of AgNO_3 solution$ 1000 = *Conversion factor ml to Litre* = Mass of the titrimetric standard of NaCl (g) m _{NaCl} = Molar mass of NaCl M_{NaCl} V_T = Titration volume of $AgNO_3(ml)$

$$\frac{Cl}{L} = \frac{(A-B) \times C_{A_{gNO_3}} \times 35.450}{ml \ sample} \qquad (2)$$

If there are x results, dependent on the experimental variables, p, q, r, each of which flocculates in a random and independent way that is, x is a function of p, q, r, So that we may write

$$x = f(p, q, r,)$$
 -----(3)

The uncertainty dx_i (that is the deviation from the mean) in the measurement of x depend on the size and sign of the corresponding uncertainties dp_i, dq_i, dr_i,.....

That is,

 $d\mathbf{x}_{i} = f(d\mathbf{p}_{i}, d\mathbf{q}_{i}, d\mathbf{r}_{i}, \dots, \dots)$ (4)

Taking partial differentiation of equation (4)

Substituting $\frac{\sum (dx_i)^2}{N-1} = S_x^2$ $\frac{\sum (dp_i)^2}{N-1} = S_p^2$ etc in equation (6)

This equation gives the variance of a quantity calculated from several experimental results [2]. For the present work we have selected a method described by APHA [3] which has precision and bias in terms of relative standard deviation of 4.2 % and a relative error of 1.7 %. For the preparation of standard solution of NaCl we have 824 mg in 1000 ml of double distilled water. The uncertainty related with molecular weight is calculated by using uncertainties in atomic weight (Table-1) given by IUPAC [4].

Table-1: Uncertainty associated with atomic weight

Element	Atomic weight	Coated uncertainty	Standard	
	$AW_{(e)}$	$U_{(ce)}$	uncertainty	
			$U_{(e)} / \sqrt{3}$	
Na	22.989770	0.0000005	0.000002	
Cl	35.4527	0.0009	0.0005196	
	58.442470			

The uncertainty contribution from molecular weight will be

$$U_{(MW_{1},q)} = \sqrt{(0.000002)^2 + (0.0005196)^2}$$

The factors affecting weighing process are precision of the balance, purity of NaCl, linearity, repeatability and sensitivity. The cause and effect diagram can be given as (Fig 1)



Fig. 1: Fish bone diagram of weighing process

The weighing process is carried out at once only. The purity of NaCl was 99.99%.

Therefore the standard uncertainty can be given as $U_{(P_{NaCl})} = \frac{0.0001}{\sqrt{3}} = 0.000058$ The external calibration of the balance used states that the difference from the actual weight on the scale pan and the reading of the scale is within \pm 0.05 mg with 95 % confidence.

Under the normal distribution a 95 % confidence gives a factor of 1.96. Therefore, the associated uncertainty expressed as standard deviation is 0.05/1.96 or 0.026 mg.

Ten repeated measurement of sample gave a standard deviation of the differences in weighing 0.006 mg. The sensitivity of the balance can be neglected. The combine standard uncertainty in weighing process will be

$$U_{(m_{NaCl})} = \sqrt{(0.026)^2 + (0.006)^2} = 0.026 \text{ mg}$$

For the volume cause and effect diagram can be given as (Fig 2)



Fig. 2: Fish-bone diagram for Burette Reading

The burette was calibrated for every 5 ml section and average error was found to be ± 0.32252 at temperature 25°C. As it has calculated without any confidence level we any assume a triangular distribution. The actual volume is more likely to be at the centre rather than at extremes of the range.

Therefore $0.32252 / \sqrt{6} = 0.131668$

A series of 20 exercises for 25 ml burette gave a standard uncertainty in form of standard deviation as 0.220987. Since the calibration is carried out at laboratory temperature varies between the limits of $\pm 1^{\circ}$ C. The uncertainty from this effect can be calculated from the estimate of temperature range and that of flask only. The liquid expansion needs to be considered here [5]

Therefore

$$U_{(t)} = \frac{8.5 \times 1 \times 0.00021}{1.732} = 0.001030$$

The combined uncertainty for volume will be

$$U_{(v)} = \sqrt{(0.131668)^2 + (0.220987)^2 + (0.001030)^2} = 0.25724$$

The uncertainty associated with standardization can be given as

$$U_{(std)} = \sqrt{\left(\frac{u_m}{m}\right)^2 + \left(\frac{u_p}{p}\right)^2 + \left(\frac{u_M}{M}\right)^2 + \left(\frac{u_{VT}}{VT}\right)^2}$$

$$U_{(std)} = \sqrt{\left(\frac{0.026}{0.824}\right)^2 + \left(\frac{0.000058}{0.9999}\right)^2 + \left(\frac{0.0001643}{58.442470}\right)^2 + \left(\frac{0.25724}{8.5}\right)^2} = 0.043$$

This is an uncertainty associated with standardization of $AgNO_3$ with NaCl. The major uncertainty is associated from volume factor and the second influential factor is weighing. The uncertainty from molecular weight and purity is very less.

The uncertainty associated with chloride estimation of ground water collected from the different places of Beed City. The sample was collected from bore well and chloride is estimated. Twenty replicate measurement of same sample was carried out. The standard deviation for the B.R. was found to be \pm 0.04429. The fish-bone diagram can be given (Fig. 3)



Fig. 3: Fish-bone diagram for determination of chloride

Table 2: Chloride content (in ppm) of Beed City during Jan 2010-Mar 2010

	S ₁	S ₂	S ₃	S_4	S ₅	S_6	S_7
1 Jan 2010	121.9	252.4	354.5	155.9	232.55	257.37	289.8
15 Jan 2010	107.7	113.4	353	212.7	445	265.8	313.3
1 Feb 2010	127.6	260.9	350.2	220	449.5	283.6	333.2
15 Feb 2010	134.7	307.7	381.4	248.1	307.7	288	319.05
1 Mar 2010	163.07	262.33	382,6	263.3	459.43	279.7	333
15 Mar 2010	134.7	250.9	460.8	262.3	448.05	299.1	343.2

S₁Islampura; S₂ Milliya Campus; S₃ Mominpura; S₄ Shahenshah nagar; S₅ Karanja; S₆ Balepeer; S₇ Azizpura

The burette was calibrated at the 25°C with an error \pm 0.2215 ml. Therefore the uncertainty will be

$$U = 0.2215 \div \sqrt{6} = 0.09045$$

The mean of burette readings for twenty measurement of the titration was 11.2 ml.

The effect of temperature will be

$$U_t = 10 \times 1 \times 0.00021 = .002352$$
$$= 0.002352 \div \sqrt{3} = 0.0013579$$

Therefore the combined uncertainty will be

$$U_{VT} = \sqrt{\left(0.0013579\right)^2 + \left(0.09045\right)^2 + \left(0.04429\right)^2} = 0.1007814$$

10 ml sample was pipette put in the conical flask. The pipette was calibrated with an error of $\pm\,$ 0.19. and the standard deviation of $\pm\,$ 0.0685 ml. Therefore

At 25°C
$$U_t = 10 \times 1 \times 0.00021 = 0.0021$$

= 0.0021÷ $\sqrt{3}$

Therefore error is considered as triangular

$$U = 0.19 \div \sqrt{6} = 0.07757$$
$$U_{(samp)} = \sqrt{(0.001212)^2 + (0.07757)^2 + (0.0685)^2} = \pm 0.103492$$

The combine uncertainty of chloride will be

$$U_{(samp)} = \sqrt{\left(\frac{U_{A-B}}{A-B}\right)^2 + \left(\frac{U_{C_{AgNO_3}}}{C_{AgNO_3}}\right)^2 + \left(\frac{U_{V_{sample}}}{V_{sample}}\right)^2}$$

$$U_{(samp)} = \sqrt{\left(\frac{0.1007814}{11.2}\right)^2 + \left(\frac{0.043}{0.016988}\right)^2 + \left(\frac{0.103492}{10}\right)^2} = 2.531$$

The expanded uncertainty is obtained by multiplying coverage factor of 2 and the result is given as, 5.062 mg.

4. CONCLUSION

The major contribution for uncertainty is form standardization of silver nitrate.

Chloride Estimation: The chloride content of different samples during the period of Jan 2010 to March 2010 (average of twenty sample readings) is given in the table 2.

The values clearly indicate that chloride content varied from 107.7 ppm to 459, 43 ppm the chloride in the month of March is more compared to other month, still the variation is marginal since the effect of evaporation on ground water is less compared to surface water. The water level of underground is decreases in summer and hence it affects the water quality parameters.

It is not possible to compare the water quality of underground water for different places, since there are various factors such as geochemical structure, depth of bore well or open well, leaching of salt, soil texture etc.

5. ACKNOWLEDGEMENTS:

The authors are thankful of Management, Milliya College, Beed for providing laboratory facilities and to the students Amer Shabbir Khan, Chisti Abdul Haque, Afroz Ali Bage, Shaikh Haider, Sy Shoeb Taufique, Mirza Atufa and Sk Farheen Ab Gaffar for help during sampling and analysis of samples.

6. REFERENCES

- Isabel Tavernier's, Erik Van Bockstee, Mare, De Loose, 2004 Trends in quality in the analytical laboratory.
 Traceability & measurement uncertainty of analytical results, *Trends in analytical chemistry* 23 (7): 480-490, 2000.
- Skoog, Holler and Crouch, Principles of Instrumental analysis: 6th edition, 2007; 980-983.
- APHA. Standard Methods for examination of water wastewater 18th edition, 1992; 4-49.
- 4. IUPAC. Pure and Applied Chemistry, 1997; 69: 2471-2473.
- 5. Eurachem/CITAC Guide "Quantifying Uncertainty in Analytical measurement" second edition. 2000.
- Steven D.Phillips and Keith R Eberhardt B. J Res Natl Inst Stand Technol, 1977; 102: 577.