Announcing the Final Examination of Cameron Houmann for the degree of Master of Science

Time & Location: March 27, 2015 at 9:00 AM in ENGR II 442
Title: Functional Characterization of Green Sorption Media and Scaling of Pilot Studies for Copper Removal in Stormwater Runoff

Green adsorption media with the inclusion of renewable and recycled materials can be applied as a stormwater best management practice for copper removal. A green adsorption media mixture composed of recycled tire chunk, expanded clay aggregate, and coconut coir was physicochemically evaluated for its potential use in an upflow media filter. The results found that the use of the green adsorption media mixture in isolation or the coconut coir with an expanded clay filtration chamber could be an effective and reliable stormwater best management practice for copper removal.

Batch adsorption tests revealed that the media and media mixture follow both the Freundlich and Langmuir isotherm models and that the coconut coir had the highest affinity for copper. A screening of desorbing agents revealed that hydrochloric acid has good potential for copper desorption, and desorption equilibrium fit the Freundlich isotherm model. Both adsorption and desorption kinetic data had high correlation with the pseudo-second order model and revealed a rapid desorption reaction. Batch equilibrium data over 3 adsorption/desorption cycles found that the coconut coir and media mixture were the most resilient and demonstrated that they could be used through 3 or more adsorption/desorption cycles. The coconut coir also performed the best under dynamic conditions, having an equilibrium uptake of 1.63 mg·g⁻¹ at an influent concentration of 1.0 mg·L⁻¹ and a hydraulic retention time of 30 minutes. A physical evaluation of the media found the macro-scale properties, such as particle size distribution and mass-volume relationships, and observed the micro-scale properties such as pore microstructure, crystalline structure, and elemental composition. FE-SEM imaging found a strong correlation between the porosity of the micro pore structure and the adsorptive capacity. The equilibrium and dynamic adsorption testing results were confirmed by elemental analysis using EDS.

Effective design of sorption media reactors is highly dependent on selection of the hydraulic residence time when scaling up the lab-scale reactor to the field-scale and this was demonstrated through the use of the Damköhler and Pécelt numbers via a dimensional analysis. A new scaling-up theory was developed through a joint consideration of the Damköhler and Pécelt numbers for a constant media particle size such that a balance between transport-controlled and reaction-controlled kinetics can be harmonized. Selection of an optimal hydraulic residence time can be accomplished by developing a relationship between the sorption capacity of the media and the Damköhler number. A series of column breakthrough tests at varying hydraulic residence times revealed a clear peak adsorptive capacity for the media mixture at a Damköhler number of 2.7. The Pécelt numbers for the column breakthrough tests indicated that mechanical dispersion is an important effect that requires further consideration in the scaling-up process. However, perfect similitude of the Damköhler number cannot be maintained for a constant media particle size, and relaxation of hydrodynamic similitude through variation of the Pécelt number must occur.

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Bachelor's of Civil Engineering, BS, 2013, Walla Walla University

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Approved for distribution by Dr. Ni-Bin Chang, Committee Chair, on March 3, 2015.
The public is welcome to attend.