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XING PROFIL

... aus Wasser und Luft. Diese Literaturliste wurde im Dezember 2013 zusammengestellt und gibt einen Einstieg in die Literatur zur Anwendung von Zeolithen als Ammoniakfilter bzw. Ionenaustauscher für Ammonium. Anwendungen für die Katalyse - auch wenn dort oft Ammoniak beteiligt ist - wurden ausgelassen.

Die Literatur zu diesem Feld ist sehr reichlich. Grundsätzliche Arbeiten kann man hier sehen, aber auch einige mit starkem regionalen Bezug. Da beim Einsatz von Naturzeolithen als Filtermaterial jeder Fall anders ist (abhängig von der Lagerstätte des Minerals und dem zu reinigenden Medium), sollte man die Literatursuche so spezifisch wie möglich anstellen, um nicht allzu viele Publikationen zu erhalten, die nicht auf die eigene Anwendung übertragbar sind.

Al-Jabi, L. F., et al. (2008). "Conservation of ammonia during food waste composting." *Environ Technol* 29(10): 1067-1073.

An experiment was conducted to quantify ammonia (NH₃) losses during food waste composting and to evaluate the effectiveness of mature aerobic sewage sludge/olive pomace compost and phillipsite/chabazite zeolite in reducing NH₃ losses during composting. Food waste amended with chopped barley straw was composted for a period of 68 days in three in-vessel reactors. The mature aerobic sewage sludge/olive pomace compost and the zeolite were placed on a mesh tray above the waste mixture in the first and second reactors, respectively. The third reactor contained straw-amended food waste only and served as a control. It was found that the mature aerobic sewage sludge/olive pomace compost reduced NH₃-N losses by 36% of initial TN through nitrifying volatilized NH₃ into nitrate (NO₃⁻). Zeolite reduced NH₃-N losses by 41% of initial total nitrogen due to adsorption of volatilized NH₃. The use of mature compost in conservation of nitrogen is a promising cheap method; however, it needs further optimization and research.

Andrés T. Aguayo, A. G. G. J. E. M. O. J. M. A. J. B. (1994). "Isotherms of chemical adsorption of bases on solid catalysts for acidity measurement." *Journal of Chemical Technology & Biotechnology* 60(2): 141-146.

The measurement of the adsorption equilibrium constants of the bases and the total mass of base adsorbed at 200 °C are proposed as reproducible indices of average acidity strength and of total acidity of the solid, respectively. The adsorption of different bases (ammonia, n-butylamine, tert-butylamine, pyridine) in gas phase on solid acidic catalysts (silica-alumina and zeolite catalysts and a silica gel) has been studied, by applying the calorimetric method in flow regime through an isothermal bed of solid. Both the conditions under which the adsorption is exclusively chemical as well as those under which the adsorption is not

limited by the internal diffusion of the base have been determined. For these acidity measurements tert-butylamine behaves well and is an alternative base to ammonia.

Ban, Z. and G. Dave (2004). "**Laboratory studies on recovery of N and P from human urine through struvite crystallisation and zeolite adsorption.**" *Environ Technol* 25(1): 111-121.

Struvite [$Mg(K, NH_4)(PO_4) \times 6H_2O$] crystallisation and adsorption to zeolite have been proposed as a method for nutrient recovery from human urine collected with urine separating toilets. The aim of the present study was to optimise the use of MgO (to precipitate struvite) and zeolite (to adsorb ammonia) in this process. The experiments were performed with fresh urine, to which various amounts of MgO and zeolite were added. After repeated stirring and settling for 3 days the supernatant was analysed for pH, total-N, total-P and acute toxicity for *Daphnia magna* (24- and 48-h EC₅₀). The results show that addition of MgO reduced P and addition of zeolite reduced N in the supernatant, as expected. The required concentration of MgO added was less than expected from the stoichiometric Mg-P-ratio for struvite. In combination with zeolite the requirement for MgO was reduced even further. Zeolite was effective in reducing total-N, but because of its interaction with MgO the effect of zeolite on N as well as P reduction was rather complicated. The optimal combination of MgO and zeolite for combined N and P recovery was found to be around 0.5 MgO per litre urine and 15 g zeolite per litre urine. These additions reduced supernatant P from about 1300 mg l⁻¹ to 10 mg l⁻¹ and N from 8000 mg l⁻¹ to 1000 mg l⁻¹. The 24-h EC₅₀ for *D. magna* was not significantly affected by these additions. The expected recovery potentials for P and N by addition of MgO and zeolite are, thus, about 99% for P and 90% for N. However, these figures need to be verified, and pilot plant experiments at a science centre with urine separation wastewater treatment (www.universeum.se) are in progress.

Brown, D. R. and A. J. Groszek (2000). "**Heats of Adsorption of Ammonia on a Zeolite Catalyst and an Acid-Activated Clay Catalyst Determined by Flow Adsorption Microcalorimetry.**" *Langmuir* 16(9): 4207-4212.

Measurements of heats of adsorption of ammonia from a nitrogen carrier have been carried out on zeolite Y and K10 clay catalysts in the acid and Na⁺ forms. The equipment used was a new model of the Microscal flow calorimeter (FMC) linked to a thermal conductivity detector in which the rates of adsorption and desorption and the associated rates of heat evolution or absorption were measured simultaneously at atmospheric pressure and temperatures ranging from 150 to 207 °C. Ammonia was used as a probe interacting with the acid sites on the catalysts. The work revealed new information in surface heterogeneity of the catalysts existing under flow conditions at atmospheric pressure of a nitrogen carrier. It was found that the irreversibly adsorbed ammonia is mobile on both catalysts. Molar heats of adsorption recorded as surface coverage is increased show that the sites covered first are not necessarily those with the highest heats of adsorption, illustrating that this flow technique gives important

information on the relative accessibilities of acid sites as well as their strengths.

Burgess, R. M., et al. (2004). **"Use of zeolite for removing ammonia and ammonia-caused toxicity in marine toxicity identification evaluations."** Arch Environ Contam Toxicol 47(4): 440-447.

Ammonia occurs in marine waters including effluents, receiving waters, and sediment interstitial waters. At sufficiently high concentrations, ammonia can be toxic to aquatic species. Toxicity identification evaluation (TIE) methods provide researchers with tools for identifying aquatic toxicants. For identifying ammonia toxicity, there are several possible methods including pH alteration and volatilization, Ulva lactuca addition, microbial degradation, and zeolite addition. Zeolite addition has been used successfully in freshwater systems to decrease ammonia concentrations and toxicity for several decades. However, zeolite in marine systems has been used less because ions in the seawater interfere with zeolite's ability to adsorb ammonia. The objective of this study was to develop a zeolite method for removing ammonia from marine waters. To accomplish this objective, we performed a series of zeolite slurry and column chromatography studies to determine uptake rate and capacity and to evaluate the effects of salinity and pH on ammonia removal. We also assessed the interaction of zeolite with several toxic metals. Success of the methods was also evaluated by measuring toxicity to two marine species: the mysid *Americamysis bahia* and the amphipod *Ampelisca abdita*. Column chromatography proved to be effective at removing a wide range of ammonia concentrations under several experimental conditions. Conversely, the slurry method was inconsistent and variable in its overall performance in removing ammonia and cannot be recommended. The metals copper, lead, and zinc were removed by zeolite in both the slurry and column treatments. The zeolite column was successful in removing ammonia toxicity for both the mysid and the amphipod, whereas the slurry was less effective. This study demonstrated that zeolite column chromatography is a useful tool for conducting marine water TIEs to decrease ammonia concentrations and characterize toxicity.

Busca, G. and C. Pistarino (2003). **"Abatement of ammonia and amines from waste gases: a summary."** Journal of Loss Prevention in the Process Industries 16(2): 157.

The technologies that allow the abatement of ammonia and amines from waste gases are briefly described. Advantages and drawbacks of thermal and catalytic oxidation processes, condensation, adsorption on solids, scrubbing and...

Cai, L., et al. (2007). **"Evaluation of zeolite for control of odorants emissions from simulated poultry manure storage."** J Environ Qual 36(1): 184-193.

Poultry operations are associated with emissions of aerial ammonia (NH₃), volatile organic compounds (VOCs), and odor, and the magnitude of emissions is influenced by manure management practices. As a manure treatment additive, zeolites have been shown to have the potential to control NH₃. Because of their properties it is also expected that zeolites could effectively adsorb VOCs and odor. The

effectiveness of zeolite in controlling odor and VOCs was qualitatively evaluated in this controlled laboratory study involving simulated poultry manure storage. In the first two trials, zeolite was topically applied on nearly fresh laying hen manure at the rates of 0, 2.5, 5, and 10% (by weight). In the third trial, zeolite was topically applied at 5% with each addition of fresh manure into the storage vessel. Headspace samples from the emission vessels were collected with solid phase microextraction (SPME) and analyzed on a multidimensional-gas chromatograph-mass spectrometry-olfactometry (MDGC-MS-O) system for identification and prioritization of poultry manure odorants. Acetic acid, butanoic acid, isovaleric acid, indole, and skatole were consistently controlled in the headspace, with the reduction rate being proportional to the zeolite application rate. Dimethyl trisulfide and phenol were consistently generated, and with a few exceptions, the rate of generation was proportional to the application rate. Average reduction of the odor caused by all odorants evaluated with SPME-GC-O was 67% (+/-12%) and 51% (+/-26%) for the two topical applications, respectively, while no significant reduction of VOCs and odor was detected for the layered application.

Ciahotný, K., et al. (2006). "Removal of ammonia from waste air streams with clinoptilolite tuff in its natural and treated forms." *Adsorption* 12(3): 219-226.

Natural and impregnated clinoptilolite tuffs were studied to assess their potential to remove ammonia from air and, in a subsequent application, to use the spent adsorbent as a fertilizer. H_2SO_4 , H_3PO_4 and HNO_3 , as agents containing important plant nutrients compatible with soil, were selected for impregnation to enhance sorption capacity of the natural clinoptilolite tuffs for ammonia removal. Sorbents were characterized using N_2 adsorption isotherms at 77 K, X-ray analysis and high pressure mercury porosimetry. Ammonia breakthrough curves on fixed beds of sorbent were determined using appropriate NH_3 and H_2O input concentrations, flow rates and temperatures similar to the conditions in animal breeding farms. Impregnated clinoptilolite tuffs showed adsorption capacities comparable to SSP-4, an activated carbon that is commercially used for NH_3 removal. Impregnations with H_2SO_4 and HNO_3 are particularly important, since such modified adsorbents exhibit relatively high breakthrough capacities, thus rendering them potentially useful for practical applications in controlling ammonia emissions. The main contribution to the sorption capacity enhancement on impregnated clinoptilolite tuff samples seems to be due to the chemical reaction of ammonia with acids remaining in the macro- and mesopores.

Cotman, M. and A. Z. Gotvajn (2010). "Comparison of different physico-chemical methods for the removal of toxicants from landfill leachate." *J Hazard Mater* 178(1-3): 298-305.

Our work was focused on investigation of different treatment procedures for the removal of toxic fractions from a landfill leachate, because sometimes the existing treatment in biological sequencing batch reactor (SBR) is not efficient enough, leading to a hazardous environmental impact of the present persistent and toxic compounds. The efficiency of the procedures used was monitored by

chemical analyses and two toxicity tests (activated sludge and *Vibrio fischeri*). The existing SBR (HRT=1.9 days) removed 46-78% of COD and 96-73% of NH₄⁽⁺⁾-N. Experiments were conducted with three landfill leachate samples expressing significant difference in concentrations of pollutants and with low BOD(5)/COD ratio (0.06/0.01/0.03). The applied methods were air stripping, adsorption to activated carbon and zeolite clinoptilolite and Fenton oxidation. Air stripping at pH 11 was a viable treatment option for the removal of ammonia nitrogen (up to 94%) and reduction of toxicity to microorganisms. In the adsorption experiments in batch system with different concentration of PAC the most effective was the highest addition (50.0g/L(-1)) where 63-92% of COD was removed followed by significant reduction in toxicity to *V. fischeri*. In the column experiments with clinoptilolite 45/93/100% of NH₄⁽⁺⁾-N as well as 25/32/39% of COD removal was attained. The removal efficiency for metals followed the sequence Cr>Zn>Cd>Ni. The procedure with zeolite was the second most efficient one regarding reduction of toxicity to both organisms. Fenton oxidation at molar ratio Fe(2+):H₂O₂=1.0:10.0 assured 70-85% removal of COD but it only slightly reduced the toxicity.

Coughlan, B. and R. G. Shaw (1976). "Ion-exchanged zeolite A: sorptive properties of carbon dioxide and ammonia-III. Physical state of the adsorbed phase." Proc R Ir Acad [B] 76(14-16): 227-239.

Coughlan, B. and R. G. Shaw (1976). "Ion-exchanged zeolite A: Sorptive properties of carbon dioxide and ammonia-I. Sorbents and sorption equilibria." Proc R Ir Acad [B] 76(14-16): 191-210.

Doonan, C. J., et al. (2010). "Exceptional ammonia uptake by a covalent organic framework." Nat Chem 2(3): 235-238.

Covalent organic frameworks (COFs) are porous crystalline materials composed of light elements linked by strong covalent bonds. A number of these materials contain a high density of Lewis acid boron sites that can strongly interact with Lewis basic guests, which makes them ideal for the storage of corrosive chemicals such as ammonia. We found that a member of the covalent organic framework family, COF-10, shows the highest uptake capacity (15 mol kg⁽¹⁾, 298 K, 1 bar) of any porous material, including microporous 13X zeolite (9 mol kg⁽¹⁾), Amberlyst 15 (11 mol kg⁽¹⁾) and mesoporous silica, MCM-41 (7.9 mol kg⁽¹⁾). Notably, ammonia can be removed from the pores of COF-10 by heating samples at 200 degrees C under vacuum. In addition, repeated adsorption of ammonia into COF-10 causes a shift in the interlayer packing, which reduces its apparent surface area to nitrogen. However, owing to the strong Lewis acid-base interactions, the total uptake capacity of ammonia and the structural integrity of the COF are maintained after several cycles of adsorption/desorption.

Englert, A. H. and J. Rubio (2005). "Characterization and environmental application of a Chilean natural zeolite." International Journal of Mineral Processing 75(1-2): 21.

Abstract The use of natural zeolites for environmental applications is gaining new research interests mainly due to

their properties and significant worldwide occurrence. The present work describes the characterization of a natural Chilean zeolite and the results as adsorbent for ammonia from aqueous solutions. The zeolitic-rich tuff sample, mainly composed of clinoptilolite and mordenite, consisted of 13 μm mean volumetric particle diameter, 55 $\text{m}^2 \text{g}^{-1}$ (methylene blue adsorption) and 177 $\text{m}^2 \text{g}^{-1}$ (nitrogen adsorption) of specific surface area. Particles were negatively charged over a broad pH range (with or without ammonia) and 1.02 meq $\text{NH}_4^+ \text{g}^{-1}$ cation-exchange capacity. The ammonia removal appears to proceed through ion-exchange and rapid kinetics (rate constant of 0.3 min^{-1}) at neutral pH value, with removal capacities up to 0.68 meq $\text{NH}_4^+ \text{g}^{-1}$. The Langmuir isotherm model provided excellent equilibrium data fitting ($R^2=0.97$). Results indicate a significant potential for the Chilean natural zeolite as an adsorbent/ion-exchange material for wastewater treatment and water reuse applications.

Fachini, A. and M. T. Vasconcelos (2006). "Effects of zeolites on cultures of marine micro-algae: A brief review." *Environ Sci Pollut Res Int* 13(6): 414-417.

GOAL, SCOPE AND BACKGROUND: The cation-exchange capacity of zeolites is well known and has been increasingly explored in different fields with both economic and environmental successes. In aquatic medium with low salinity, zeolites have found multiple applications. However, a review of the literature on the applications of zeolites in salt waters found relatively few articles, including some recently published papers. The purpose of this review is to present the state-of-the-art on applications of using zeolites for amending the trace elemental contents of salt water as well as the implications of this property for promoting marine micro-algal growth. **MAIN FEATURES:** This paper deals with the following features: Sorption capacity of zeolites including 1. application of zeolites in saltwater, 2. the role of silicon and zeolites on cultures of micro-algae, and 3. the role of organically chelated trace metals. **RESULTS:** The following competing factors have been identified as effects of zeolites on algal growth in salt water: (i) ammonia decrease: growth inhibition reduced; (ii) macro-nutrients increase, mainly silicon: stimulation of silicon-dependent algae; (iii) trace metals increase (desorption from zeolites) or decrease (adsorption): inhibition or stimulation, depending on the nature of the element and its concentration; and, (iv) changes in the chelating organics exudation: inhibition or stimulation of growth, depending on the (a) nature of the complexed element; (b) bioavailability of the complex; and (c) concentration of the elements simultaneously present in inorganic forms. **DISCUSSION:** Zeolites have been capable of stimulating the growth of the silicon-demanding marine micro-algae, like diatoms, mainly because they can act as a silicon buffer in seawater. Zeolites can also influence the yield of non-silicon-demanding algae, because the changes they can cause (liberation and adsorption of trace elements) in the composition of the medium. **CONCLUSIONS:** Zeolites have been capable of stimulating the growth of the marine micro-algae. However, the extent of ion exchange between zeolite and seawater, which conditions the effects, will depend on several factors: (1) initial metal concentration in seawater; (2) levels of trace metals in the zeolites (contaminants); (3) characteristics of the zeolites in terms of both ion-exchange capacity and specific affinities for the

different cations; (4) quantity of zeolite per litre of solution; (5) pH and (6) response of the organism in terms of liberation of organic ligands. RECOMMENDATIONS AND PERSPECTIVES: RECOMMENDATIONS: Therefore, a previous investigation in each particular case is recommended, in order to select the zeolitic characteristics and concentrations that will maximize the algal yield. PERSPECTIVES: Stimulation of phytoplankton growth can be economically relevant since phytoplankton constitutes the basis of the marine food webs and is required in fish farming nurseries in the marine aquaculture industry. Zeolites are cheap, only small amounts (few milligrams per liter of culture) are required and the addition of some micro-nutrients may be omitted. Therefore, the inclusion of zeolites in algal cultures in aquaculture may have economic advantages.

Fang, J., et al. (2010). "[Removal of high concentration NH₄(+) -N by nanochem zeolite ion exchange technology]." *Huan Jing Ke Xue* 31(1): 111-116.

This paper assesses the potential of NanoChem zeolite for ammonia removal from synthetic solution and actual landfill leachate. The data from experiments in batch study were applied to Langmuir isotherm. The saturated amount of NH₄(+) -N adsorbed per unit weight of NanoChem zeolite was about 364 mg x g⁻¹), which yield significantly 3-30 times higher ammonium adsorption capacity than nature zeolite and Microporous molecular sieves. The results of batch study showed that the contact time needed at least 20 h in order to attain exchange equilibrium; the ammonia removal capacity of NanoChem zeolite increased with the increase of initial ammonia concentration, while the ammonia removal rate decreased with the increase of initial ammonia concentration; the pH had an effect on ammonia removal efficiency as it can influence both the character of the exchanging ions and the NanoChem zeolite itself; regeneration made little change on ammonia removal efficiency, repeatability was good. In column study, the NanoChem zeolite was used for high ammonia nitrogen removal such as actual landfill leachate and the ammonia nitrogen was removed 100%.

Farkas, A., et al. (2005). "Ammonium exchange in leakage waters of waste dumps using natural zeolite from the Krapina region, Croatia." *J Hazard Mater* 117(1): 25-33.

The paper presents the results of investigating the treatment of leakage waters from waste dumps using activated carbon and natural zeolite clinoptilolite, known as a very selective and efficient cation exchanger for ammonium ions. The results are presented of chemical and physical analyses of leakage waters characterized by a high content of ammonium (820 mg L⁻¹) and organic pollutants (1033 mg L⁻¹ C). Physical and chemical characteristics of zeolite and the exchange of ammonium ions in model and real solutions were determined in laboratory trials. Treatment of leakage water with 0.04-2.5% (w/w) activated carbon (Norit 0.8 Supra) led to a reduction of total organic carbon in leakage water from 1033 to 510 mg L⁻¹. Pretreatment of leakage water with activated carbon did not improve the exchange of ammonium ions on zeolite. Without pretreatment of leakage water, the exchange of ammonium ions amounted to 4.2 mg NH₄⁺/g zeolite. Addition of activated carbon, regardless of its mass,

increased the exchange of ammonium ions to only 5.7 mg NH₄⁺/g zeolite. In the model solution of an equal concentration of ammonium as the real solution, 17.70 mg NH₄⁺/g zeolite was exchanged. Organic pollutants that were not eliminated by activated carbon (most probably components of natural origin) adsorbed to zeolite and prevented the exchange of NH₄⁺ ions, which was also reduced due to the presence of K⁺ and Ca²⁺ ions.

Green, M., et al. (2002). "Production of gaseous nitrogen compounds in a novel process for ammonium removal." *Water Sci Technol* 46(1-2): 215-222.

The production of gaseous nitrogen compounds, particularly the greenhouse gas nitrous oxide, was investigated in a novel process for ammonium removal from wastewater. The process is based on the adsorption of ammonium on zeolite followed by bioregeneration. The zeolite serves the dual purpose of an ion exchanger and a physical carrier for nitrifying bacteria which bio-regenerate the ammonium saturated mineral. An analysis of the nitrifying population composition in the reactor fed with simulated secondary effluent (NH₄⁺ = 50 mg/l) revealed that about half of the bacteria in the biofilm were common ammonium oxidizers *Nitrosococcus mobilis* and *Nitrosomonas*, while the other half were nitrite oxidizers. The amount of nitrogen losses, under different conditions, and the identification of the emitted gases (N₂ or N₂O) were investigated in two sets of experiments: (I) batch experiments using biomass originating from the ion exchange reactor with and without the addition of nitrite, and (II) continuous experiments using the ion exchange reactor with zeolite as the biomass carrier. In the batch experiments, nitrite and oxygen concentrations were determined as the major parameters responsible for the formation of gaseous nitrogen gas during ammonia oxidation by autotrophic bacteria. Continuous experiments showed that the major parameter significantly affecting nitrogen losses was the amount of ammonium adsorbed by the zeolite during the ion exchange phase. The amount of ammonium adsorbed determines the ammonium concentration during the initial period of bioregeneration, which in turn directly influences oxygen demand and the resulting concentrations of oxygen and nitrite. It was concluded that the formation of nitrogen gas compounds in the ion exchange/bioregeneration process can be eliminated by adjusting the operational regime to have a shorter adsorption phase resulting in smaller amounts of ammonium adsorbed per cycle.

Huo, H., et al. (2012). "Ammonia-nitrogen and phosphates sorption from simulated reclaimed waters by modified clinoptilolite." *J Hazard Mater* 229-230: 292-297.

This paper presents the investigation of the ammonia-nitrogen and phosphates sorption from simulated reclaimed wastewater by modified clinoptilolite. The results showed that the modified clinoptilolite has a high sorption efficiency and removal performance. The ammonia-nitrogen and phosphates removal rate of the modified clinoptilolite reached to 98.46% and 99.80%, respectively. The surface of modified clinoptilolite became loose and some pores appeared, which enlarged the specific surface area; the contents of Na and Fe increased, and the contents of Ca and Mg decreased. The modified clinoptilolite possesses rapid sorption and slow balance characteristics

and ammonia-nitrogen and phosphates sorption is more consistent with the Langmuir isotherm model. The adsorption kinetics of ammonia-nitrogen and phosphates follows the Elovich adsorption dynamics equation, which describes the sorption of ammonia-nitrogen and phosphates in aqueous solution as mainly a chemical sorption. Results from the thermodynamics experiment involving ammonia-nitrogen and phosphates sorption reveal that the process is a spontaneous and endothermic process, and is mainly driven by entropy effect.

James, D. W. and M. E. Harward (1962). "**Mechanism of NH₃ Adsorption by Montmorillonite and Kaolinite.**" *Clays and Clay Minerals* 11(1): 301-320.

Dry, homoionic systems of two montmorillonites and a kaolinite were treated with NH₃ and then evacuated exhaustively to eliminate any physically adsorbed ammonia. It was concluded that the NH₃ retained by the minerals was associated with the exchangeable cations. The mechanism of this adsorption process is the same as that which leads to the formation of inorganic amines, namely, the mutual attraction between unshared electrons in the NH₃ molecules and ionic centers of positive charge. This sorption process is reversible at elevated temperatures and is described by the equation, $n\text{NH}_3 + \text{CX} \rightarrow/\leftarrow (\text{nNH}_3 \cdot \text{C})\text{X}$, where n is the number of NH₃ molecules associated with each exchangeable cation, C, on exchange complex X. Accordingly, n is a coordination number and has the following values for the cations indicated: NH₄, 0; K, 0; H, 1; Ca, 2; Mg, 2; Alin, 3; Alex, 6. Here in and ex refer to interior and exterior exchange sites respectively. The retention of NH₃ by cations which saturate the exchange complex of clays was shown to be analogous to the formation of ammoniates by reaction of NH₃ with inorganic salts. A reduced retention of NH₃ by the Mg and Al 1:1 systems was ascribed to the possibility that exchangeable Mg and Al on kaolinite occur as hydroxy complexes. A significant amount of NH₃ was adsorbed to the weak acid hydroxyl groups on the broken clay edges, Relative to exchange capacities this phenomenon was greater in magnitude on the 1:1 than on the 2:1 clays. Energies of NH₃ adsorption on CaCl₂, Ca-bentonite and NH₄-bentonite were determined. Values of ΔH as a function of temperature were shown to be different for the Ca and NH₄-clay systems. The data indicated stronger energies of retention of NH₃ by the Ca-clay than for the NH₄ clay. The thermodynamic data thus support the mechanisms proposed here.

Jarkko Helminen, J. H. E. P. I. T. (2000). "**Comparison of sorbents and isotherm models for NH₃-gas separation by adsorption.**" *AiChE Journal* 46(8): 1541-1555.

Adsorption equilibrium isotherms of ammonia gas were measured at temperatures between 298 and 393 K on 13X zeolite, 4A zeolite, alumina, silica gel, and activated carbon. The applicability of these sorbents to ammonia gas separation was compared based on equilibrium data. In the pressure range of 1 to 100 kPa activated carbon has its highest working capacity (5.5 mmol·g⁻¹) at 298 K, and the working capacity drops rapidly with temperature, reaching its lowest point at 393 K. The two zeolites provide almost the same working capacity, 3.0-3.5 mmol·g⁻¹, over the entire temperature range. Silica gel and alumina showed

low working capacities. The experimental equilibrium data were fitted to 16 different isotherm models, with accuracy and reliability statistically evaluated. The Langmuir-Freundlich model with the van't Hoff equation for the equilibrium constant and with a thermal expansion equation for the saturation sorbate concentration provided the most accurate fit for the 13X and 4A zeolites. This model was also very accurate for the alumina and silica gel data, even though the Dubinin-Astakhov model gave slightly higher predictions. The Henry and vacancy solution models provided the best fit for activated carbon.

Ji, G., et al. (2011). **"Wastewater treatment efficiency of a multi-media biological aerated filter (MBAF) containing clinoptilolite and bioceramsite in a brick-wall embedded design."** *Bioresour Technol* 102(2): 550-557.

A multi-media biological aerated filter (MBAF) with clinoptilolite media was used to treat synthetic wastewater. Coal ash bioceramsite with supplemental metallic iron was added to the clinoptilolite media of MBAFs in a brick-wall embedded design. Performance parameters, such as hydraulic, organic, N and P loading capacity and microbial community composition were studied for different quantity of supplemental metallic iron contained in three MBAFs. The MBAFs with more metallic iron were found to have superior hydraulic and organic loading, and higher N and P capacities. COD, NH₃-N and TP removal dropped by 7-10%, 6-7% and 4-5%, respectively, with when hydraulic loading was raised from 2.8 to 7.5 m³ m⁻² d⁻¹. NH₃-N removal also decreased 8-9% when ammonia loading was elevated from 0.078 to 0.156 kg NH₃-N m⁻³ d⁻¹. Real-time PCR revealed a relatively stable bacterial community composed primarily of eubacteria that formed after an initial 120 d operational period. Doubling the amount of metallic iron in the bioceramsite media resulted in a twofold increase of eubacteria in the MBAF, but a decrease in the ratio of anaerobic ammonia-oxidizing bacteria to total bacteria.

Jung, J. Y., et al. (2004). **"Enhanced ammonia nitrogen removal using consistent biological regeneration and ammonium exchange of zeolite in modified SBR process."** *Water Res* 38(2): 347-354.

The modified zeo-SBR is recommended for a new nitrogen removal process that has a special function of consistent ammonium exchange and bioregeneration of zeolite-floc. Three sets of sequencing batch reactors, control, zeo-SBR, and modified zeo-SBR were tested to assess nitrogen removal efficiency. The control reactor consisted of anoxic-fill, aeration-mixing, settling, and decanting/idle phases, meaning that nitrogen removal efficiency was dependent on the decanting volume in a cycle. The zeo-SBR reactor was operated in the same way as the control reactor, except for daily addition of powdered zeolite in the SBR reactor. The operating order sequences in the zeo-SBR were changed in the modified zeo-SBR. Anoxic-fill phase was followed by aeration-mixing phase in the zeo-SBR, while aeration-mixing phase was followed by anoxic-fill phase in the modified zeo-SBR to carry NH₄(+)-N over to the next operational cycle and to reduce total nitrogen concentration in the effluent. In the modified zeo-SBR, nitrification and biological regeneration occurred during the initial aeration-mixing phase, while denitrification and ammonium adsorption occurred in the following anoxic-fill phase. The

changed operational sequence in the modified zeo-SBR to adapt the ammonium adsorption and biological regeneration of the zeolite-floc could enhance nitrogen removal efficiency. As a result of the continuous operation, the nitrogen removal efficiencies of the control and zeo-SBR were in 68.5-70.9%, based on the 33% of decanting volume for a cycle. The zeo-SBR showed a consistent ammonium exchange and bio-regeneration in the anoxic-fill and aeration-mixing phases, respectively. Meanwhile, the effluent total nitrogen of the modified zeo-SBR showed 50-60 mg N/L through ammonium adsorption of the zeolite-floc when the influent ammonium concentration was 315 mg N/L, indicating the T-N removal efficiency was enhanced over 10% in the same HRT and SRT conditions as those of control and zeo-SBR reactors. The ammonium adsorption capacity was found to be 6-7 mg NH₄(+)-N/g FSS that is equivalent to 40 mg NH₄(+)-N/L of ammonium nitrogen removal.

Li, X., et al. (2003). "[Nitrogen removal in a pilot-scale zeolite reed bed system]." *Huan Jing Ke Xue* 24(3): 158-160.

In this study, the nitrogen removal efficacy of a pilot-scale zeolite reed bed system was tested for the treatment of agricultural wastewater and domestic wastewater etc. At a mean hydraulic loading of 0.6 m/d, the total nitrogen, ammonia, nitrate, nitrite in winter and spring were reduced across the system by 38.9% and 58.2%, 93.11% and 78.84%, 10.01% and 48.99%, 38.81% and 98.45%, respectively. The system performance in spring was much better than in winter. Under the same conditions, the total nitrogen, ammonia, nitrate removal rate of zeolite reed bed were 28%, 67%, 35% higher than that of gravel reed bed. The ammonia adsorption and ion exchange on zeolite and biological nitrogen removal through nitrification and denitrification were the main removal mechanism of nitrogen in the zeolite reed bed.

Liu, C. H. and K. V. Lo (2001). "Ammonia removal from compost leachate using zeolite. II. A study using continuous flow packed columns." *J Environ Sci Health B* 36(5): 667-675.

Bench-scale packed zeolite columns were set up and operated to investigate the continuous removal of ammonium ions from compost leachate. The effects of hydraulic retention time (HRT), and particle size of the zeolite on the ammonia adsorption capacity were studied. For both the coarse particle and the powdered zeolite columns, higher ammonia removal efficiencies were achieved with longer HRT (i.e., lower influent flow rate) tests. At the same HRT, ammonia removal efficiencies from tests with powdered zeolite were generally 20% higher than tests with the coarse particle zeolite. A HRT of 6 hours was found appropriate for efficient ammonia removal, and an operating capacity of 1.31 mg N/g zeolite was obtained. Over 98% of the ammonia input from the influent was consistently removed for over 5 bed volumes (BV) of compost leachate flowing through the zeolite column. Zeolite proved to have a great potential as a medium for ammonia removal in treating composting leachate.

Liu, C. H. and K. V. Lo (2001). "Ammonia removal from compost leachate using zeolite. III. Regeneration of

zeolite columns." J Environ Sci Health A Tox Hazard Subst Environ Eng 36(10): 1825-1843.

The effects of hydraulic reteneration time (HRT), and the strength of the regenerating solution on the ammonia adsorption capacity and the zeolite regeneration were studied using bench-scale packed zeolite columns. A 0.6 M NaCl solution fed at a HRT of 1 h was preferred for the regeneration process, and more than 95% of adsorbed ammonium ions were recovered after using 7-8 bed volumes (BV) of the regenerating solution. The adsorption-regeneration time ratio was approximately 5:1. High concentration of potassium ions in the composting leachate competed with NH_4^+ ions for the exchange sites, resulting in a reduction in the efficiencies of ammonia removal and zeolite column regeneration. However, Zeolite still proved to have a great potential as a medium for ammonia removal in treating composting leachate.

Liu, C. H. and K. V. Lo (2001). **"Ammonia removal from composting leachate using zeolite. I. Characterization of the zeolite."** J Environ Sci Health A Tox Hazard Subst Environ Eng 36(9): 1671-1688.

The effects of ammonium concentrations, contact time, and zeolite particle sizes on the ammonium adsorption capacities of a Canadian zeolite were studied using batch experiments. Both the rates and capacities of ammonium adsorption increased with increased concentrations of ammonium in solution. Ammonium adsorption increased significantly with decreasing zeolite particle size for all tests and the adsorption capacities ranged from 14.35-17.81 mg N/g. Also, ammonia adsorption increased with contact time, and it occurred rapidly at the beginning of contact, and then gradually decreased as time progressed. Langmuir isotherm best describes the equilibrium of ammonia adsorption on zeolite. Particle diffusion was the rate-controlling mechanism for the first 4 h of contact. In spite of competition potassium ions, zeolite has shown a great potential for ammonia removal from composting leachates.

Meisinger, J. J., et al. (2001). **"Managing ammonia emissions from dairy cows by amending slurry with alum or zeolite or by diet modification."** ScientificWorldJournal 1 Suppl 2: 860-865.

Animal agriculture is a significant source of atmospheric ammonia. Ammonia (NH_3) volatilization represents a loss of plant available N to the farmer and a potential contributor to eutrophication in low-nitrogen input ecosystems. This research evaluated on-farm slurry treatments of alum or zeolite and compared three diets for lactating dairy cows in their effectiveness to reduce NH_3 emissions. NH_3 emissions were compared using a group of mobile wind tunnels. The addition of 2.5% alum or 6.25% zeolite to barn-stored dairy slurry reduced NH_3 volatilization by 60% and 55%, respectively, compared to untreated slurry. The alum conserved NH_3 by acidifying the slurry to below pH 5, while the zeolite conserved ammonia by lowering the solution-phase nitrogen through cation exchange. The use of alum or zeolite also reduced soluble phosphorus in the slurry. NH_3 loss from fresh manure collected from lactating dairy cows was not affected by three diets containing the same level of crude protein but differing in forage source (orchardgrass silage vs. alfalfa silage) or neutral detergent fiber (NDF)

content (30% vs. 35% NDF). NH₃ losses from the freshly excreted manures occurred very rapidly and included the urea component plus some unidentified labile organic nitrogen sources. NH₃ conservation strategies for fresh manures will have to be active within the first few hours after excretion in order to be most effective. The use of alum or zeolites as an on-farm amendment to dairy slurry offers the potential for significantly reducing NH₃ emissions.

Miyoshi, T., et al. (1977). "Properties of thirteen kinds of adsorbents for removal of hydrogen sulfide, methanethiol, methyl sulfide, trimethylamine, and ammonia." *Sangyo Igaku* 19(1): 2-7.

Adsorption of hydrogen sulfide, methanethiol, methyl sulfide, trimethylamine, and ammonia on thirteen kinds of adsorbents (5 kinds of silicate, 4 kinds of activated carbon, and 4 kinds of zeolite) was measured by gravimetry, at 30 degrees C and 50 Torr, using an adsorption apparatus with a spring balance in order to find the most suitable adsorbent for the removal of these gases by dry process. The relations between the amount of these gases adsorbed (mmol/cm²) on the adsorbent and the surface properties or the porous structure were examined to clarify the mechanism of adsorption of these gases on them through surface pH, pore size distribution, and area of an adsorbed particle of these gases. Among the thirteen adsorbents, the activated carbon Nos. 6 and 7 were the most suitable adsorbent for methanethiol, methyl sulfide, and trimethylamine whose area of an adsorbed particle (wrho) was larger than about 17 A², and zeolite Nos. 12 and 13 were most suitable for removal of hydrogen sulfide and ammonia (wrho less than about 17A²). The amount of these gases adsorbed (mmol/cm²) on these adsorbents was mainly determined by their porous structure rather than by their surface properties.

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Moussavi, G., et al. (2011). "The investigation of mechanism, kinetic and isotherm of ammonia and humic acid co-adsorption onto natural zeolite." *Chemical Engineering Journal In Press, Corrected Proof.*

This study examined the applicability of the natural zeolite for simultaneous removal of ammonia and humic acid, two of the most encountered concurrent contaminants in the surface waters. The influence of various operating parameters including pH (2-10), concentrations of zeolite (1-10g/L), initial concentration of ammonia (10-100mg/L) and/or humic acid (2-20mg/L), contact time (5-90min), and temperature (20-50°C) was investigated on the removal of target contaminants from water through different experimental runs. The results indicated that zeolite had best performance for simultaneous removal of ammonia and humic acid at the pH close to that of natural waters. The adsorption of humic acid was found to be improved in the presence of ammonia. The removal of ammonia and humic acid as single or binary components using natural zeolite was indicated to be a rapid process, following the pseudo-second-order kinetic model. The temperature positively influenced the removal of target contaminant both as single and binary components, although with greater influence for lower concentrations of zeolite. Equilibrium adsorption of ammonia and humic acid onto natural zeolite had best fitness with the Freundlich isotherm at all temperatures ranging from 20 to 50°C. The maximum experimental adsorption capacities of ammonia and humic acid as binary components were 49.7 and 10.5mg/g, respectively. It was understood from the results of this study that adsorption onto natural zeolite is an efficient in performance, simple to operate, and economical process and thereby affordable technology for simultaneous removal of ammonia and humic acid from the contaminated water source. Highlights ° The natural zeolite was examined for its capability to remove mixture of ammonia and humic acid from water. ° The highest removal of target contaminants was achieved at a pH close to that of natural water. ° The adsorption of ammonia and humic acid was improved when fed as binary component. ° Iranian natural zeolite attained higher ammonia and humic acid removal than those reported in the literature.

Nah, I. W., et al. (2008). "Removal of ammonium ion from aqueous solution using magnetically modified zeolite." *Environ Technol* 29(6): 633-639.

This paper assesses the potential of magnetically modified zeolite (MMZ) for ammonia removal from aqueous solution. The effects of relevant parameters such as contact time, pH and initial ammonia concentration were examined. The results show that ammonium ion removal by MMZ occurs rapidly within the first five minutes, pH has an effect on ammonium ion removal efficiency, and the ammonium ion removal capacity of MMZ increases with increase in initial ammonium ion concentration. The Langmuir and Freundlich adsorption isotherms were used to determine the adsorption characteristics. Ammonium-laden MMZ seems to be regenerated completely by sodium chloride solution at pH 11-12.

Olszewska, D. (2006). "Ammonia and water sorption properties of the mineral-layered nanomaterials used as the catalysts for NO_x removal from." *Catalysis Today*

The object of the study is the influence of acidity and hydrophilic properties of the surface of catalyst of the selective catalytic reduction (SCR) of nitrogen oxides by NH₃. A series of catalysts prepared with the ZrO₂-pillared...

Orescanin, V., et al. (2011). "A combined treatment of landfill leachate using calcium oxide, ferric chloride and clinoptilolite." *J Environ Sci Health A Tox Hazard Subst Environ Eng* 46(3): 323-328.

The aim of this research was development of appropriate procedure for treatment of landfill leachate taken from old sanitary landfill Piskornica (Koprivnica, Croatia). Due to complex nature of the effluent a combined treatment approach was applied. Samples were treated with calcium oxide followed by ferric chloride and finally with clinoptilolite. The optimum amount of treating agents and contact time were determined. Application of calcium oxide (25 g/L, 20 min. contact time) resulted in the reduction of color, turbidity, suspended solids and ammonia for 94.50%, 96.55%, 95.66% and 21.60%, respectively, while the removal efficiency of Cr (VI), Fe, Ni, Cu, Zn and Pb was 75.00%, 95.34%, 56.52%, 78.72%, 73.02% and 100.00%, respectively. After addition of ferric chloride (570 mg Fe(3+)/L, 20 min. contact time) removal efficiency of color, turbidity, suspended solids and ammonia increased to 96.04%, 99.27%, 98.61%, and 43.20%, respectively. Removal of ammonia (81.60%) increased significantly after final adsorption onto clinoptilolite (25 g/L, 4 h contact time). Removal of COD after successive treatment with calcium oxide, ferric chloride and clinoptilolite was 64.70%, 77.40% and 81.00%, respectively.

Pak, D., et al. (2002). "Use of natural zeolite to enhance nitrification in biofilter." *Environ Technol* 23(7): 791-798.

To enhance nitrification, natural zeolite and activated carbon were tested as a media in a biofilter to treat wastewater containing relatively high concentrations of TKN. Using those media, the adsorption isotherms for ammonium ion were compared; the K values for natural zeolite and activated carbon were found to be 0.5117 and 0.0006, respectively. In comparison of the performance of the two media, two identical, lab-scale biofilters were then operated for 4 months. The effect of NH₃-N loading rates on the performance was investigated. The results showed that higher NH₃-N removal efficiency and faster nitrification were achieved in the biofilter with natural zeolite throughout the experimental period. *Nitrosomonas* and *Nitrobacter*, two principal nitrifiers, in biofilm grown on two different media were counted and compared. *Nitrobacter* which is the more fragile of the two principal nitrifiers was outgrown in the biofilm on natural zeolite media. The reason for this may be due to the ammonium ion exchanging capacity of natural zeolite which provided the favorable environment for *Nitrobacter*.

Qing, C. S., et al. (2012). "[Denitrification water treatment with zeolite composite filter by intermittent operation]." *Huan Jing Ke Xue* 33(12): 4380-4386.

The zeolite composite filters (ZCF) with the size of 4-8 mm

were prepared using raw zeolite (0.15-0.18 mm) as the main material and the cement as binder. After a combination of material characterizations, such as the void fraction, apparent density, compression strength and surface area, the optimal prepared conditions of composite filters were obtained as follow: weight ratio of m (zeolite): m (cement) = 7 : 3, curing for 15 d under the moisture condition and ambient temperature. Through upflow low-concentration ammonia nitrogen wastewater, ZCF filled in the experimental column was hung with the biological membrane. Thus, intermittent dynamic experiments were conducted, the intermittent operation cycle included adsorption, biological regeneration and drip washing. Until concentration of ammonia nitrogen was more than 2 mg x L(-1) of effluent standards, water in experiment column was firstly emptied, and then blast biological regeneration was conducted. After the filters were bathed with water, the zeolite adsorption-biological regeneration cycle was performed repeatedly. The experimental results show that under conditions of 24 h blast and 5 d of continuous operation period, ammonia nitrogen removal rate is up to 87.6% on average, total nitrogen removal rate reaches 51.2% on average.

Romero, J. V., et al. (2012). "SO₂ and NH₃ gas adsorption on a ternary ZnO/CuO/CuCl₂ impregnated activated carbon evaluated using combinatorial methods." ACS Comb Sci 14(1): 31-37.

Ternary libraries of 64 ZnO/CuO/CuCl₂ impregnated activated carbon samples were prepared on untreated or HNO₃-treated carbon and evaluated for their SO₂ and NH₃ gas adsorption properties gravimetrically using a combinatorial method. CuCl₂ is shown to be a viable substitute for HNO₃ and some compositions of ternary ZnO/CuO/CuCl₂ impregnated carbon samples prepared on untreated carbon provided comparable SO₂ and NH₃ gas removal capacities to the materials prepared on HNO₃-treated carbon. Through combinatorial methods, it was determined that the use of HNO₃ in this multigas adsorbent formulation can be avoided.

Srinivasan, R., et al. (2008). "Evaluation of removal of orthophosphate and ammonia from rainfall runoff using aboveground permeable reactive barrier composed of limestone and zeolite." J Environ Sci Health A Tox Hazard Subst Environ Eng 43(12): 1441-1450.

This paper evaluates the design and performance of an Aboveground Permeable Reactive Barrier (APRB) system made of polyethylene mesh bags (FlowBags) containing crushed limestone and zeolite for adsorption of orthophosphate-P (PO₄-P) and ammonia-N (NH₄-N) from rainfall runoff. Laboratory batch experiments, simulated runoff experiments and actual APRB implementations were performed to evaluate the performance of the APRB. Batch experiments were performed to determine adsorption efficiency of crushed zeolite and limestone as reactive materials in APRB for removal of dissolved ammonium nitrogen and orthophosphate phosphorus from aqueous solutions under controlled laboratory conditions. Adsorption efficiencies of zeolite and limestone were tested individually and in combination. Results show adsorption efficiency increases when the materials are used in combination. Effects of particle size, contact time, pH, and

temperature were studied. Major emphasis was given to short contact times because the contact of rainfall runoff water under field conditions with APRBs would be approximately 5 minutes. Maximum removal of approximately 70% PO₄-P and NH₄-N was seen at 45 degrees C in 5 minutes within a pH range of 8-11. Optimum adsorbent concentration was 0.3 ppm with 20 g limestone and 10 g of zeolites. Simulated field experiments and actual APRB field installations showed variable results. Results from field evaluations of APRB showed mixed results from very high to negligible removal of orthophosphate-P and ammonia-N at different monitoring sites and storm events. Such variability may be due to the design of the bags, other biotic and abiotic factors and various physical factors, which are absent in the laboratory conditions. Some APRB design problems were also observed under field conditions and solutions are suggested. Overall results indicate that APRBs composed of combinations of crushed zeolite and limestone will offer an effective low maintenance and green alternative to remove dissolved nutrients from runoff and protect surface water resources from eutrophication.

Wang, Y., et al. (2006). "Ammonia removal from leachate solution using natural Chinese clinoptilolite." *J Hazard Mater* 136(3): 735-740.

This paper assesses the potential of natural Chinese clinoptilolite for ammonia removal from the leachate solution of sewage sludge. In batch study the effects of relevant parameters, such as contact time, initial ammonia concentration and particle size of clinoptilolite, were examined respectively. The results show that the data obtained from batch studies were fit to Langmuir and Freundlich isotherms and the Langmuir isotherms reflect more reasonable for ammonium ion uptake onto clinoptilolite; the clinoptilolite adsorption process has been proved effective, at laboratory scale, the maximum adsorption capacity of the clinoptilolite, for ammonium concentration ranging from 11.12 to 115.16 mg NH₄-N L⁻¹ in leachate solution, was about 1.74 mg NH₄-N g⁻¹; the time to adsorption equilibrium was 2.5 h in leachate solution and 1.5 h more than for in NH₄Cl synthetic solution; ammonium adsorption increased with decreasing clinoptilolite particle size; the ammonia removal capacity of clinoptilolite increased with increasing initial ammonia concentration. It is believed that as adsorption agent for NH₄-N removal from sludge leachate, natural Chinese clinoptilolite can be feasible.

Yang, X., et al. (2009). **Comparison of Polypropylene and Zeolite Medium Combined in Biological Aerated Filter Treating Domestic Sewage.** 2009 International Conference on Energy and Environment Technology. Guilin, China, CS Digital Library. 2: 488-491.

Treatment efficiency and microorganisms' property of polypropylene and zeolite medium coupled in biological aerated filter(BAF) were investigated in this paper. The reactors were operated in parallel with upflow mode using domestic sewage as influent up to BOD₅ volumetric loading of 3 kg BOD₅•m⁻³d⁻¹, NH₃-N surface loading of 0.5 g NH₃-N•m⁻²d⁻¹, and air/liquid ratio of 10:1 in room temperature. The results suggested that the differences of COD removal were not obvious for these two carriers, and

the removal efficiency was up to 85%. In addition, the nitrogen removal ability was limited for both, the removal efficiency of $\text{NH}_3\text{-N}$ and TN by polypropylene BAF was 77% and 36% respectively. On the contrary, nitrification was improved by 11% contributing to ion exchange capacity of zeolite, and the total nitrogen removal capacity was equal to 55% for the inner anoxic environment. The results of biomass and biofilm activity change were similar in these two mediums. Biomass tended to decrease gradually along water flow, and that the biofilm activity change appeared obvious characteristics of reversed "V" shape. The activity enrichment was obtained at the point of organic famine transferring to feast regime. Overall, zeolite was superior to polypropylene in biological aerated filter process, and the special structure was beneficial to nitrogen degradation

Zhu, W.-L., et al. (2011). "Kinetic Adsorption of Ammonium Nitrogen by Substrate Materials for Constructed Wetlands." *Pedosphere* 21(4): 454.

Abstract Constructed wetlands (CWs) are engineered systems that utilize natural systems including wetland vegetations, soils, and their associated microbial assemblages to assist in treating wastewater. The kinetic adsorption of ammonium nitrogen ($\text{NH}_4\text{-N}$) by CW substrate materials such as blast furnace slag (BFS), zeolite, ceramsite, vermiculite, gravel, paddy soil, red soil, and turf, was investigated using batch experiments and kinetic adsorption isotherms. Both Freundlich and Langmuir isotherms could adequately predict the $\text{NH}_4\text{-N}$ adsorption process. The maximum adsorption capacities of $\text{NH}_4\text{-N}$, estimated from the Langmuir isotherm, ranked as: zeolite (33 333.33 mg kg⁻¹) > turf (29 274.01 mg kg⁻¹) > BFS (5 000 mg kg⁻¹) > vermiculite (3 333.33 mg kg⁻¹) > gravel (769.23 mg kg⁻¹) > paddy soil (588.24 mg kg⁻¹) > red soil (555.56 mg kg⁻¹) > ceramsite (107.53 mg kg⁻¹). Some properties of the substrate materials, including bulk density, specific gravity, hydraulic conductivity, uniformity coefficient (K₆₀), curvature coefficient (C_c), organic matter, pH, exchangeable (or active) Cu, Fe, Zn and Mn, total Cu, and Fe, Mn, Zn, Cd, Pb and Ca, had negative correlations with $\text{NH}_4\text{-N}$ adsorption. Other properties of the substrate materials like particle diameter values of D₁₀, D₃₀ and D₆₀ (the diameters of particle sizes of a substrate material at which 10%, 30% and 60%, respectively, of the particles pass through the sieve based on the accumulative frequency), cation exchange capacity (CEC), exchangeable (or active) Ca and Mg, and total K and Mg had positive correlations with $\text{NH}_4\text{-N}$ adsorption. In addition, active K and Na as well as the total Na had significant positive correlations with $\text{NH}_4\text{-N}$ adsorption. This information would be useful for selection of suitable substrate materials for CWs.