Expt. No. 2 Date

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Title: Digital pH meter

Aim: To determine the pH of a given fluid using a digital pH meter

Apparatus/Components of a Digital pH meter
→ pH meter
→ pH electrode
→ ATC Probe
→ Electrode Holder
→ Buffer solutions (pH 4, pH 7 and pH 10)
→ Distilled water
→ Tissue paper
→ Beaker
→ Power adapter

Theory:
The pH of a solution is a measure of its acidity or alkalinity, determined by the concentration of hydrogen ions (H^+). The pH is mathematically expressed as

$$pH = -\log[H^+] = \log \frac{1}{[H^+]}$$

→ A pH of 7 indicates neutrality
→ A pH below 7 indicates acidity
→ A pH above 7 indicates alkalinity

The pH meter measures pH based on the difference in hydrogen ion concentration across a glass membrane. It consists of two electrodes
a) Measurement Electrode: Contains a sensitive glass membrane that interacts with H^+ ions.

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b) Reference Electrode: Provides a constant potential.
When the pH probe is immersed in a solution, the difference in H^+ concentration between the solution and the buffer inside the electrode generates a voltage, which the pH meter converts into a pH value.

Working Principle of pH meter:
→ The working principle of pH meter is based on the relation between the electric voltage and hydrogen ion concentration.
→ The pH meter consists of glass (also called as measurement electrode) and reference electrode.
→ Both electrodes are connected to a voltmeter.
→ The measurement electrode consists of a glass membrane, which is sensitive to hydrogen ion concentration.
→ The reference electrode is standard and has constant potential.
→ The acidic solution is rich in H^+ ion concentration.
→ When pH probe is dipped in an acidic solution and switch on the voltmeter
→ The H^+ ion moves close to the glass membrane on the sensitive glass bulb
→ A similar reaction occurs inside the bulb, which is filled with a buffer solution of neutral pH.
→ The H^+ ions present inside the bulb also moves closer to glass membrane
→ Hence, this causes the difference in the concentration of hydrogen ions across the membrane.
→ When the hydrogen ion concentration inside the glass bulb is less than the outside solution, then the given solution is acidic and hence the pH is lower than 7.
→ When the hydrogen ion concentration inside the glass bulb is

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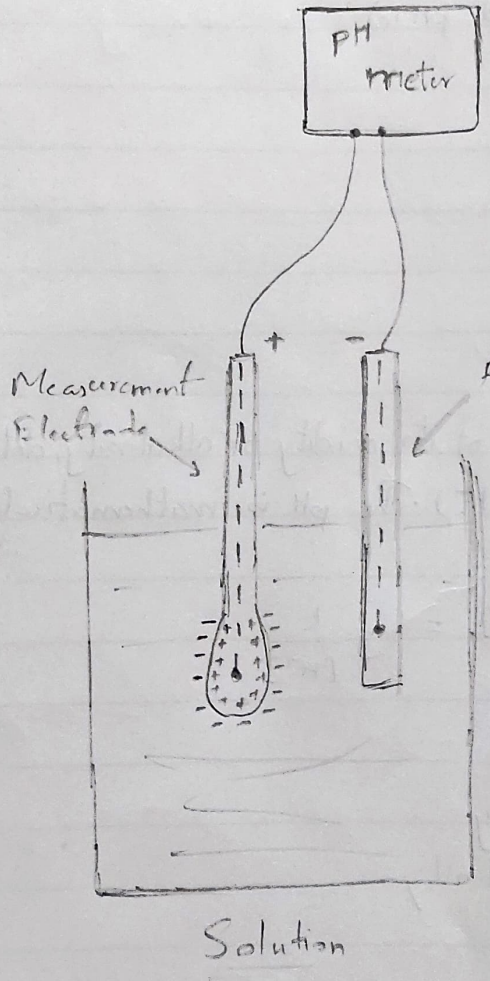

pH measurement

similar to the outside solution, then the given solution is natural pH hence the pH is 7.
→ When the hydrogen ion concentration inside the glass bulb is more than the outside solution, then the given solution is alkaline and hence the pH is higher than 7.

Procedure

a) Calibration:

1) Rinse the pH electrode and ATC probe with distilled water.
2) Dry both probes using a clean tissue paper.
3) Power on the pH meter and select pH mode
4) Start caliberation using pH 7 buffer solution
- Dip both probes into the solution
- Press the CAL mode and allow the reading to stabilize
- Press ENTER to accept the calibration value.

5) Repeat the calibration for pH 4 and pH 10 buffer solutions, rinsing the probes with distilled water between steps.
6) Ensure the buffer solutions are used only once and stored between 25°C to 27°C.

b) Measurement:

1) Rinse the pH electrode and ATC probe with distilled water and dry them.
2) Power on the pH meter and the pH mode.
3) Immerse both probes into the test sample and swirl gently.
4) Wait for the reading to stabilize and note the pH value along with the temperature
5) Rinse the probes before testing the next sample or storing the meter.

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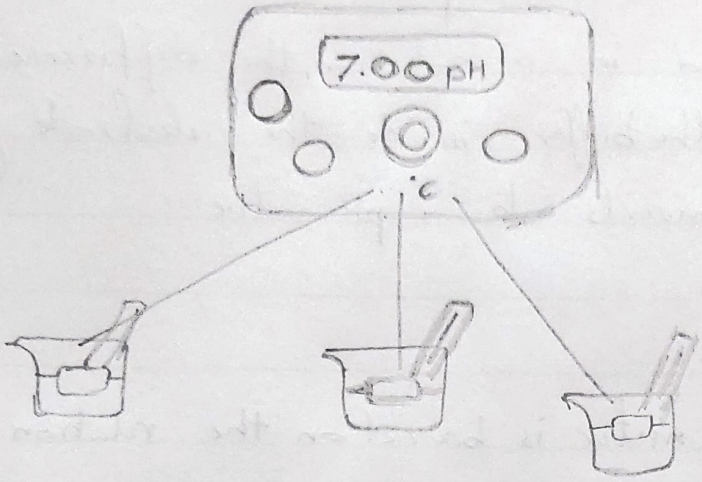

Manual Temperature Compensation

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Observations:

→ We tested and caliberated for basic and neutral and got the caliberation values as:

a) Basic solution - pH 10.1

b) Neutral solution - pH 7

→ We then tested the pH of the mud sample and got the value as

Conclusion:

The pH of the mud sample was found to be , indicating that it is slightly alkaline. This suggests the presence of basic components in the sample, making it more neutral but leaning towards alkalinity. Proper pH balance in drilling mud is essential for maintaining drilling efficiency and preventing corrosion or equipment damage.

Precautions:

1) Do not stir the solution using the pH electrode

2) Always caliberate the meter before testing - using fresh buffer solutions

3) Avoid direct sunlight and temperature fluctuations during measurement

4) Keep the electrode hydrated in storage solution when not in use.

5) Use single-use buffer solutions for accurate caliberation.

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Assignment - 2

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1) Full form of ATC in pH measurement equipment is:
Automatic Temperature Compensation

2) pH meter shouldn't be exposed to direct sunlight because:
Effect on accuracy of equipment (Evaporation of electrolyte solution takes place)

3) During the caliberation of pH meter, the first buffer solution to be used
Buffer Solution (pH-7)

4) Determine the pH of a solution that has H^+ concentration of 6.45×10^{-3} M

We know the formula: $pH = -\log[H^+]$

$\therefore pH = -\log[6.45 \times 10^{-3}] = -\log[6.45] + -\log[10^{-3}]$

$\therefore pH = 3 - \log[6.45] = 2.19$

$\therefore$ The pH of solution is 2.19

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