

# pH in Soil

## Smartphone-based determination of pH after reaction with a chemically bound pH indicator

### Introduction

Soil pH is a key indicator of soil health because it directly influences the availability of nutrients to plants.<sup>1</sup> In acidic soils (pH < 5.5), elements such as manganese and aluminum can reach concentrations that are toxic to plant roots. Conversely, in alkaline soils (pH > 7.5), essential micronutrients, including iron, zinc, and copper, become less soluble and therefore less available for plant uptake.<sup>1</sup> For most agricultural crops, a slightly acidic to neutral pH range of 6.0–7.0 provides optimal conditions for nutrient availability and plant growth.<sup>1</sup> Consequently, routine soil pH measurement is an essential component of effective nutrient management and soil fertility assessment.<sup>1</sup>

Soil pH is commonly determined in a suspension prepared with calcium chloride (CaCl<sub>2</sub>). The use of CaCl<sub>2</sub> minimizes variations caused by differences in soil electrolyte concentrations, resulting in more stable and reproducible measurements across diverse soil types. This approach is specified in both ISO 10390<sup>2</sup> and DIN EN 15933:2012-11.<sup>3</sup>

### Experimental

The following application note describes a simple way to determine the pH value in soil samples using the MQuant® pH 0–14 Universal Indicator strips in combination with the smartphone-based MQuant® StripScan app. This method offers a rapid, convenient, cost-effective, and easy-to-use approach to detecting the pH in soil samples while also allowing for comparisons with other methods such as visual evaluation, reflectometric method, and pH electrode to ensure the accuracy and validity of results.

### Method

Special indicator dyes are covalently bound to the reagent papers, which changes the color depending on the pH value of the sample.

### Measuring Range

pH 0–14

### Applicable Sample

Soil samples

### Reagents and Accessories

#### Test/Reagent Kit(s)

- MQuant® pH Indicator Strips pH 0–14 Universal Indicator (**1.09535**)
- Calcium chloride dihydrate for analysis EMSURE® ACS, Reag. Ph Eur (**1.02382**)
- Distilled water (e.g., from a suitable Milli-Q® system) or water for analysis (**1.16754**)

#### Accessories

- MQuant® Card (provided with the test strip box)
- MQuant® StripScan App (can be downloaded via the Apple App Store or Google Play Store)
- Balance
- Standard laboratory glassware (e.g. volumetric flask, Erlenmeyer flask)

### Analytical Procedure

#### Reagent Preparation

- CaCl<sub>2</sub>-solution 0.01 mol/L: Dissolve 0.919 g calcium chloride dihydrate in water for analysis and make up to 500 mL with water for analysis in a volumetric flask to prepare a 0.0125 mol/L CaCl<sub>2</sub>-solution.

#### Sample Preparation

- Homogenize 10 g of soil sample (exactly weighed) with 25 mL of 0.0125 mol/L CaCl<sub>2</sub>-solution by shaking for 15 minutes.

### Measurement

For analysis, follow this procedure:

- Start the App.

- Get your MQuant® test strip and the MQuant® Card ready.
- Dip the test strip into the soil slurry (15–25 °C) for 10 minutes, ensuring that the reaction zone is completely immersed.
- Then remove the strip from the suspension and quickly rinse the reaction zones with distilled water to remove particles.
- Shake off excess liquid from the strip and dry the backside of the strip using a paper towel.
- Select the parameter pH (1.09535) in the app. Wait 15 seconds until the color of the pH strip has

completely developed (a countdown is displayed on the screen, which begins immediately after selecting the parameter pH).

- Just before the end of the countdown, place the test strip on the MQuant® Card.
- After the waiting time is elapsed, place the MQuant® Card with the test strip within the viewfinder on your phone screen, and align the camera along the reference points.
- The picture is captured automatically by the camera of the smartphone.
- The result is displayed on the screen.

## Results

**Table 1.** Comparison of MQuant® StripScan, visual evaluation, Reflectoquant® pH test (1.16996), and pH electrode (acc. to DIN EN 15933:2012-11)

| Sample | pH value   |                 |                 |              |
|--------|------------|-----------------|-----------------|--------------|
|        | StripScan* | Visual readout* | Reflectoquant®* | pH electrode |
| 1      | 6.3        | 7               | 6.9             | 6.88         |
| 2      | 5.0        | 6               | 5.3             | 5.68         |
| 3      | 6.0        | 7               | 6.8             | 6.71         |
| 4      | 6.6        | 7               | 7.2             | 7.30         |
| 5      | 6.0        | 7               | 6.8             | 6.78         |

\*results are based on the average of a 5-fold determination

**Note:** Result graduation provided by MQuant® StripScan is identical with graduation on test strip package. (The results above were obtained using the previous app version with its graduations of 0.5 pH units)

## Conclusion

The MQuant® pH 0-14 Universal Indicator strip in combination with the MQuant® StripScan app is a quick and easy way to analyze the pH-values in soil samples. The measured values are comparable to those measured with the Reflectoquant® test and the pH electrode.

## References

1. Khaled, F.; Sayed, A. Soil pH and Its Influence on Nutrient Availability

and Plant Health. *Int. J. Adv. Chem. Res.* **2023**, 5 (2), 61–63. DOI: 10.33545/26646781.2023.v5.i2a.204.

2. ISO 10390:2021. Soil, Treated Biowaste and Sludge — Determination of pH; International Organization for Standardization: Geneva, Switzerland, **2021**. <https://www.iso.org/standard/75243.html>.
3. DIN EN 15933:2012-11. Sludge, Treated Biowaste and Soil — Determination of pH; Deutsches Institut für Normung: Berlin, Germany, **2012**. <https://www.din.de/en/getting-involved/standards-committees/naw/din-standards/wdc-beuth:din21:175880818>.

## Featured Products

| Description                                                                   | Cat. No. |
|-------------------------------------------------------------------------------|----------|
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| MQuant® pH Indicator Strips pH 0–14 Universal Indicator                       | 1.09535  |
| <b>Products for sample preparation</b>                                        |          |
| Calcium chloride dihydrate for analysis EMSURE® ACS, Reag. Ph Eur             | 1.02382  |
| Distilled water (e.g., from a suitable Milli-Q® system) or water for analysis | 1.16754  |

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