National Technical University of Athens

GLOBAL WtERT COUNCIL

WORLD BIOGAS ASSOCIATION

THESSALONIKI2021

Nitrogen and phosphorus recovery from swine manure

I. González-García[1], V. Oliveira[2], B. Molinuevo-Salces[1], B. Riaño[1], M.C. García-González[1], C. Dias-Ferreira[2,4]

Mail: gongarib@itacyl.es

[1]Agricultural Technological Institute of Castilla y León (ITACyL) Ctra. Burgos, km. 19, 47071 Valladolid, Spain.
[2]Research Centre for Natural Resources, Environment and Society (CERNAS), College of Agriculture, Polytechnic Institute of Coimbra, Bencanta, 3045-601 Coimbra, Portugal
[4]Universidade Aberta, Lisboa, Portugal

INTRODUCTION

The use of organic fertilizers such as livestock wastewaters for agricultural production, will be a practical demonstration of circular economy in action, with many economical and environmental advantages.

Nevertheless, the efficiency of nutrient use through the whole food chain should be increased

Nutrient Use Efficiency for Nitrogen = 20%
Nutrient Use Efficiency for Phosphorus = 30%

Low NUE = large leakage of nutrients **=** health problems and environmental issues

INTRODUCTION

Environmental issues driven by nutrient loss:

- Water: eutrophication due to N and P leaks (reduction of water quality and biodiversity)
- Atmosphere: NOx and NH_3 reduce air quality and affect human health. N_2O and methane contribute to climate change

INTRODUCTION

What to do: To avoid nutrient losses and increase nutrient recovery, increasing NUE.

How to do it: Applying technologies that can be used in the key waste streams to recover nutrients with sufficient quality, safe, easy to store, and easy to use by farmers.

OBJETIVE OF THIS WORK

METHODOLOGY

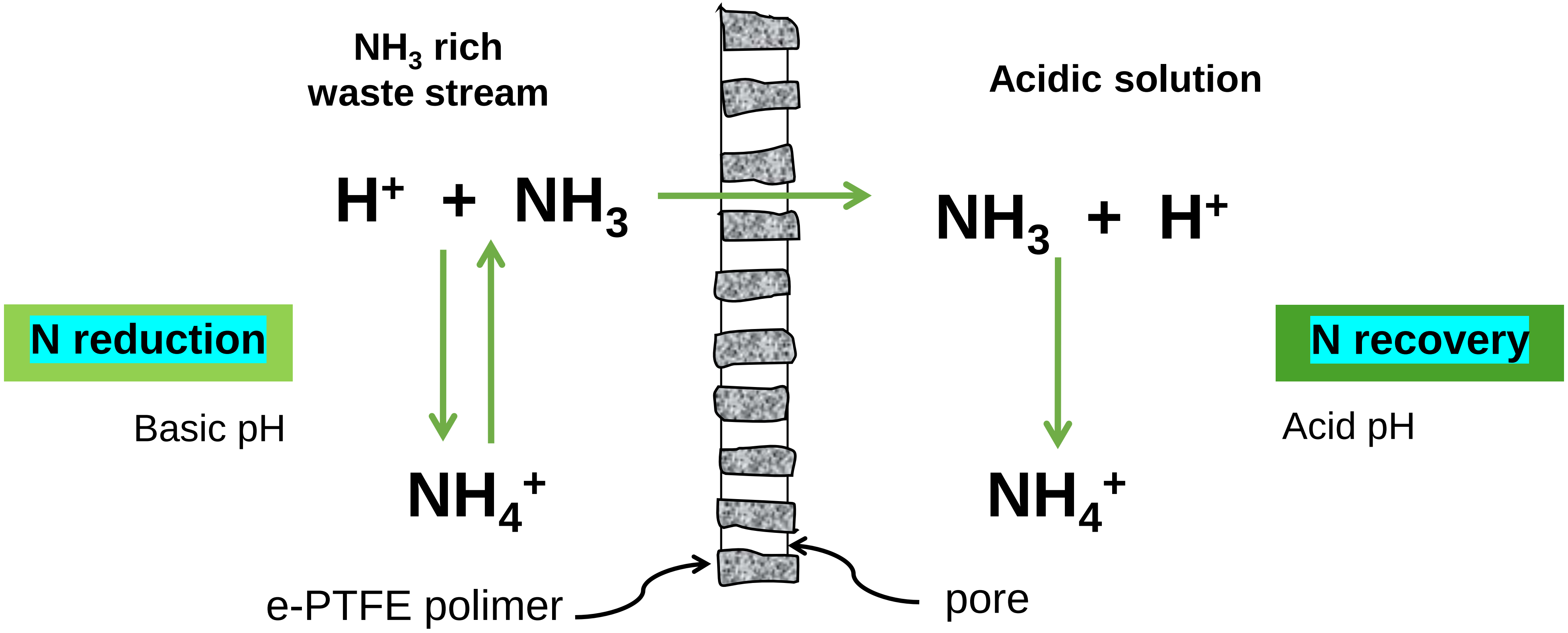
The experiments designed and implemented for the N and P recovery from swine manure, had two phases:

A) FIRST PHASE: N was recovered from swine manure using gas-permeable membrane (GPM) technology

B) SECOND PHASE: P was recovered from the previously treated swine manure, using an electrodialytic process, which involves the use of ion-exchange membranes

METHODOLOGY: FIRST PHASE

N recovery with gas-permeable membrane technology



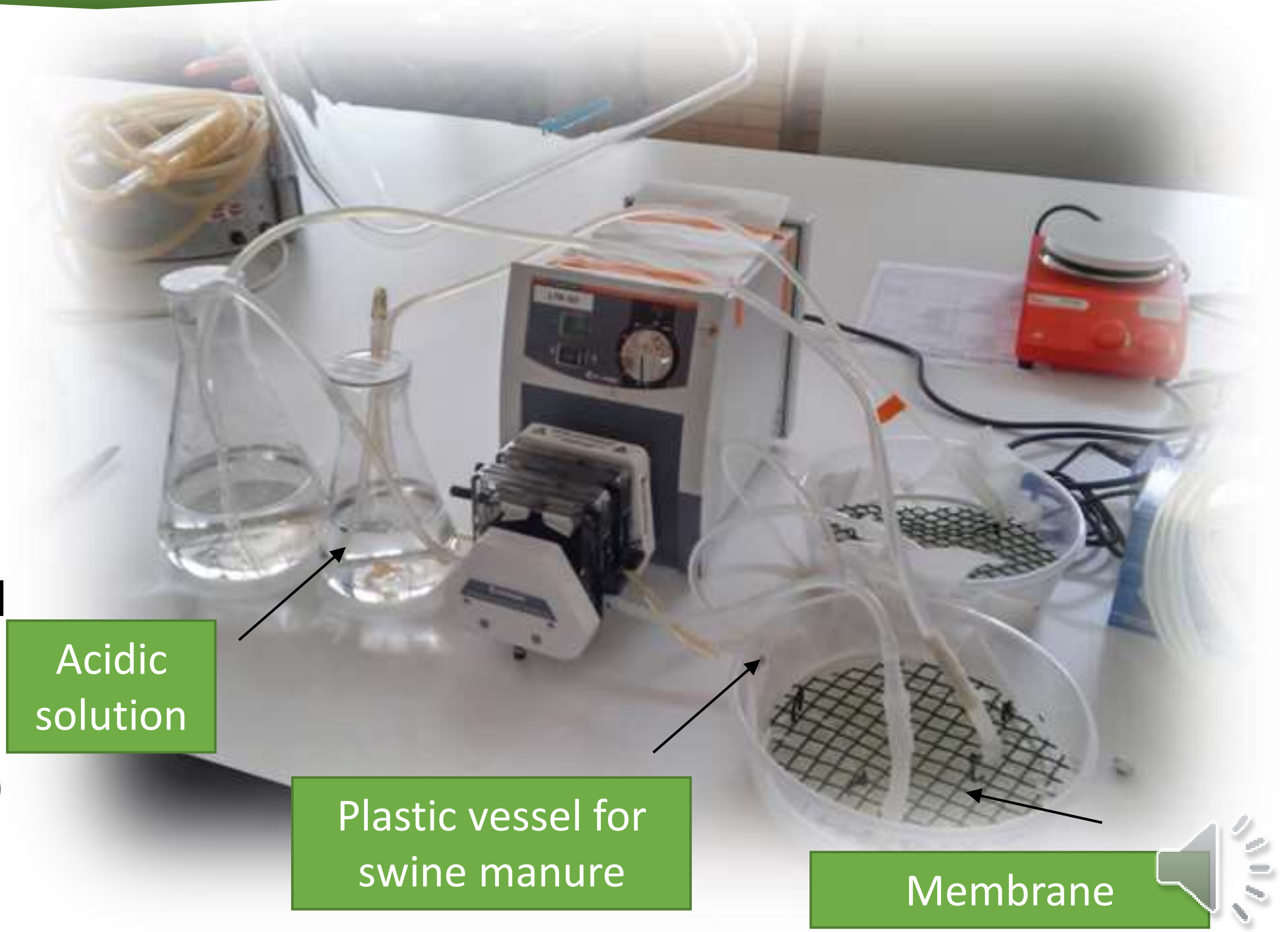
METHODOLOGY: FIRST PHASE

Inside the membrane submerged in the swine manure, recirculates the acid solution (H_2SO_4), recovering the ammonia as ammonium sulphate solution.

The swine manure was constantly agitated and low aeration was used.

To maximize this recovery the acidic solution pH was kept at pH <2

The amount of N recovered daily (mg NH_4 + L^{-1}) and the pH were monitored.

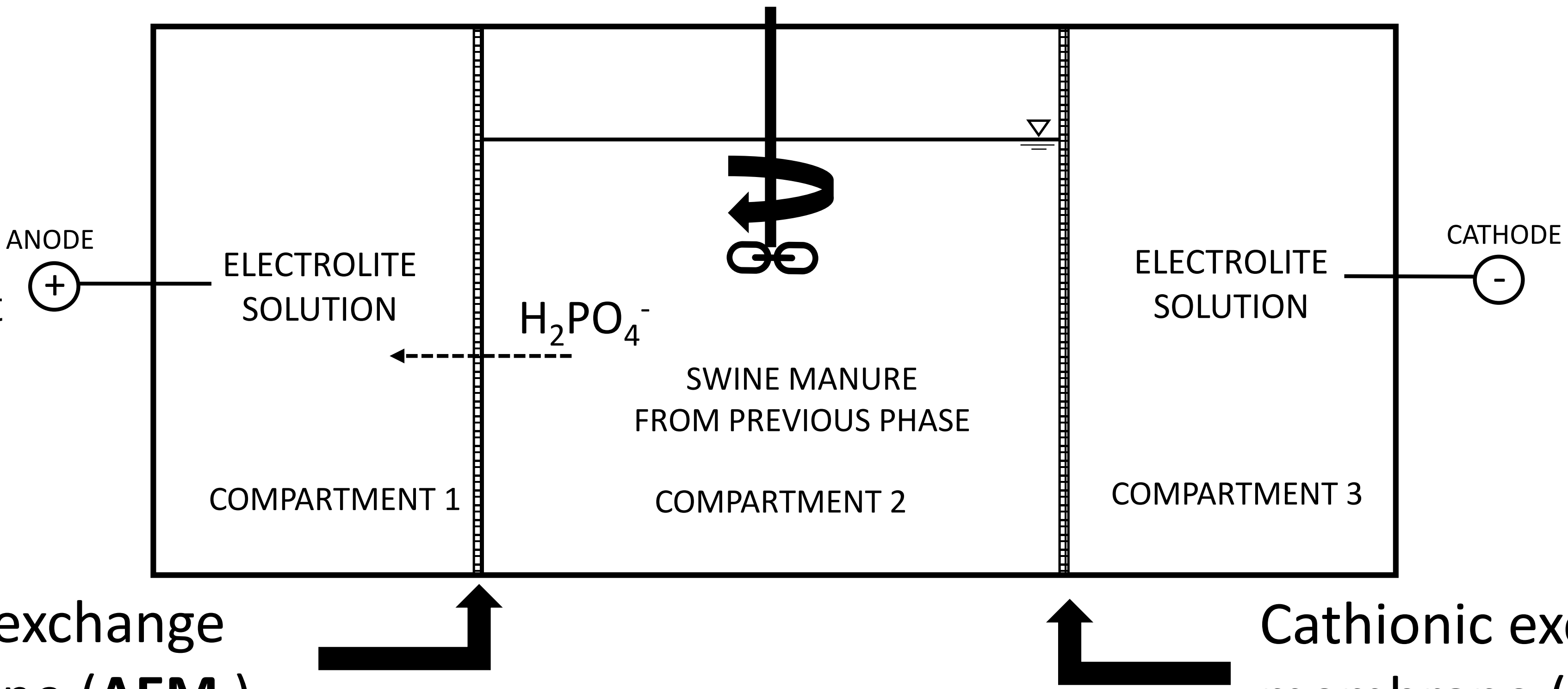


METHODOLOGY: SECOND PHASE

P recovery with electrodialytic process

The previously treated swine manure was put in compartment 2, and it was constantly agitated.

The electrical current is responsible for the ions movement from the residue to the electrodialitic solution.



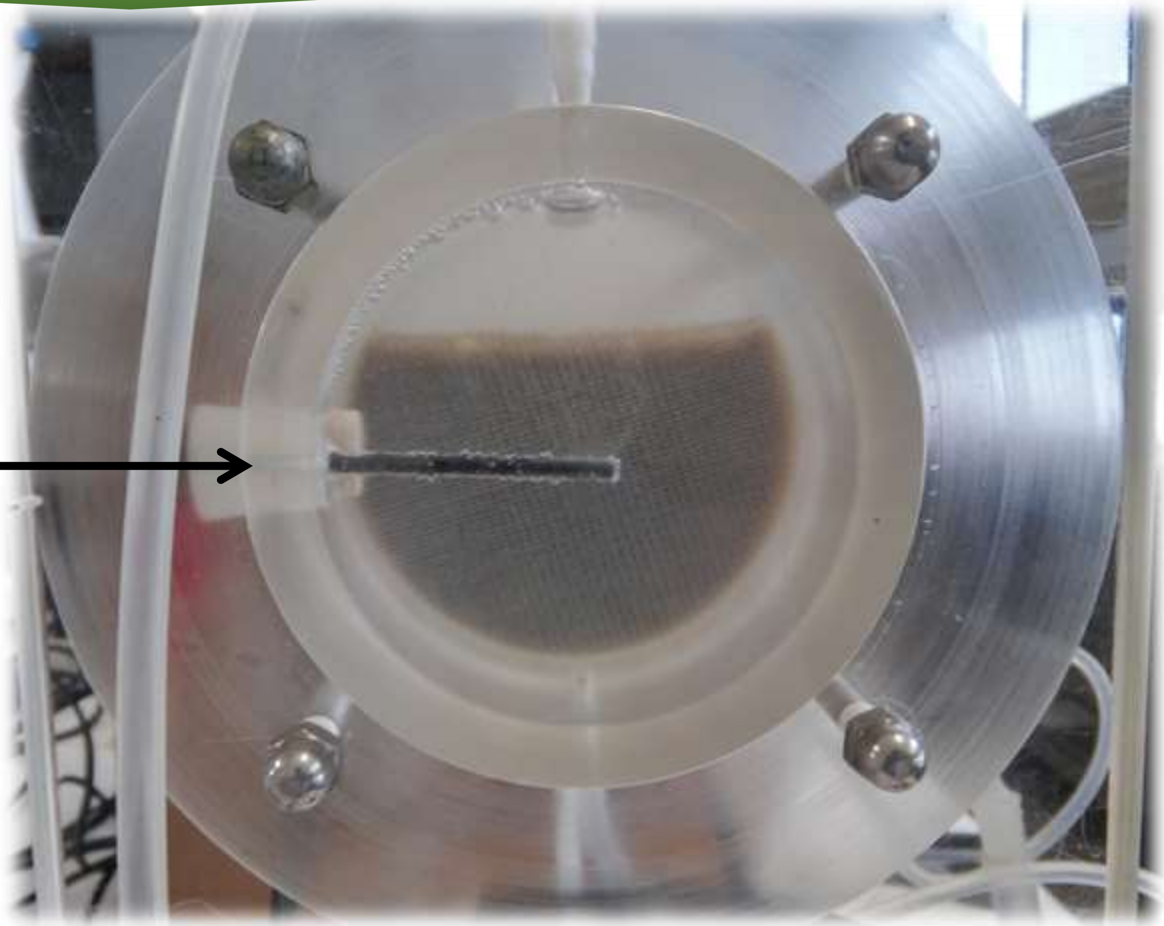
Compartments 1 and 3 contained $NaNO_3$ as electrolyte, to recover cations and anions respectively

Anionic exchange membrane (**AEM**)

Cathionic exchange membrane (**CEM**)

METHODOLOGY: SECOND PHASE

Water splitting in the anionic membrane keeps low the pH of the residue

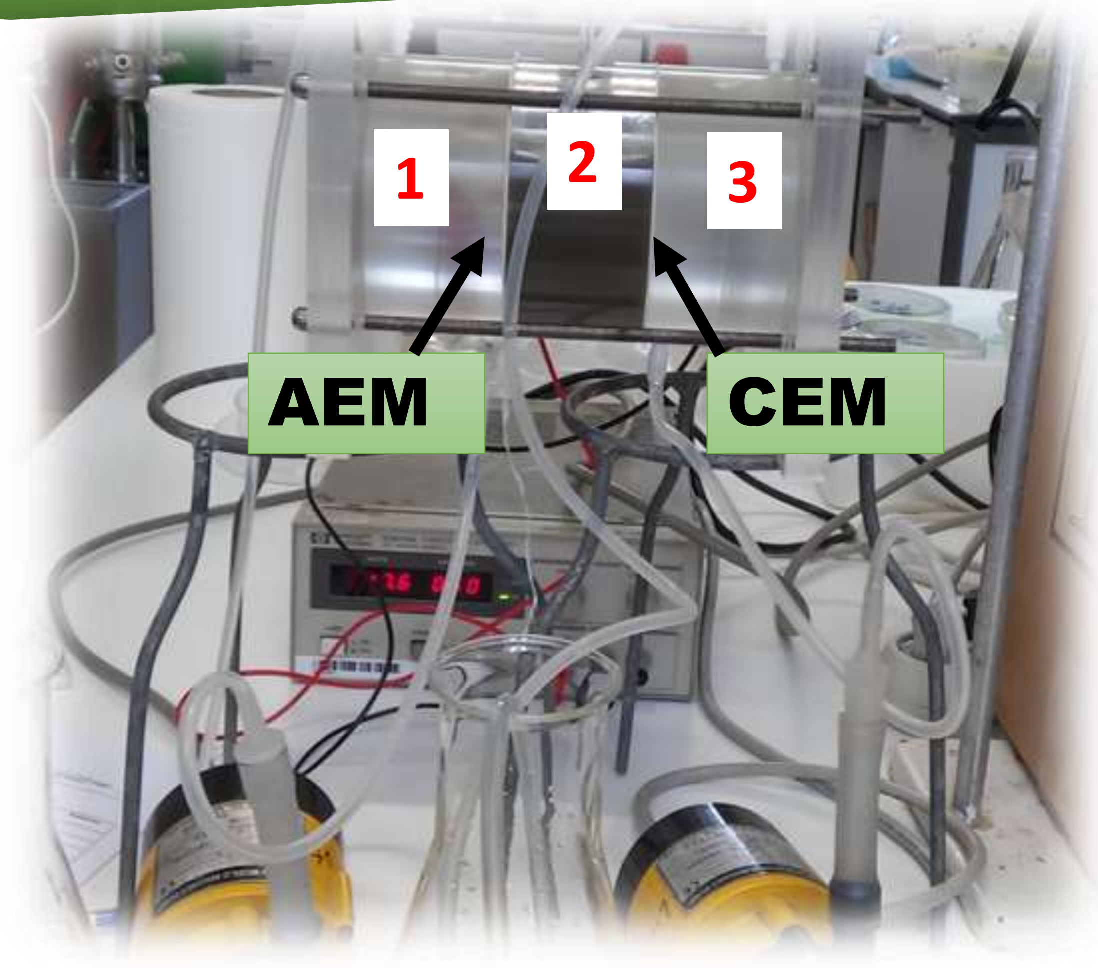


METHODOLOGY: SECOND PHASE

The recirculation of the electrolityc solution as made with a pump, between the corresponding compartment and an external flask. The power supply mantained a current of 50 mA.

Samples of the manure and the electrolyte solution in each flask were taken daily to monitor the pH and conductivity and to analyse the amount of P.

The voltage and the electric current were also monitored daily.

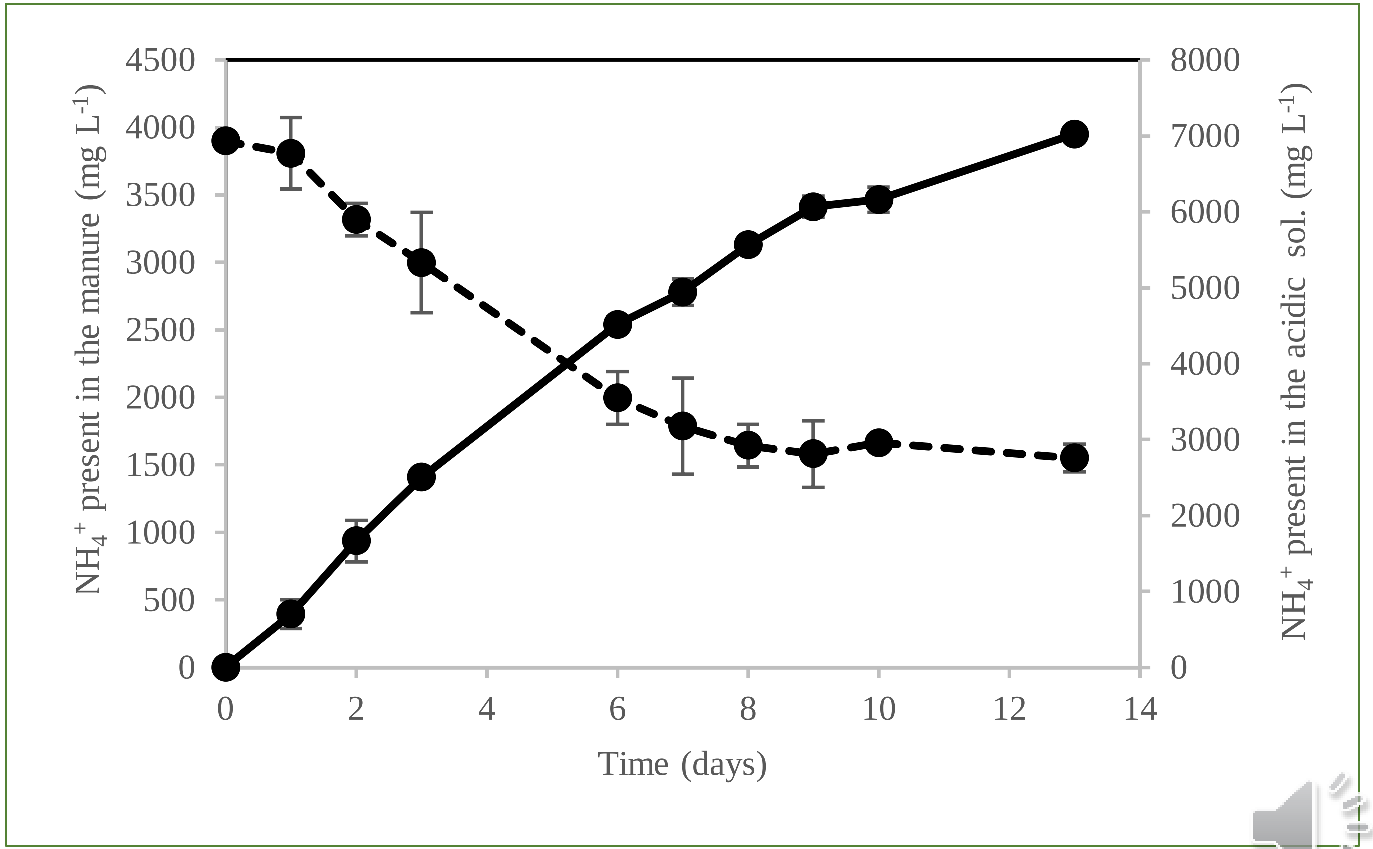


RESULTS: FIRST PHASE

The first phase was carried out for 13 days.

It was observed a decrease of NH_4^+ in the manure, from the initial concentration of 3900 mg NH_4^+ L^{-1} to 1550 mg NH_4^+ L^{-1}, which means an NH_4^+ removal of 2080 mg of NH_4^+, 60% of the initial amount of NH_4^+

Recovery of 51% of the removed ammonia in the acidic solution

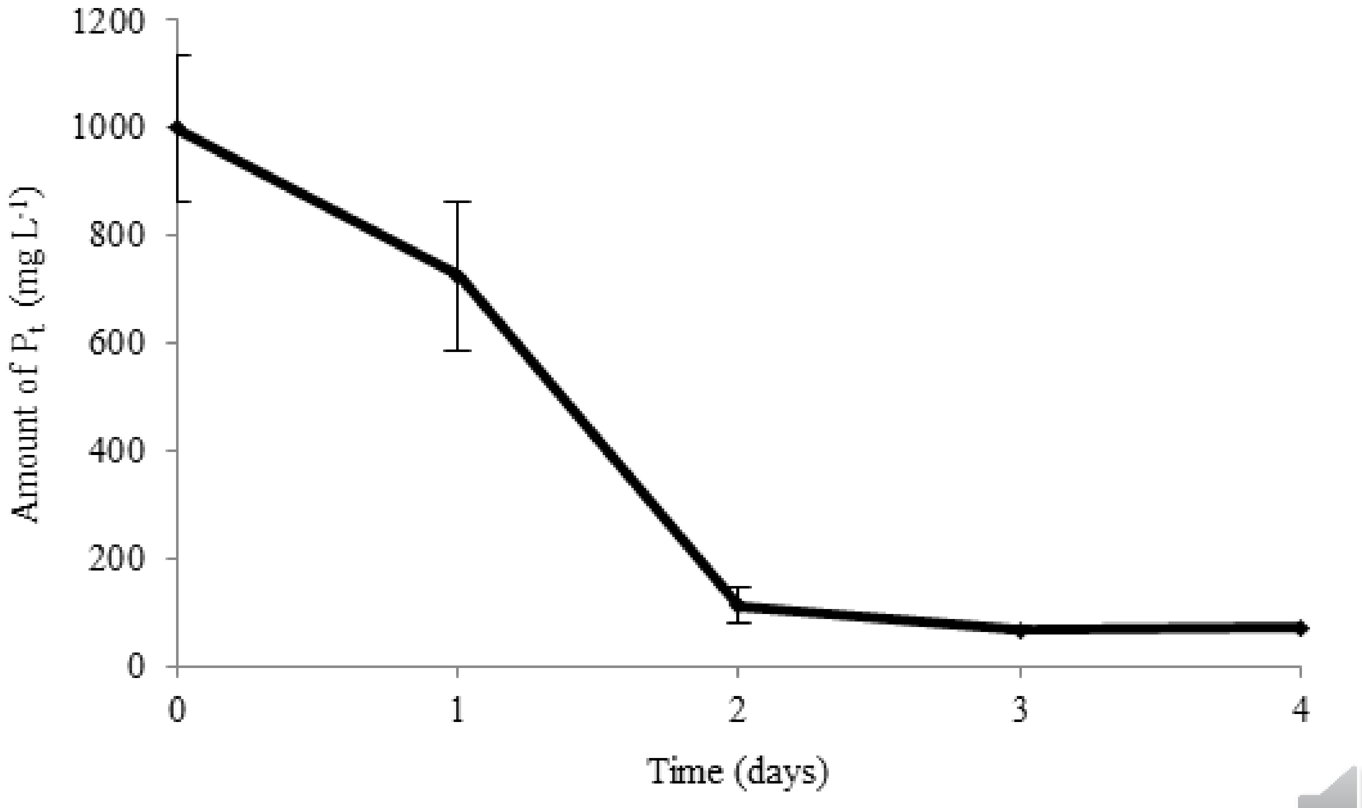


RESULTS: SECOND PHASE

The second phase were conducted for 4 days.

The initial concentration of P of the manure was 1000 mg L^{-1}, and during the experiment, the amount of P decreased reaching a final value of 110 mg L^{-1} .

Recovery of 89% of the initial P into the electrolytic solution.



CONCLUSIONS

<u>AMMONIUM SULPHATE SOLUTION :</u>

NO NEED OF FURTHER TREAMENT

EASY TO STORE AND SAFE

APPLICATION (FETIGATION) AS LIQUID BIO-BASED FERTILIZER

<u>P RICH SOLUTION :</u>

PRECIPITATION AS STRUVITE

EASY TO STORE AND SAFE

APPLICATION AS

SLOW-RELEASE BIO-BASED FERTILIZER

CONCLUSIONS

The results of this study showed the **great potential** of combining gas-permeable membrane + ion exchange membranes for nutrient recovery and reuse

National Technical University of Athens
GLOBAL WtERT COUNCIL
WORLD BIOGAS ASSOCIATION

THESSALONIKI2021

Thank you

This study was supported by FEDER- INIA project: RTA 2015-00060-C04-C01. Isabel González was supported by a grant from the Spanish National Research Agency (Agencia Estatal de Investigación, AEI) training program of research staff under the grant number BES-2017- 082327.

This work has also been funded by project 0340-SYMBIOSIS-3-E and 745_Symbiosis_3_E co-funded by FEDER "Fundo Europeu de Desenvolvimento Regional" through Interreg V-A España-Portugal (POCTEP) 2014-2020. Verónica Oliveira has been funded through FCT "Fundação para a Ciência e para a Tecnologia" by POCH – Programa Operacional Capital Humano within ESF – European Social Fund and by Portuguese national funds from MCTES (SFRH/BD/115312/2016). CERNAS is funded by the FCT – Portuguese Foundation for Science and Technology (UID/AMB/00681/2013).