Potential of using synthesized Nano-zeolite for Nitrogen and Phosphors removal

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Introduction

Main aim:
Find the right nanomaterials for dairy wastewater treatment:

- Cheap,
- Easy to fabricate
- Efficient,
- Easy to recycle/reuse.

- Assess the performance of nanomaterials on removal of nutrients and organic contaminants from dairy wastewater and optimum nanomaterials structures and operational conditions

- Nano-zeolite was chosen as a candidate.

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Nano-zeolite

- Nano-zeolite refers to Nanocrystalline zeolites, namely zeolites with crystal sizes less than 100 nm, have resulted in increased surface area and decreased diffusion path lengths, enhanced ion exchange properties and high potential environmental decontamination.

- Chen et al. (2012) investigated the simultaneous sequestration of ammonium and phosphate from anaerobically digested swine wastewater using Nano-zeolites synthesized from fly ash (FA).

- It is hypothesized that NZ for treatment of dairy wastewater may allow simultaneous removal and recovery of Nitrogen and Phosphorus.

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Method

- Coal fly ash (FA) was obtained from the Moneypoint thermoelectric power plants located in Co. Clare. Nano-Zeolite (NZ) was synthesized via alkaline hydrothermal treatment.

- X-ray Diffraction (XRD) and Scanning electron microscopy (SEM) were performed on the samples (FA and NZ) to analyze their Chemical composition. The cation exchange capacity (CEC) and the phosphorous sorption index (PSI) of solids (FA and NZ) was also studied.

- Batch immobilization experiments with synthesized wastewater(SW, ammonium=100mg/L, Phosphate= 50mg/L) were performed to study the sorption efficiency of FA/NZ on ammonium and phosphate by adding 0.5g samples into 50ml SW (1g/100ml). Samples were shake at a speed of 250rpm and collected at each setting time and centrifuged for analysis.

- Sorption isotherm tests were conducted at different concentration of ammonium (50, 100, 150, 200, 250mg/L) and phosphate (25, 50, 90, 130, 170mg/L) solution.

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Nano-zeolite characterization

The characterization of NZ have been done by SEM and XRD.

- SEM observation of the FA showed the presence of micro-particles in the shape of smooth balls.
- NaOH solution affected the FA by deforming ball-like shape and changing smooth surface into various irregularly shaped of crystals, e.g., plates and rods.

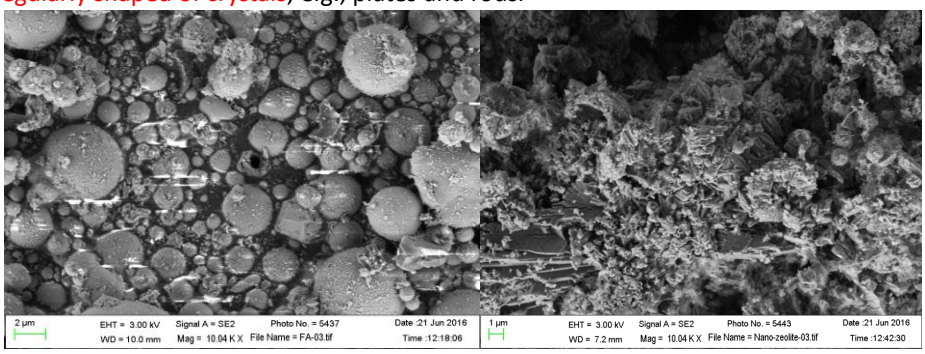

Figure 1. SEM images of the FA and the NZ.

Nano-zeolite characterization

The XRD images shows that main mineralogical components changed from quartz and mullite (FA) to NaP1 (Na6Al6Si10O32·12H2O) (NZ).

As a result, the change of microscopic structure enhanced the CEC and PSI of the NZ versus the untreated FA.

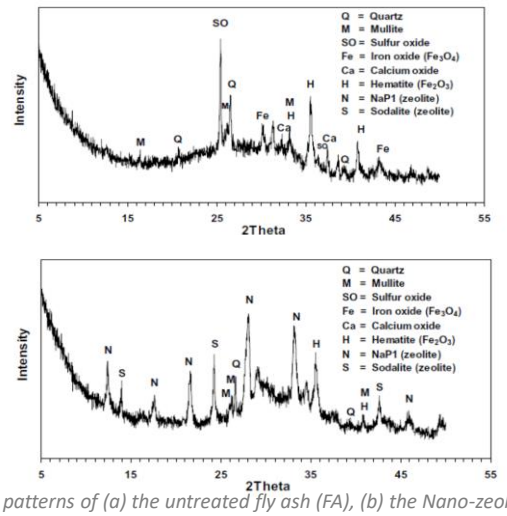

Fig. 2. XRD patterns of (a) the untreated fly ash (FA), (b) the Nano-zeolite (NZ).

constituent	FA(%)	NZ(%)
SiO2	41.8	49.2
Al2O3	14.6	15.1
Na2O	3.5	2.6
K2O	4.3	2.7
CaO	9.6	9.4
Fe2O3	7.1	8.2
MgO	0.3	2.5
CEC (cmol/kg)	1.78	117
P sorption index (PSI g/kg)	3.78	12.6

Table 1. Chemical composition, surface area and cation exchange capacity (CEC) of raw fly ash (FA) and zeolite synthesized from fly ash (NZ).

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Result

- The removal efficiencies of N and P in SW over time at the Nano-zeolite dosage of 1 g/100 ml can be seen in Fig. 3.
- The reactions reached equilibrium in 60 mins, the concentration of NH4-N decreased from 118 to 35 mg/L (71% removal) while the concentration of PO4-P decreased from 52 to 45 mg/L (12% removal) .
- The sorption capacity of NZ on ammonium and phosphate are 7.8mg/g (R2= 0.883) and 1.2 mg/g (R2= 0.732) after fitted with Langmuir isotherm model.

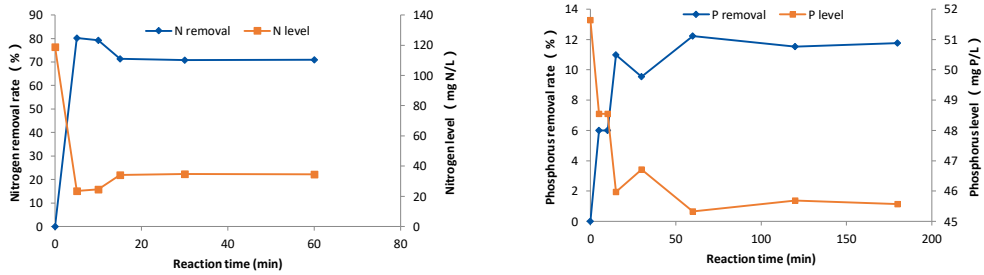

Figure 3. Average removal rate (%) and level of Nitrogen and Phosphorus (mg/L) by Nano-zeolite

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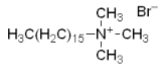
Surface modification

- Due to the negative charge on the surface, NZ shows little affinity for anions aqueous solution. To change the surface properties, Hexadecyltrimethylammonium (HDTMA) was employed as an organic surfactants.



- 10 g of NZ and 50 mL HDTMA solution of a concentration of 3g/L was mixed in a reciprocal shaker at 200 rpm and 25 °C for 8 h. Then, the solids were collected by precipitation and washed several times with DI water until no Br– was detected by AgNO3 solution. Finally, the solids were dried at room temperature (25 ° C).

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Surface modification

- The sorption capacity of NZ on N and P are 7.8mg/g (R2= 0.883) and 1.2 mg/g (R2= 0.732) after fitted with Langmuir isotherm model.
- the predicted maximum monolayer sorption capacity for ammonium and nitrate were found to be 6.95 and 2.58mg/g,

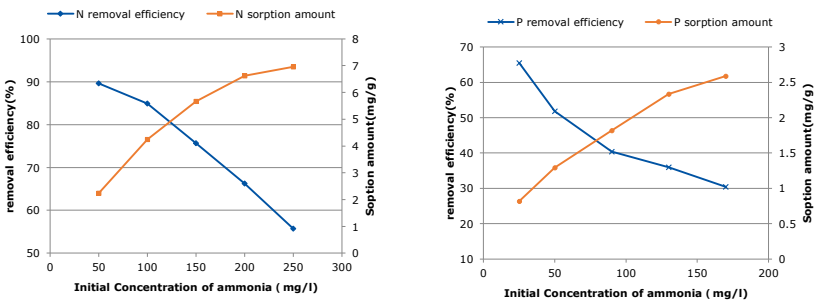

Figure 3. Effect of initial concentration of ammonium and phosphate on modified NZ sorption (surfactant dosage 3 g/L; reaction time 8 h).

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THANKS