Project-based learning on developing a novel technology for manure management

Moure Abelenda, A.*, Aiouache, F. & Roberts, J.
School of Engineering, Lancaster University, LA1 4YW, UK
*Corresponding author: a.moureabelenda@lancaster.ac.uk

Introduction

Farming is responsible for 30 % global anthropogenic emissions (Lal, 2021).

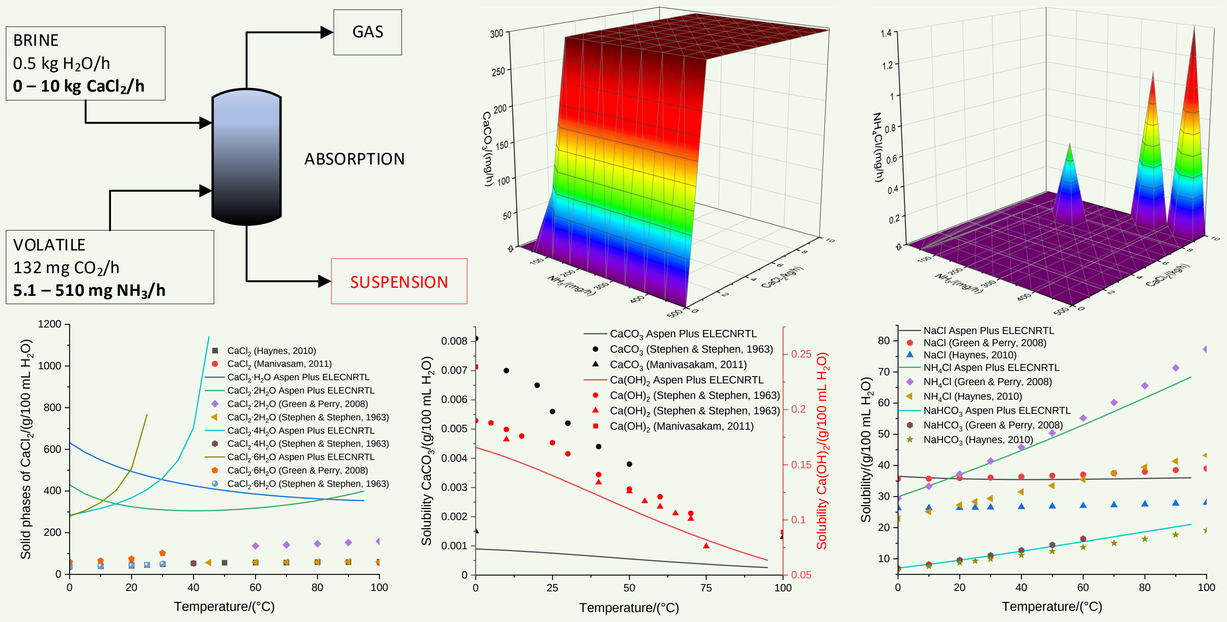
Static chamber method wide employed for measuring atmospheric pollution.

Modified Solvay process: $CO_{2(g)} + NH_{3(g)} + H_2O_{(l)} + NaCl_{(aq)} \rightarrow NaHCO_{3(s)} + NH_4Cl_{(aq)}$

Modelling with Aspen Plus® v12 on the potential material phases formation.

Previous investigations on likelihood of absorption of NH_3 in brine of $CaCl_2$.

$$CO_{2(g)} + 2\,NH_{3(g)} + H_2O_{(l)} + CaCl_{2(aq)} \rightarrow CaCO_{3(s)} + 2\,NH_4Cl_{(aq)}$$



Validation of simulation is useful task for youth to understand role in society.

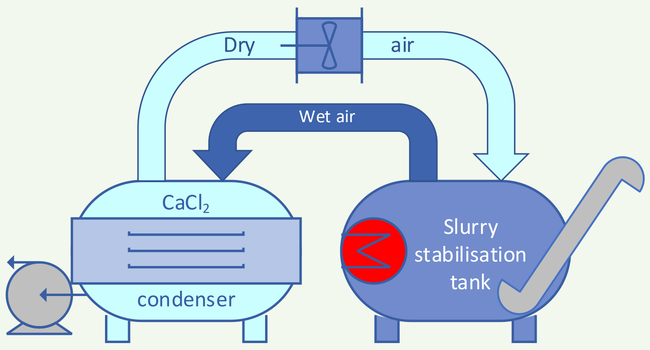
Educational needs at Advanced levels: Motivation and Significant Learning.

Doubts about active teaching-learning methods to meet curriculum content.

Methodology

5-day placement for 3 students (Year 12) on the In2ScienceUK programme.

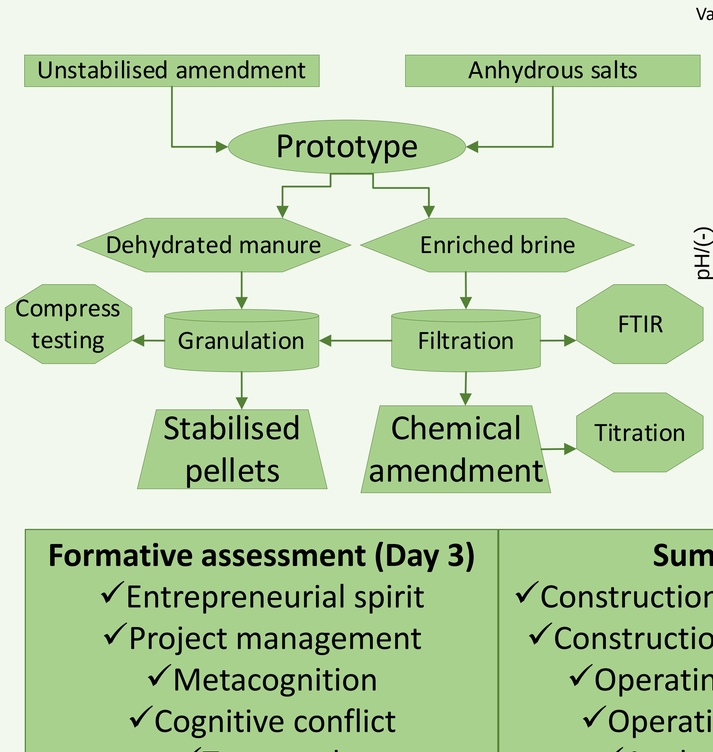
Improving the artefact to handle manure (Moure Abelenda et al., 2023a).

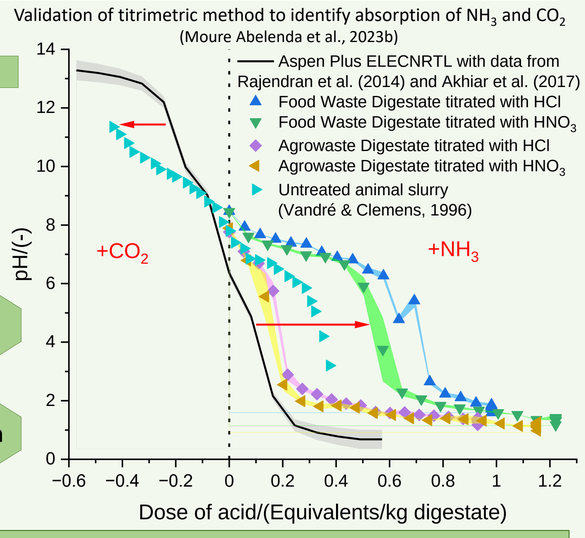


Analysis solid-liquid separation performance based on power consumption.

Titration of the resulting brine to determine the absorbed CO_2 and NH_3.

Compression testing of granular fertiliser with dewatered liquor as binder.





Formative assessment (Day 3)	Summative assessment (Day 5)
✓Entrepreneurial spirit	✓Construction of the prototype (cognitive exercise)
✓Project management	✓Construction of the prototype (physical activity)
✓Metacognition	✓Operating the artefact (cognitive exercise)
✓Cognitive conflict	✓Operating the artefact (physical activity)
✓Teamwork	✓Analysis of results (cognitive exercise)
	✓Analysis of results (physical activity)

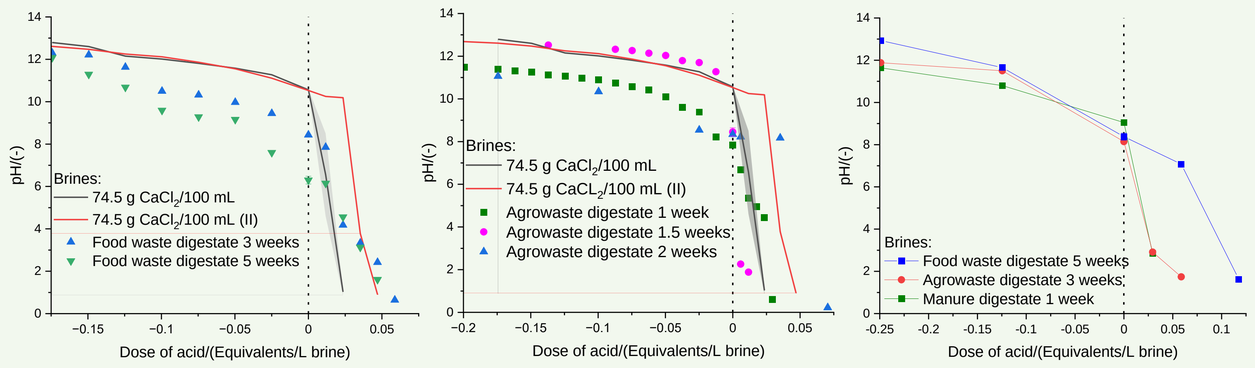
Results and discussion

Buffer capacity of the brine depended on: Manure type and Residence time.

Alkaline pH of the brine of $CaCl_2$ (deliquescent) favoured absorption of CO_2.

High ammonia content minimised the precipitation of $CaCO_3$ in the brine.

Titration curve of fresh brine 74.5 g $CaCl_2$/100 mL considered as reference.



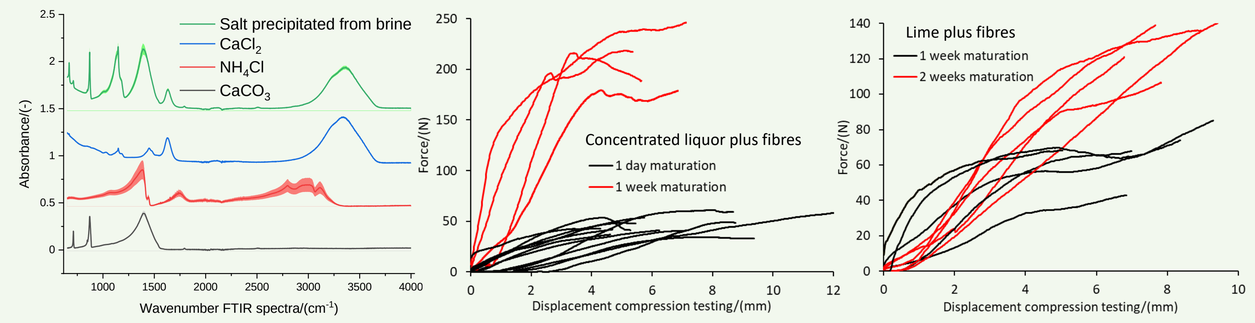
Identification of the type of crystals formation by comparing FTIR spectra.

The salt precipitated from the brine included $CaCl_2$, NH_4Cl, and $CaCO_3$.

Depleted brine was suitable as chemical amendment of untreated slurry.

Feasibility of using the precipitated salts as binding agents for granulation.

Maturation time enhanced binding capacity of dehydrated liquor and lime.

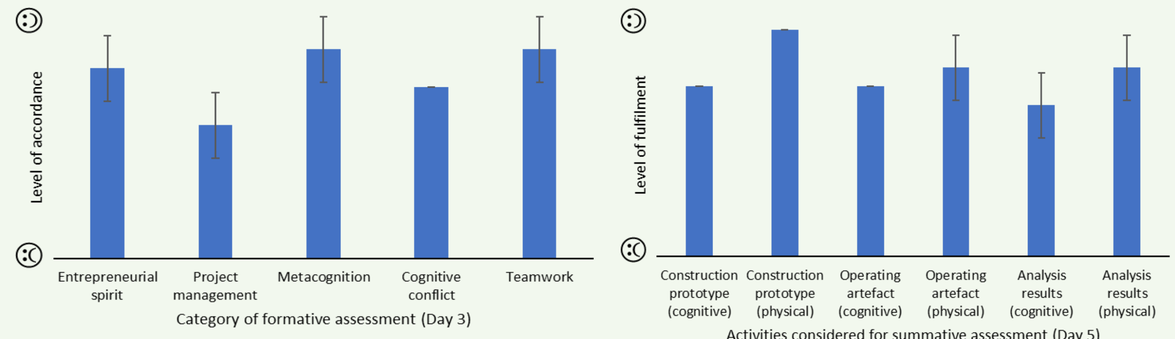


Prototype development enabled greater involvement of students in activity.

Increase in environmental awareness regarding function of organic matter.

Positive evaluation of students' satisfaction during event and at the end.

Holistic approach covering chemical, mechanical, and electrical engineering.



(Moure Abelenda et al., 2023c)

Conclusions

Artefact operation offered promising results to be adopted by stakeholders.

Didactic tool was found suitable for A-level students (secondary education).

Acknowledgements

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