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Title: Testing low-cost materials for nutrients adsorption in wastewater.

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Abstract

The following study was conducted on behalf project ''Supporting OWSSB in upgrading Capacity in Wastewater and faecal Sludge Management (SO-WOP)''. The project aims to improve capacity of the Odisha Water Supply and Sewerage Board (India), to effectively manage wastewater treatment, to introduce low-cost technology, to carry out pilot interventions and explore the possibilities to reuse treated wastewater and sludge in a ''capacity development'' approach. In this project, the Jatni septage treatment plant was selected as a benchmark case study. The plant is composed by a receiving chamber with screen, settler thickener, anaerobic baffled reactor, planted gravel filter (PGF), polishing pond, and sludge drying beds. After the technical assessment, the activity was focused on improving the removal of nutrients. With this regard, tests for the phosphates and ammonium adsorption by mean of low-cost adsorption media were conducted.

The first phase consisted in batch tests with the objective of characterizing the adsorption isotherms. Four adsorbents were evaluated: two types of active carbon, raw biochar and zeolites (clinoptilolite). Batch tests consisted in introducing a known mass of sample in a mixed reactor and, after the equilibrium time, measuring the contaminant equilibrium concentration. For each sample, 10 g of adsorbent were placed in test tubes. The tubes were filled with a solution of 50 ml of water and contaminant (ammonium or phosphate) at known concentration. The tubes were then mixed for 14 hours at 21°C. The contaminant concentrations in the liquid phase were finally measured.

The resulting isotherms of ammonium adsorption by clinoptilolite is reported in Figure 1. The adsorption capacity at equilibrium was also calculated according to:

$$Q = \frac{C_0 - C_{eq}}{m_{ad}} * V$$

where Q is the adsorption capacity [mg/g], C_{eq} is the contaminant concentration in the liquid phase [mg/l], C_o is the initial contaminant concentration [mg/l], V is the volume of solution [l], and m_{ad} is the mass of adsorbent [g].

The results of ammonium adsorption capacity of different materials are reported in Table 1. For phosphates, activated carbon showed higher adsorption capacity than zeolites. Adsorption capacity of biochar was found to be close to zero. This is in partial contrast with other scientific publications, which report adsorption capacity for biochar higher than zero.

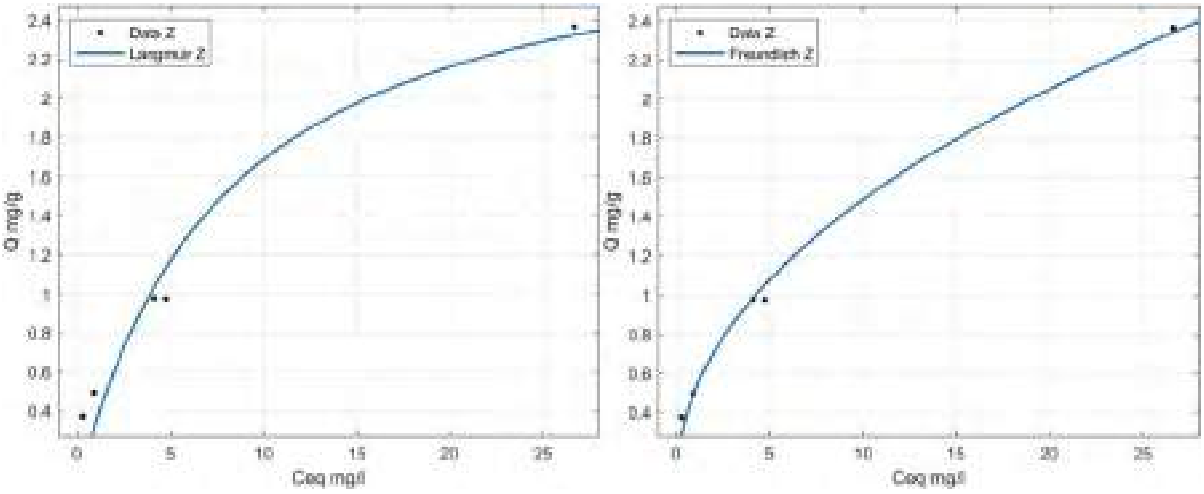

Figure 1 : Langmuir (left) and Freundlich (right) isotherm fitting for ammonium adsorption with zeolites at 21 °C.

Table 1. Ammonium adsorption capacity of different materials

	Ammonium Adsorption capacity (mg/g)		
	C_{eq} =1 mg/l	C_{eq} =3 mg/l	C_{eq} =4mg/l
Activated Carbon	0.015 - 0.019	0.027 - 0.038	0.037 - 0.055
Biochar	0.043 - 0.046	0.054 - 0.064	0.054 -0.072
Zeolite	0.495	0.786 - 0.818	0.976 - 0.979

After having completed the characterization of the materials, adsorption column tests were conducted. The instrumental set up is reported is Figure 2. These tests were preceded by a tracer test for the determination of the hydrodynamic dispersion coefficient of the column. In column adsorption tests, the adsorbent was introduced in the column and a solution of water and contaminant was pumped into the column at a flow Q_{in} = 0.28 ml/s. Samples were taken every 2 hours at different sampling ports located at different height of the column. Ammonium and phosphates concentration were measured with a spectrophotometer. The test was stopped when saturation of the material was reached. The breakthrough curve of the ammonium adsorption test with zeolites at a height of 0.22 m is reported in Figure 2. Experimental measurements were compared to a general adsorption model. The fitting yielded a retardation factor of around 1100, in accordance with other publications [1].
Additional column adsorption tests and evaluations of possible field applications are currently ongoing.

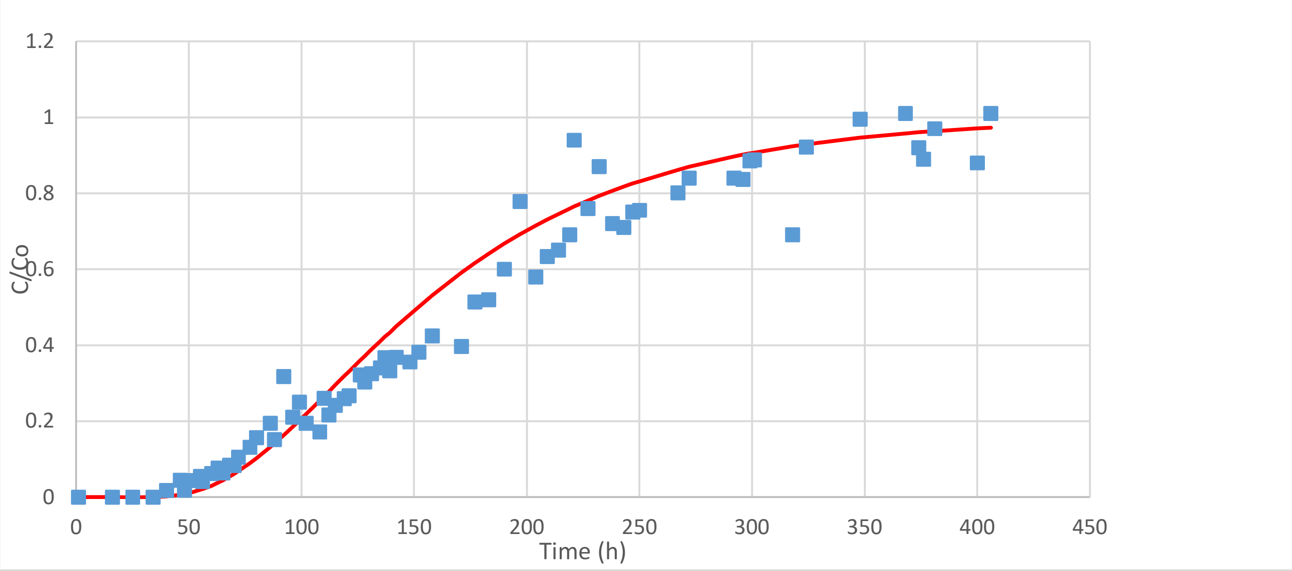

Figure 2 : Breakthrough curve of ammonium adsorption with zeolites at a column height of 0.22 m.

References

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