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Expertimental Study of Organic and Inorganic Compound Adsorption on Biochar Samples

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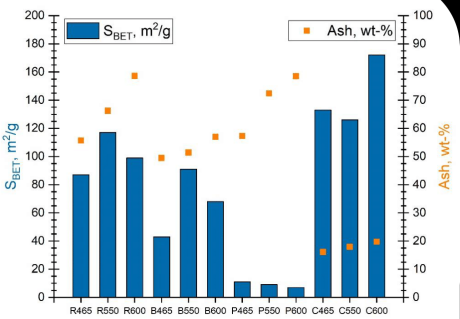
Biochar – product of partial oxidation of biomass in a controlled environment (fluidized bed catalyst reactor). Promising material for adsorption purposes due to rich microstructure of its surface.

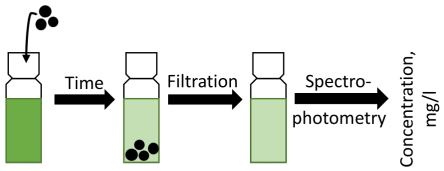
Materials

- Twelve samples of sorbents were studied.
- These samples varied in source (rice husk, wheat bran, peat and coal) and treatment temperature in the fluidized bed catalyst reactor (465, 550, 600 °C).
- As model pollutants two compounds were used: Cu^{2+} ions (solution of copper sulfate) and methyl green). No joint-pollutant experiments were conducted.
- Material surface area and ash contents were measured during an earlier study.



R – rice husk biochar; B – wheat bran biochar; P – peat; C - coal

Methods

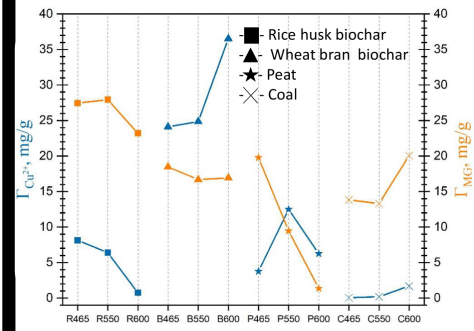


- **Adsorption capacity experiment**: all sorbents were tested, no stirring, reaction time – 7 days;
- **Thermodynamic experiment**: 3 sorbents were tested (R465,550,600), no stirring, reaction time – 7 days, different initial pollutant concentration;
- **Kinetic experiments**: 1 sorbent was tested (R465), solutions were stirred. For activation energy experiments kinetic curves were built for different reaction temperatures;
- Filtration was carried on paper filters under normal pressure;
- Optical density of solutions were measured at λ=632 nm (MG), 805 nm (Cu^{2+}).

Adsorption capacity experiments

- Wheat bran biochar – good capacity for MG and Cu^{2+} alike;
- Rice husk biochar – good MG adsorption capacity;
- No clear dependence from carbonization temperature can be noticed.

$$\Gamma = \frac{(C_{in} - C_{fin}) * V}{m_s}$$

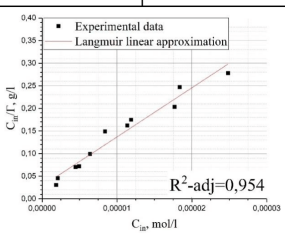


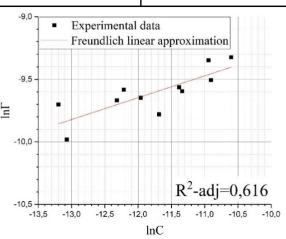
Biochars: R – rice husk; B – wheat bran; P – peat; C - coal

Thermodynamic experiment

- Adsorption isotherms were built to determine the adsorption model (Langmuir or Freundlich);
- Langmuir model showed best accordance with experimental data for all three samples;

R^2-adj	R465	R550	R600
Langmuir	0,954	0,959	0,970
Freundlich	0,616	0,299	0,634

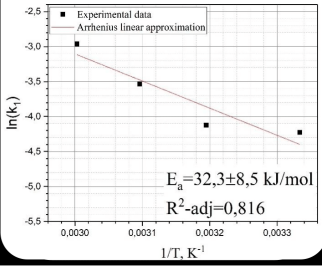




Kinetic experiment:

Activation energy

- Reaction constants were determined from kinetic curves using Lagergren kinetic model;
- The calculated data may indicate that the reaction is mostly physical in nature



Conclusion

- Biochars can be used as effective adsorbents, best utilized at lower concentrations of certain pollutants;
- Wheat bran biochar had the highest adsorption capacity for the inorganic model pollutant, while the best results regarding the organic substance belonged to samples of rice husk biochar;
- The Langmuir adsorption isotherm best describes the data, which hints to the process characteristics;
- The kinetic model is described well by the Lagergren model, and the effective activation energy is 32,3 kJ/mol, which may indicate the mostly physical nature of the process.