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Statistical Comparison in Testing Tools of pH of Mud

Tarunika Sharma[1], Rashi Khubnani[1] and N. L. Ramesh[2]

[1]Department of Applied Sciences, New Horizon College of Engineering, Bengaluru – 560103, Karnataka, India; tarunika.sharma@gmail.com, rashi.khubnani@gmail.com

[2]Department of Mathematics, Ramaiah Institute of Technology, Bengaluru – 560054, Karnataka, India; nlramesh@msrit.edu

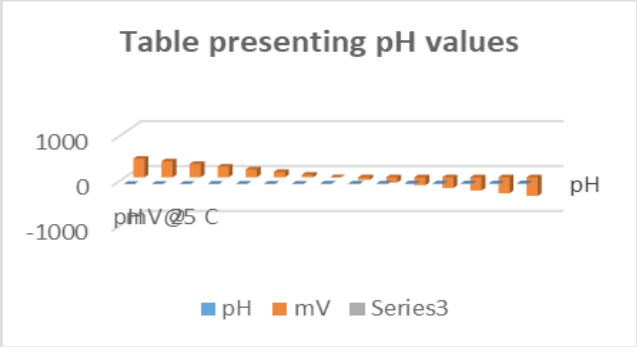
Abstract

As long as a mine is in operation, solid mine waste must be evaluated for environmental impact. Because of this, there is now a need for instruments and procedures to comprehend the net acidity of mine wastes. In order to give a rough assessment of the waste's present net acidity, rinse and paste pH tests are frequently employed during the first screening process. The pH value is basically defining hydrogen ion concentration which define acidic and basic behavior of substances. Since hydrogen ion (H+) is a key component in a variety of chemical reactions. Therefore, an honest measure of the pH is very significant in substances like (mud, water, fruits, vegetables etc.). In this study using statistical analysis of mud samples, the comparison between two different method of testing tools that is pH meter and pH kit is done. The low pH mud has its own harmful consequences, whereas high pH mud tends to develop deposits that clog pipes and alter reaction processes, among other things.

Keywords: *Hydrogen Ion, pH-Testing Kit, pH Meter.*

1.0 Introduction

pH is one of the most common factor used in chemistry. It is well-defined as the negative logarithm of the hydrogen ion concentration pH = -log10[H+]. It is called as the power of hydrogen or potential of hydrogen, this calculation was first introduced by biochemist S.P.L. Sorensen to express the hydrogen ion concentration. This is a unit for measuring, which gives the amount of acidity or alkalinity of a solution. The pH value of substances is combination of the ratio of hydrogen ion [H+] and hydroxyl ion [OH-] concentrations. If the pH value is less than 7 then the material is acidic whereas if the pH value is more than 7 then the material is alkaline. But if the pH value is equal to 7 then the material is neutral[1]. The behavior of materials at different pH values is explained in Table 1 and Graph 1.



Graph 1. This graph presents pH values of different materials.

**Author for correspondence*

Table 1. Behavior of materials

Behavior of materials	pH	mV@ 25° C (77°F)
H^+(Acid)	0	+414
	1	+355
	2	+296
	3	+237
	4	+177
	5	+118
	6	+59
Neutral	7	0
OH^-(Alkaline)	8	-59
	9	-118
	10	-177
	11	-237
	12	-296
	13	-355
	14	-414

2.0 Properties of Soil

Soil consist of minerals, water, air, Soil Organic Matter (SOM). These components have impact on the texture, structure and quality of mud. Agricultural mud is a combination of around 50% solid particles and 50% pores[2,3]. The combination of all the components in soil is explained in (Figure 1).

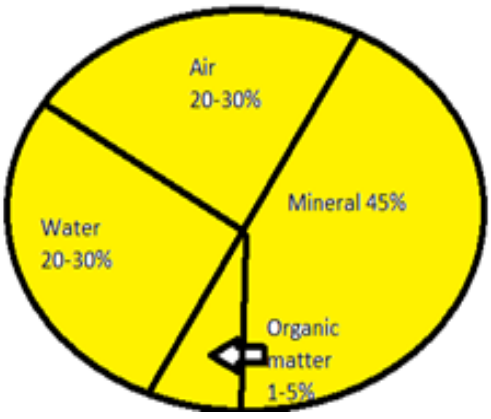


Figure 1. Components present in soil.

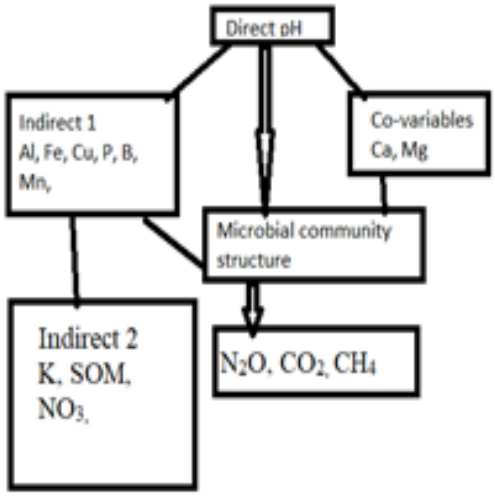


Figure 2. Flowchart presenting direct and indirect impacts of pH.

The most significant factor affecting the structure of the soil prokaryotic community in soils is typically stated as pH. Previous research assessment of microbial communities across pH gradients throughput DNA

sequencing and discovered that bacterial and archaeal community architectures are both substantially impacted by pH variations. By managing the pH level of mud, the better quality of crop production is possible in agriculture fields.

Although it is rarely discussed in microbial ecology, direct and indirect impacts of pH are often well-described in the field of soil fertility studies. The various substances and variables that typically co-variate with pH (such as Ca, Al, Fe, and Mn) must be taken into consideration when pH is measured. Figure 2 explains the flowchart for direct and indirect impacts of pH on the mud[4-9].

2.1 Techniques for Measurement of pH

Many techniques exist to test the pH level of mud, some of the techniques are listed here:

(a) Digital Image processing
(b) Soil pH were determined by using pH meter.
(c) Artificial Neural Network (ANN)
(d) Technique for digital image processing used in geographic information systems and remote sensing.
(e) Automatic irrigation system
(f) Rapid soil testing and Soil Test Kits (RST and STK)
(g) FD- Fractal Dimension
(h) Fuzzy expert system
(i) Kentucky soil analysis
(j) To analyze the changes in soil pH, use an acidic soil and a calcareous soil.
(k) Morphological partial differential equation-based segmentation scheme.
(l) Calculate the physical and chemical characteristics of soil.
(m) Soil moisture Assessment.
(n) Thin section method.
(o) Automatic soil texture categorization method using wavelet-based statistical models and hyper-spectral soil fingerprints.
(p) Noninvasive microwave imaging system
(q) An algorithm based on the PALSAR, SAR, and MODIS information fusion Approach
Mono-configuration Terra SAR-X.

2.2 pH Meter

An electrical device known as a pH meter is used to measure the pH of liquids and semi-solids. The characteristics of this indicator were utilized to precisely calculate the acidity or alkalinity of various substances. The pH meter is better than other pH indicators for determining the pH of a liquid or semi-solid substance because it gives accurate values[9,10].

2.3 pH Kit

Similar to test strips, pH chemical test kits are simple to use but have a number of limitations. In order to use a soil test kit, you must combine the soil with some chemicals, distilled or DI water, and a tube. The pH levels in your sample and the chemicals, like test strips, react to modify the color of your sample. The colour change of the test kits will be subjective, much like with test strips, and readings will differ from person to person[9,10].

3.0 Statistical Calculation

Different mud samples are collected from various areas to test the pH level through two types of testing parameter, in which one is pH meter and another one is pH kit.

3.1 Anova Test

ANOVA, commonly referred to as one factor analysis of variance, provides a method for comparing numerous population means at once. We can examine all of the means at once as opposed to performing this pairwise. The difference between the sample means and the variation within each of our samples must be compared in order to run an ANOVA test. Since the F statistic makes use of the F-distribution, we integrate all of this variation into a single statistic. By dividing the variation within each sample by the variation between samples, we achieve this[11-13].

3.2 Formulas

Total degree of freedom (DF) = N-1; N is total number of subjects.

Summation of squares between variables (SS_B) = $\sum n(\bar{x_i} - \bar{x})^2$; n is the number of subjects in the respective variable.

Summation of squares within variables (SS_W) = $\sum(n\text{-}1(s)^2$; s is the Standard deviation in the respective variable.

Total sum of squares = $SS_T = SS_{B+} SS_W$

Mean square between variables (MS_B) = $\frac{SS_B}{(K-1)}$; K is the number of variables.

Mean square within variables (MS_W) = $\frac{SS_W}{(N-K)}$

F = $\frac{MS_B}{MS_W}$

Hypothesis: There are two types of hypothesis in this study one is null hypothesis (H_O) and another is alternative hypothesis (H_1).

H_O: The mean of two variables do not significantly differ from one another.

3.3 Sample Data

pH level of different mud samples							
pH meter	8.29	8.45	8.73	8.28	8.59	8.61	
pH kit	7.89	6.28	7.96	7.89	6.32	7.02	6.69

3.4 Analysis of Variance Outcomes

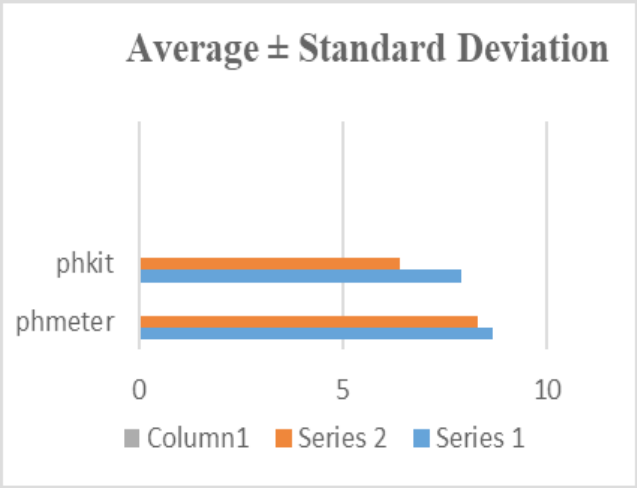
Data calculation				
Variables	**N**	**Mean**	**Standard Deviation**	**Standard Error**
pH meter	6	8.4917	0.1831	0.0748
pH kit	7	7.15	0.7556	0.2856

ANOVA calculation			
Basis	**Degrees of freedom (DF)**	**Summation of squares (SS)**	**Mean square (MS)**
Between variables	1	5.8159 (SS_B)	5.8159 (MS_B)
Within variables	11	3.5932 (SS_W)	0.3267 (MS_W)
Total	12	9.4091 (SS_T)	

F-statistics value = 17.80435; P-value = 0.00144

G-One-Way ANOVA [Average ± Standard Deviation]

H-Variable 1. [8.6748, 8.3086]; Variable 2. [7.9056, 6.3944]



Graph 2. This graph presents the average standard deviation of two variables.

H_1: Two variables mean differ significantly from one another.

Critical values of F for the 0.05 significance level at degree of freedom (5, 6) is 4.95

4.0 Conclusion

Throughout this effort, we have noted the following observations:

- The calculated value of F-statistics for the taken samples, is more than the critical value. As a result, the alternative hypothesis is accepted and the null hypothesis is disproved. Hence pH meter gives better results than the pH chemical test kit. Testing of pH in substances is very important as pH affects the availability of crucial nutrients, so it is significant character in any substances. The majority of horticultural crops will thrive on soils with a pH of between 6 (slightly acidic) to 7.5. (slightly alkaline)
- Alumina refinery waste known as "red mud," or "bauxite residue," is produced during the mining process. It has a pH of 10.5–12.5, making it very alkaline. Serious environmental issues including alkaline dust formation and alkali seepage in ground water are brought on by red mud. The neutralization of red mud with acid is one way to reduce its toxicity and make it less harmful to the environment.Alternatively, the experimental values can be used to perform an Analysis Of Variance (ANOVA) based on the Taguchi method.

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