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The potential for a simple method for *in situ* faecal sludge pH determinations

C. Bourgault, J. M. Laurens & C.C. Dorea (Canada)

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pH is a critical parameter for faecal sludge characterisation. However, basic laboratory facilities with such instrumentation are not always available in resource limited contexts. Furthermore, the operational importance (e.g. during lime stabilisation) of this parameter warrants a method that can be applied in situ. This study assesses the potential of a method for in faecal sludge pH determinations using a commercially-available soil pH meter. Results reveal that this simple and low-cost method can relatively reasonably estimate pH when compared to a conventional laboratory pH meter. Further work is necessary to better characterise its limitations.

Introduction

pH is a measure of the acidity or basicity of a matrix (i.e. liquid or semi-solid). It is a critical parameter in faecal sludge characterisation with many practical applications. As reviewed by Niwagaba et al. (2014) the pH of FS (from septic tanks) is usually between 6.5 to 8.0. pH plays an operationally important role during different biological treatments (e.g. composting or anaerobic digestion), as microbial processes are many times sensitive to specific pH ranges. Such processes often require near neutral pHs. Also, in the chemical treatment of faecal sludge (e.g. lime stabilisation) monitoring of this parameter is important. Substantial pathogen inactivation of pathogens can be achieved at pHs of 12 or higher (Polpraset & Valencia 1981).

Photograph 1. Collection of faecal sludge sample for analysis in Durban (South Africa).

Source: C. Bourgault

pH determinations of faecal sludge samples typically rely on approaches adapted from conventional wastewater treatment. Strande et al. (2014) cite the use of the method as prescribed in the *Standard Methods*

(APHA 2005). The Pollution Research Group of University of KwaZulu-Natal (Durban, South Africa) has conducted extensive characterisation of faecal sludge samples (Reddy 2013) using a method based on the USEPA Method 9040C (USEPA 2015). However, both of these methods (APHA 2005; USEPA 2015) require a conventional pH meter and probe, which may not be appropriate for resource limited contexts. Furthermore, at times such methods may also require dilution of samples in deionised water, for example, in samples of low water content (Photograph 1), which is not always available in basic laboratories in developing countries.

Conventional glass-type probes are widely used for pH measurement due to their relatively good sensitivity, selectivity, stability and long lifetime. However, such devices could present some disadvantages for pH measurement of on-site solids samples: for instance the need to dilute the samples, high-cost and their mechanical fragility. Consequently, non-glass based electrodes can be an attractive option over glass electrodes where robustness is necessary (e.g. field applications in developing countries). Commercially available soil pH meters may offer such advantages (i.e. relative simplicity, low cost, and robustness) for applications relevant to faecal sludge management. The objective of this study was to assess the potential for faecal sludge pH measurements using a commercially-available soil pH meter.

Materials and methods

A commercially-available dual probe pH Analyzer (Luster Leaf®, USA) soil pH meter (Photograph 2) was tested in acidic and alkaline conditions. To this end, the soil pH meter was placed in a 1 litre of deionised water in a beaker that sat on a magnetic mixer. The solution pH was adjusted to different acidic pHs with a HCl solution until a target pH of 3.0 was reached. The pH of the solution was also continuously measured against a "standard" HQ40d pH meter (HACH, USA) that was operated and calibrated according to the manufacturer's instructions. The soil pH meter was then rinsed and the deionised water changed prior to the subsequent alkaline condition testing. A similar test procedure was followed with the pH being gradually increased from neutral using a NaOH solution until a target alkaline pH of 9.0 was reached.

Photograph 2. Dual probe soil pH meter used in this study.

Source: JM Laurens

Results and discussion

Given the conditions tested, results indicate that overall a reasonable (in view of field applications in developing countries) estimation of pH can be achieved with the soil pH meter (Figure 1) with a good correlation between the conventional pH meter and the simplified method (R^2 = 0.9553). At acidic pHs (< 7.0), it seemed that a better correlation could be achieved between the simplified method and the conventional pH meter. However, at alkaline pHs (> 7.0), the soil pH meter seemed to overestimate the pH by almost a unit. The maximum reading on the soil pH meter was of 10.5. Thus, testing at higher pHs higher than 10.5 would not have yielded results of interest to this study given the trend of overestimation observed at alkaline pHs.

These preliminary results would indicate that the soil pH meter could be a potentially interesting option for in situ pH monitoring of biological treatment of faecal sludge. Treatment processes of interest typically require pH to be in the near neutral range for optimum results. However, the application of the soil pH meter may be precluded for faecal sludge chemical treatment such as lime stabilisation, due to the limitation on the maximum possible reading and the bias towards higher readings in the alkaline range (in the model tested).

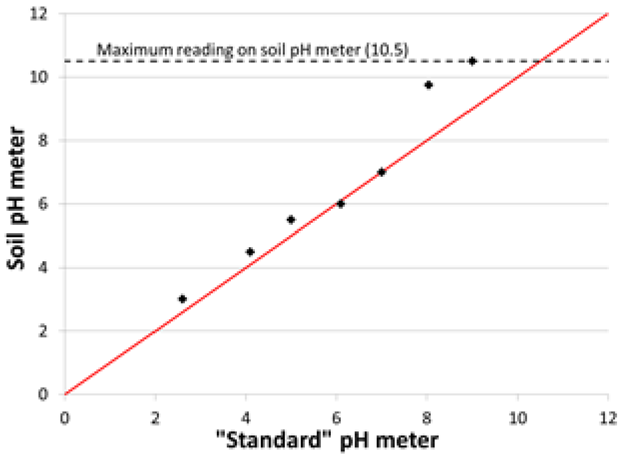

Figure 1. Comparison between "standard" and soil pH meters (solid line indicates 1:1).

Because of their low cost (the model tested was approximately 20 USD), relative availability, and ease of use to use (i.e. no required calibration or batteries), pH meters based on metal probes such as the one tested may be of interest for in situ measurements for some faecal sludge management applications. However, the limitations of such meters must be better characterised. Future work will involve the testing of such meters on faecal sludge samples, testing of other models, determination of reading stability over time, and influence of sample moisture content and chemistry.

Conclusions

Test results indicate a relatively reasonable overall estimation of pH using the soil pH meter assessed in the test conditions of this study. Better correlations were achieved in acidic ranges in comparison to the alkaline test range. Further work is warranted.

Acknowledgements

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Contact details
Caetano C. Dorea
Département de génie civil et de génie des eaux
Université Laval
Québec, QC
Canada G1V 0A6
Tel: +1 418 656 7763
Email: caetano.dorea@gci.ulaval.ca
caetanodorea@hotmail.com
www: http://www.gci.ulaval.ca/caetanodorea