Phosphorus recovery from sewage sludge by an electrokinetic process

Ribeiro, A.B.; Couto, N.; Mateus, E.P.; Guedes, P.; Ottosen, Lisbeth M.

Publication date:
2012

Phosphorus recovery from sewage sludge by an electrokinetic process

[1]Ribeiro A.B., [1,2]Couto N., [1]Mateus E.P., [1,2]Guedes P., [2]Ottosen L.M.

1.CENSE-Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal.

2.Department of Civil Engineering, Building 118, Technical University of Denmark, DK-2800 Lyngby, Denmark

Background

❖ As population keeps growing, it becomes important to guarantee the supply of staple foods, being necessary to assure good level of nutrients in the soil. Phosphorus (P) is a macronutrient indispensable for plants growth and a non-renewable resource, as phosphorites are estimated to be able to supply P for the next ca. 80 years. Additionally, the quality of this raw material has deteriorated due to contamination, which has increased processing costs of mineral P fertilizers. The recovery of nutrients, like P, from secondary resources urges.

❖Waste streams as sewage sludge (SS) and sewage sludge ash (SSA) may contain contaminants or unwanted elements regarding specific applications, but they also contain secondary resources of high value (e.g. elements with fertilizer value).

❖ The incineration of SS is an highly used technique, namely in the Northern part of Europe. With SS incineration, the matrix volume will be significantly reduced and, at the same time, organic contaminants (such as PCB, PAH, …) will be thermally destructed.

❖ However, heavy metals still remain in the ashes and, to "re-use" them as fertilizer, inorganic contaminants should be removed. Electrokinetic transport process (EK) can be an option to promote metal removal from SSA, allowing its potential re-use in agriculture or, followed by a next treatment step, phosphorous could be extensively removed from SSA matrix and further recovered in an electrolyte compartment.

Methodology

Sampling plan and ash characterization

❖ Samples were taken from an incineration plant, in Copenhagen, Denmark.

❖ Ashes were characterized accordingly to standard methodologies.

Electrokinetic experiments

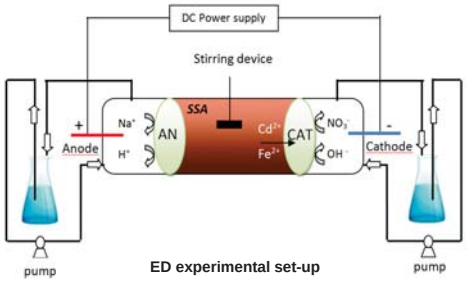
❖ Electrodialytic (ED) process, laboratory scale.

Central cell compartment: L = 10 cm; internal diameter = 8 cm

Electrolytes = 500 mL $NaNO_3$ (0,01 M)

❖ Cat = cation exchange membrane, CR67HUYN12116B and AN = anion exchange membrane, 204 SZRA B02249C, both from Ionics, were used

❖ Conditions: DC current of 50 mA, 7 days, acidified medium in the central compartment (pH ≈ 2); working electrodes were platinised titanium bars from Permaskand, with a diameter of 3 mm and length of 5 cm.



ED experimental set-up

Objectives

❖ Main objective of the work: study the potential as well as the applicability of EK process to remove metals from SSA and to recover P from SS, in this case, also searching for matrix remediation

❖This work discuss the suitability of the process to remove heavy metals from SSA to further re-use the phosphorous that is incorporated.

Results

Ash characterization

SSA presented an alkaline pH and the following characteristics:

Parameter	Data	Element	g/kg	Element	g/kg	Element	g/kg
Water content (%)	0.1 ± 0.2	Zn	3.52	Ca	162.53	Na	7.50
Solubility (%)	0.82 ± 0.01	Al	22.31	Cd	0.03	Ni	0.07
Conductivity (mS/cm)	3.2 ± 0.5	As	0.14	Cr	0.04	P	133.82
Loss on ignition (%)	0.15 ± 0.05	B	0.03	Cu	0.87	Pb	0.43
Gas production ($CaCO_3$ %)	1.6 ± 0.1	Ba	1.07	Sn	0.21	Se	0.05

Electrokinetic experiments

Phosphorous is present in SSA matrix, which shows the possibility of it being re-used in agriculture after metals removal. Otherwise, another ED step can be carried out to remove P to the anolyte compartment.
Experiments are being carried out in a laboratory cell for process optimization regarding metal removal.

Discussion and Conclusions

❖ It is expected that the application of a low-level direct current onto the fly ash segment could result in electro-migration flow, which will possibly be able to induce the migration of ions. Therefore, ED treatment could be considered an adequate alternative to reduce metals concentration in SSA prior to use as fertilizer.

❖ For this reason, ED seems to be promising in terms of being a sustainable option to recover P and handle with phosphate rock increasingly scarcity.

❖ Additional ED preliminary experiments are ongoing (results not shown); the set of major parameters, which affect the efficiency of ED process (e.g. pH, time) are also being tested and optimized.

Acknowledges: Financial support for the work is provided by projects FP7-PEOPLE-2010-IRSES-269289* ELECTROACROSS - Electrokinetics across disciplines and continents: an integrated approach to finding new strategies for sustainable development, and PTDC/ECM/111860/2009 - Electrokinetic treatment of sewage sludge and membrane concentrate: Phosphorus recovery and dewatering. N. C. acknowledges Fundação para a Ciência e a Tecnologia for her Post-Doc fellowship (SFRH/BPD/81122/2011).

CENSE center for environmental and sustainability research

FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

Technical University of Denmark DTU

9th ISEG