2019 E2S2-CREATE and AIChE® Waste Management Conference

11-13 MARCH 2019 | CREATE TOWER NUS | SINGAPORE

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Municipal solid waste biochar (MSW-BC) for the removal of volatile organic compounds (VOCs) from aqueous media was investigated in this study. Batch result supported fixed bed column study was conducted for optimization of site specific permeable reactive barrier. The characteristics of MSW-BC were evaluated under different categories, surface properties, proximates, and elemental. Batch studies for BTEX conducted in different ranger of sorbent dosages (1-10 g/L), pH conditions (3, 5, 7, 9), time intervals (0.5- 24 h) and final sorbate concentrations (10- 600 µg/L). The batch based column experiments conducted for VOCs like toluene and m-xylene. Different quantity from MSW-BC (1, 0.25 %) was utilized into the column and different inlet concentration of Toluene (1000, 4000 µg/L) Xylene (4000 µg/L) was tested for optimization. According to the MSW-BC characteristics, organic sorption favor due to high carbonized structure of sorbent increasing hydrophobicity depicted by proximate analysis of lower polarity index [(O+N)/C] (0.26). Elemental characteristics of lower bioavailable metal environment ideal for field application of MSW-BC. Maximum adsorption of the Isotherm study reveals higher capacity for all VOCs (400 – 700 µg/g). The model fittings of all isotherms well suited with Langmuir and further Fruendlich fitting describe both chemical and physical adsorption. In fixed bed column system, relatively low r^2 values (r^2 = 0.8833, 0.8808) indicated the less applicability of Adams-Bohart model. Hence, both sorbates obey the Thomas model and could explain the Langmuir kinetics adsorption by MSW-BC in a fixed bed system. Hence, it can be concluded that MSW-BC is efficient in the removal of VOCs in batch as well as fixed bed sorption systems simultaneously minimizing the waste acumination in the environment.

Environmental Impacts from Energy Use in Solar Photovoltaics Manufacturing.

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Solar energy have been considered as a clean, renewable and non-pollutive source of energy. However, the environmental impacts of solar energy are usually not considered and not well understood. Crystalline solar photovoltaic (PV) panels are the most popular form of solar energy in use currently. A cradle to gate life cycle assessment (LCA) was done for mono and polycrystalline solar photovoltaic (PV) panels. The raw materials, electricity and other inputs were considered in nine impact categories, up to the manufacturing stage. Results showed that energy input had the greatest environmental impacts among all inputs. Of all possible sources of energy input, coal use had the highest environmental impact. Increasing the proportion of renewable energy use in the manufacturing of PVs reduced the impacts across all categories. This implies that as more PVs are manufactured for use in the coming years, more carbon emissions will be expected, generating a carbon debt, unless a corresponding increase in renewable energy is use in manufacturing. This is also true for other environmental impacts, such as acidification, aquatic, terrestrial and human toxicities. However, certain processes in PV manufacturing, such as silicon ore refining has no known renewable energy substitute. The limits on the use of renewable energy in solar PVs manufacturing would limit the environmental benefits of using PVs and negatively affect decarbonization efforts.

King Coconut Husk Derived Biochar through Hydrothermal Activation Process for the Removal of Cadmium (II) and Copper (II) from Aqueous Media.

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This research was conducted to study the removal of the most prevalent heavy metal ions cadmium (II) and copper (II) by adsorption on King coconut (Red Dwarf coconut, *cocos nucifera*. var) husk biochar.

Raw king coconut biochar (RKH) and steam activated King coconut biochar (AKHC) were prepared and analysed for physical properties, surface properties, elemental composition and functional properties to identify the sorbent suitability. The efficiency of adsorption of heavy metal ions [cadmium (II) and copper (II)] on biochar were studied with batch sorption experiments. Adsorption capacities of RKH and AKHC for cadmium (II) and copper (II) at different pH, initial metal concentrations, ionic strengths and contact times between adsorbent and adsorbate were measured. Scanning electron microscopy reveals the existence of a better and highly porous structure in AKHC than that of RKH, that could be a result of the volatilization by steam process. EDX analysis indicates a carbonized structure for both adsorbents. Further, it was observed that the adsorption of Cd and Cu ions by AKHC could be increased with increasing pH and decreased with ionic strength. Supported point of zero charge pH_{pzc} (5.8, 6.9) can be used to explain the effect of pH on the higher adsorption process at higher pH. The maximum adsorption capacities of Cd and Cu of AKHC were 22.24, 34.24 mg g^{-1}, respectively, and they were considerably lower for RKH with 17.22, 21.25 mg g^{-1}. With well-fitting of Freundlich isotherm, it revealed the heterogeneous properties of the surfaces and favourable adsorption process. The kinetics fittings of pseudo second order were accommodated towards chemisorption process for both Cu and Cd. The higher sorption ability expressed by AKHC and RKH, prepared in this study, show their potential sorbent activity for environmental remediation application.

Poster Presentations

#552152: Robust Trading Strategies for a Waste-to-Energy Combined Heat and Power Plant in a Day-Ahead Electricity Market.

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Waste-to-energy (WtE) technology has been used all over the world as it can solve the dilemma of waste management, energy demand, and global warming. Many modern WtE plants are built and operated in a combined heat and power (CHP) mode due to the high overall energy efficiency. This paper studies robust trading strategies for a WtE CHP plant which sells electricity in a day-ahead electricity market and exports heat to a district heating network. Owing to the requirements of the day-ahead electricity market, plant operators must determine the trading strategy one day before real delivery of electricity. However, many key problem parameters including electricity prices, heat demand, and the amount of waste delivered to the plant are uncertain at the day-ahead stage. To derive robust electricity trading strategies for the WtE CHP plant under different types of uncertainty, a two-stage robust optimization model is developed and a solution procedure based on the column-and-constraint generation method is designed. A case study is also performed to illustrate the effectiveness of the robust model and the solution procedure.

#552156: Case Study - Demonstration Plant of Water Recycling of Treated Industrial Wastewater Using Microfiltration/Reverse Osmosis and Activated Carbon Filter for Process Use in a Petrochemical Plant, Singapore.

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Membrane processes employing pre-treatment with micro-filtration (MF) with reverse osmosis (RO) have been proven to be reliable and economical in Industrial Water Recycling facilities. This has resulted in the conversion of existing Conventional Activated Sludge (CAS) process for treated industrial wastewater recovery for process use.