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# Valorization of pyrolytic plastic-derived char for adsorption of wastewater contaminants: a kinetic and thermodynamic investigation

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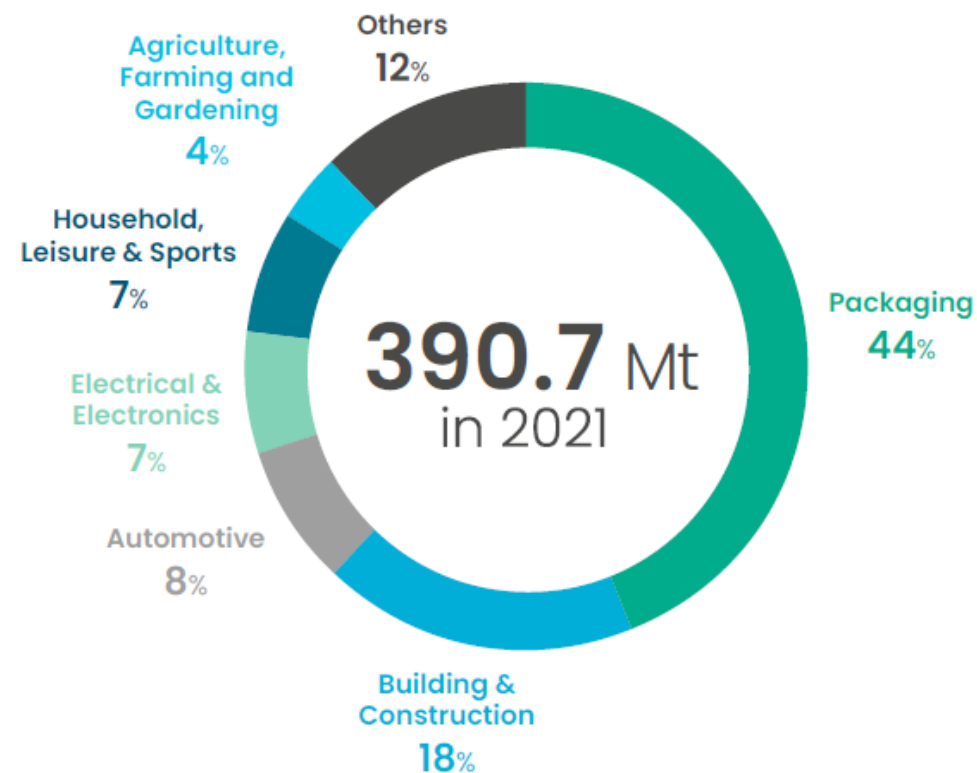
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# Plastic char generation

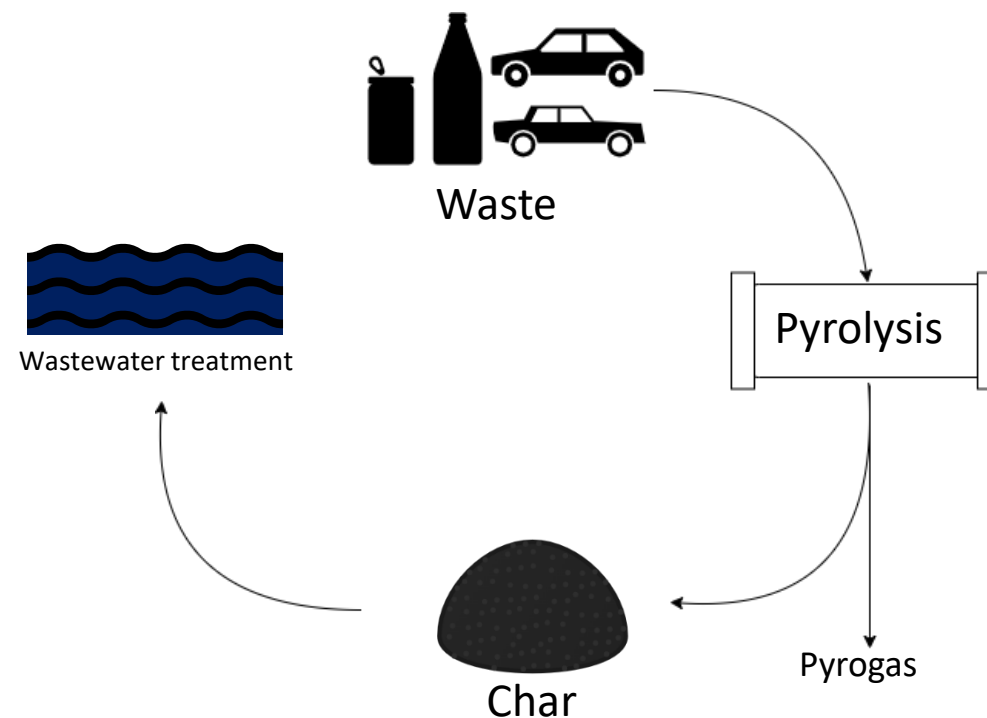
- **Char** as solid waste
- Plastic pyrolysis/gasification
- Char **valorization**
  - road construction raw material substitution
  - epoxyresins production
  - **wastewater pollutants removal**



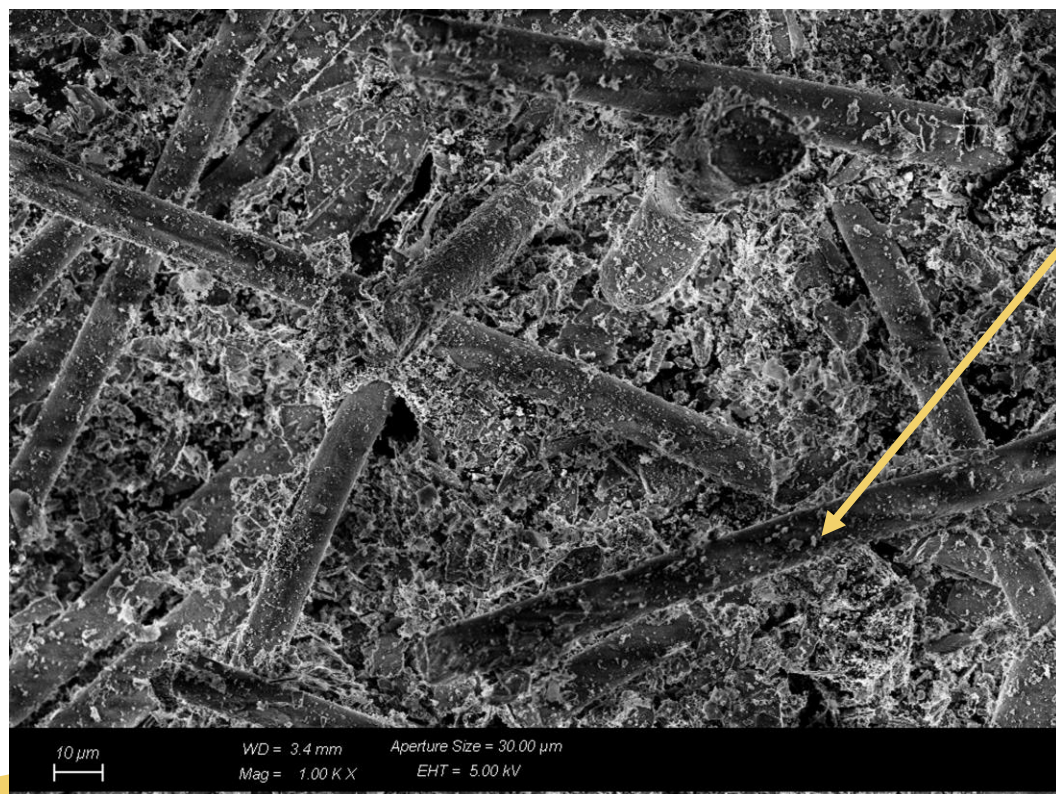
Global plastic production in 2021. Taken from Plastic Europe, *Plastics – The Facts*, 2022

# Goal and scope

- Char adsorption performance and properties
- Methylene blue as test pollutant
- Char from a real industrial process
- Mainly vehicles scrap plastic

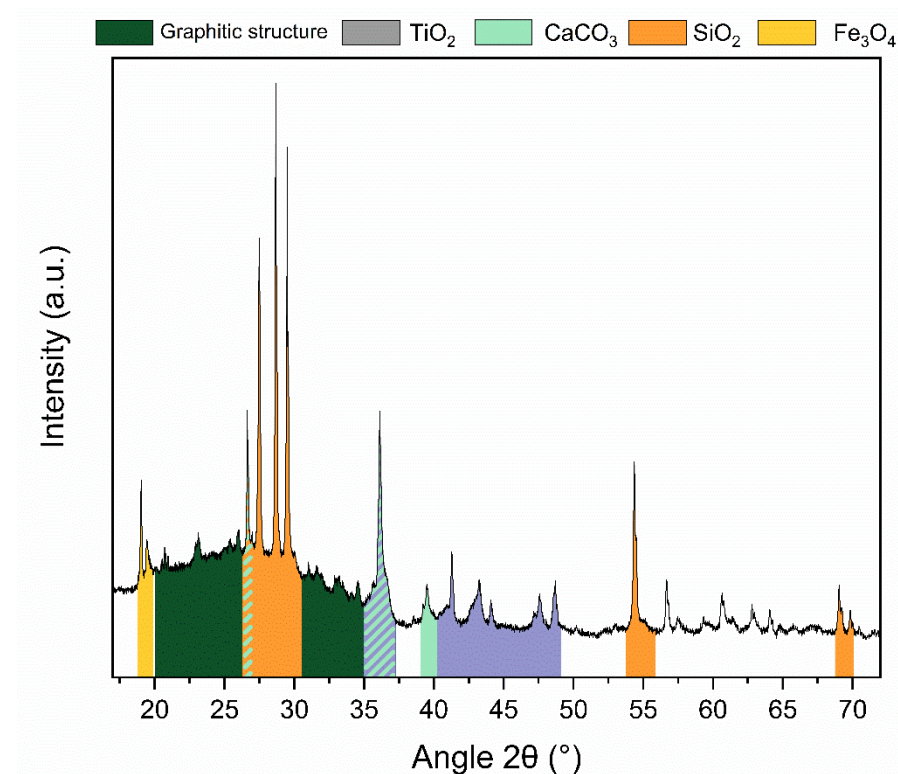


# Char characterization



FE-SEM image of PW-C. 1000x magnification

SiO<sub>2</sub>-rich rods



PW-C X-ray diffraction. Relevant presence of SiO<sub>2</sub> can be observed.

Organic compounds 20% of total mass  
Surface area = 13.6 m<sup>2</sup>/g

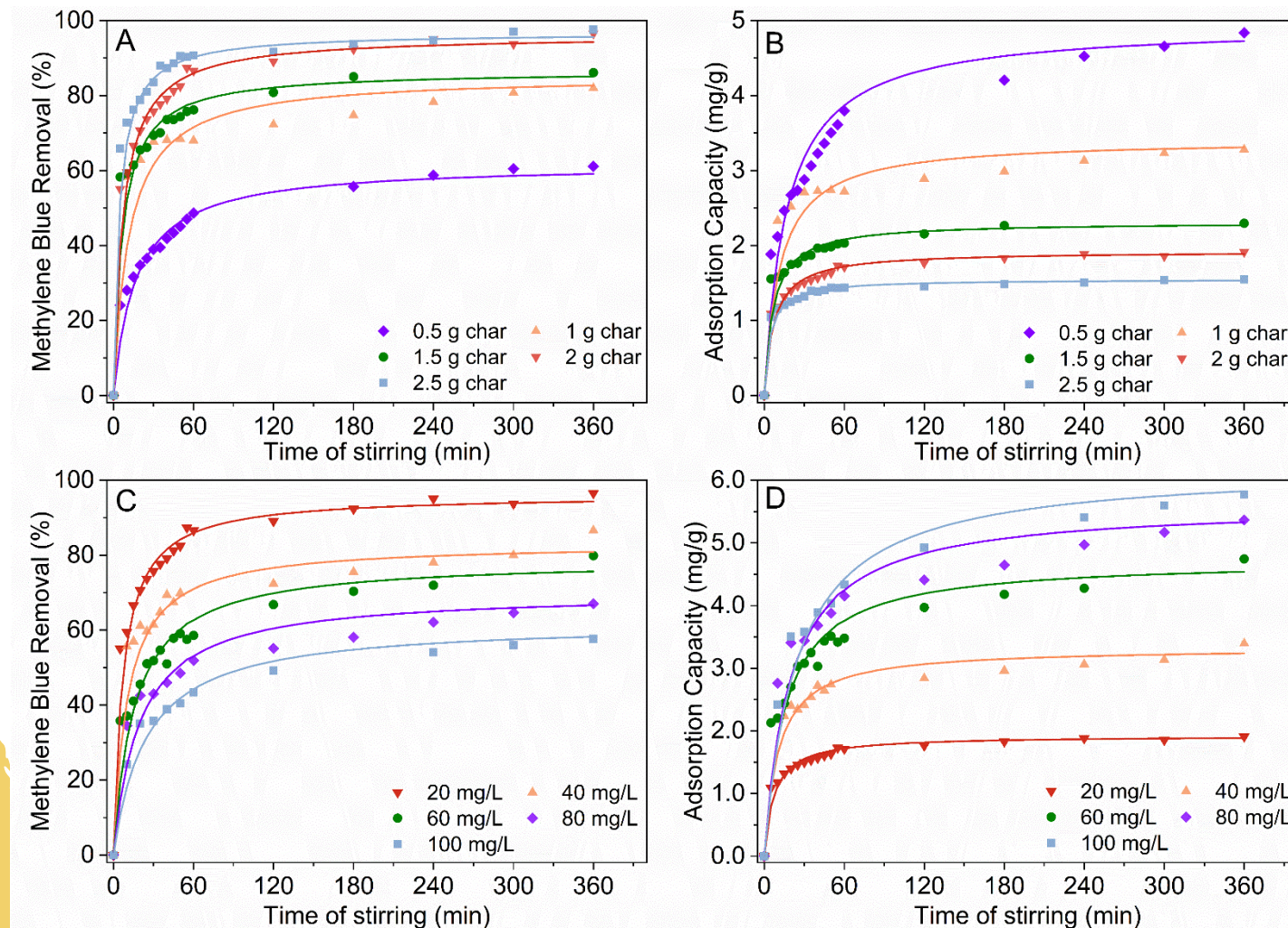


# Char adsorption performance

Added char: 10 g/L

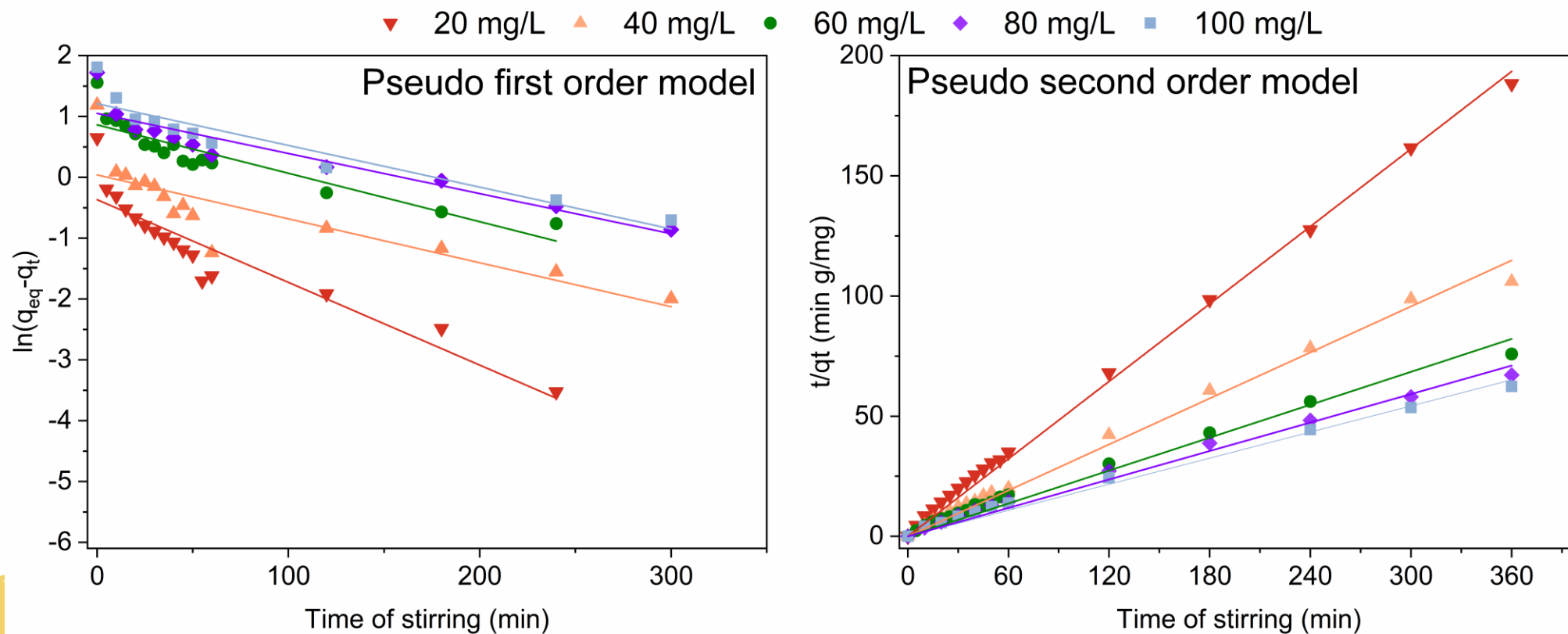
Initial methylene blue concentration: 20 mg/L  
→ 94% MB removal

Initial methylene blue concentration: 100 mg/L  
→ 5.8 mg/g adsorption capacity



PW-C adsorption performance. A, B- influence of char dosage, 20 mg/L methylene blue solution;  
C, D – influence of initial methylene blue concentration, 2 g char added to solution

# Adsorption kinetics

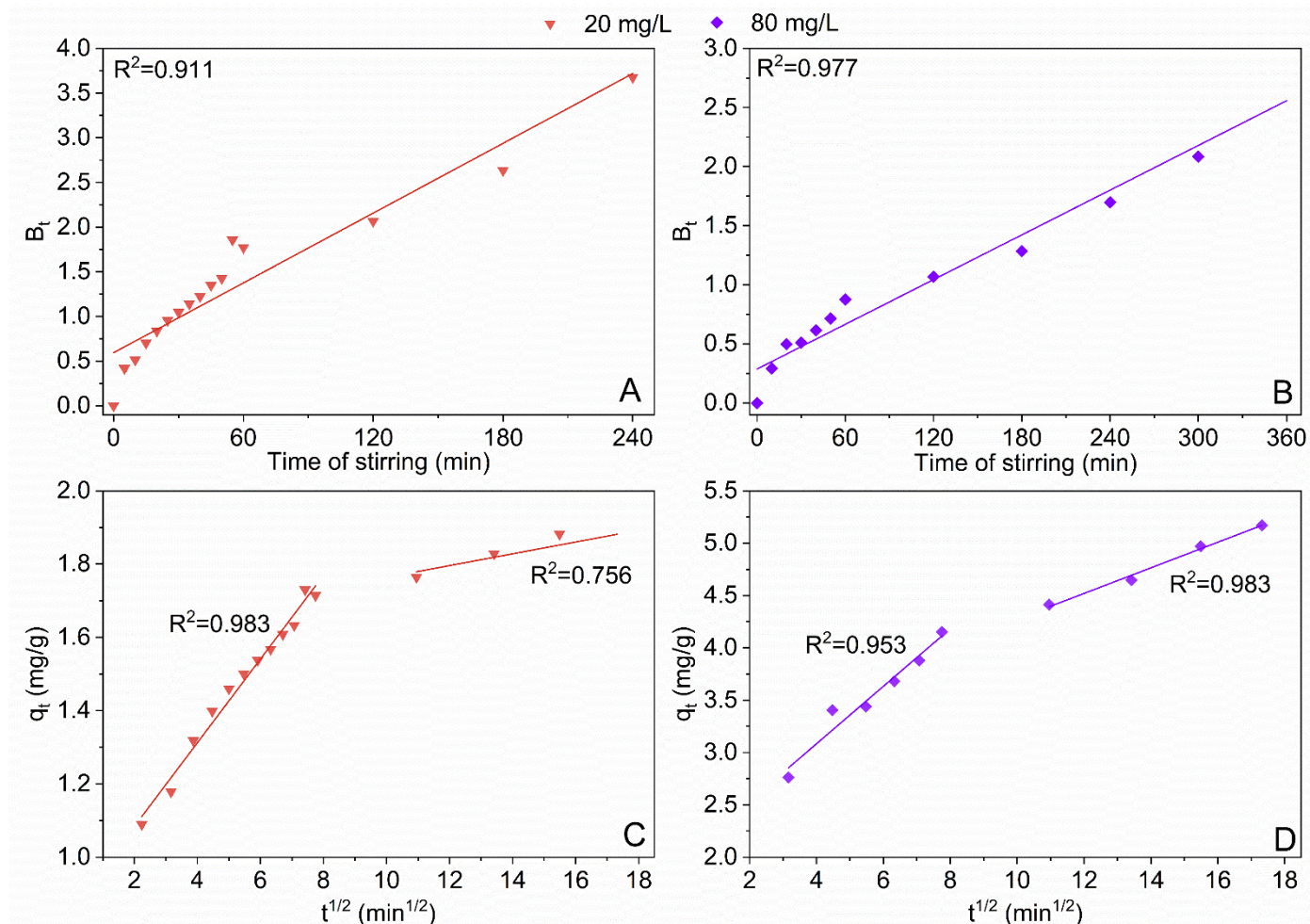


Adsorption kinetics data fitting. Pseudo first order model and Pseudo second order model. All data were collected at room temperature, with a 10 g/L char/solution ratio.



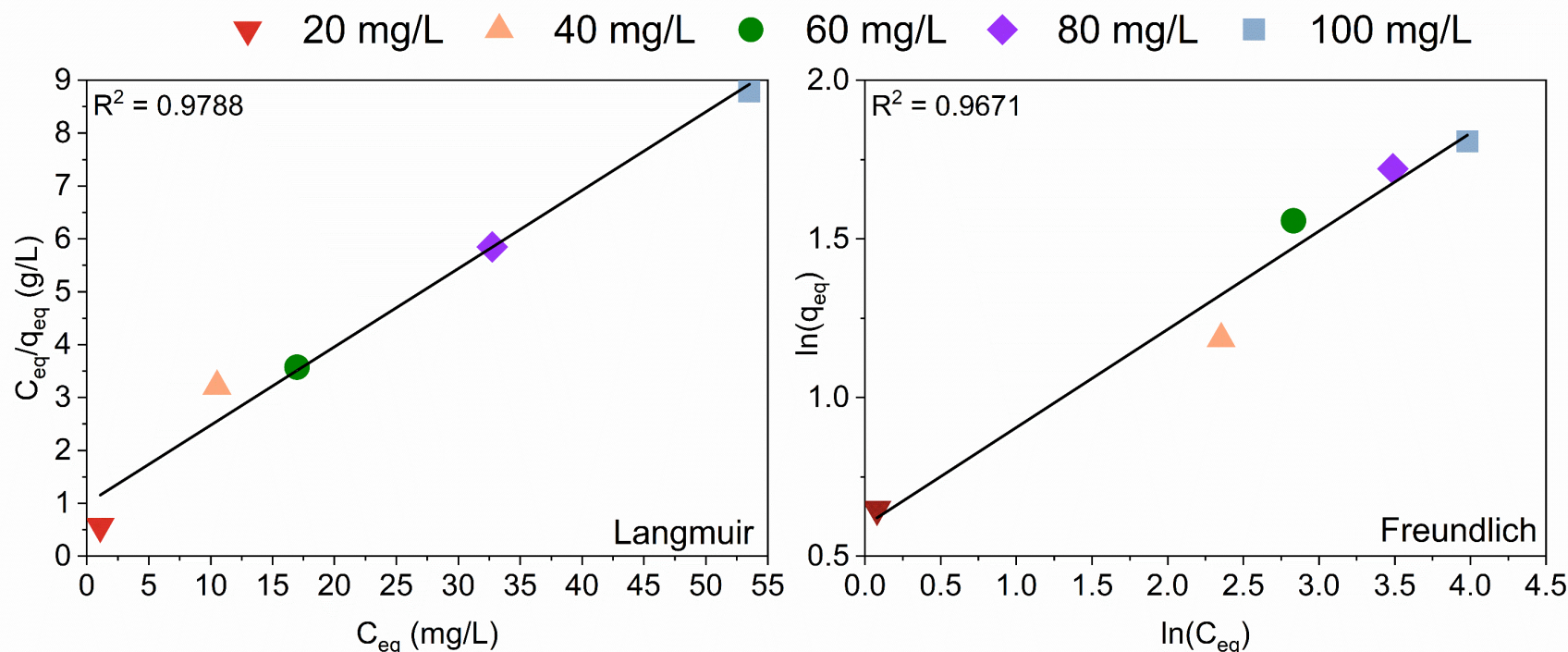
# Adsorption kinetics insight

- **External** and **internal** mass transfer relevant mechanisms
- **External** mass transfer kinetically determining step



Adsorption data fitting by kinetic models. A, B - Intra-particle diffusion model; C, D - Boyd model. All data were collected at room temperature, with a 10 g/L char/solution ratio.

# Thermodynamic properties



Langmuir and Freundlich isotherms adsorption data fitting. All data were collected at room temperature, with a 10 g/L char/solution ratio.

$$\Delta H_{\text{ads}} = 4.7 \text{ kJ/mol}$$

$$\Delta G_{\text{ads}} = \text{from } -26 \text{ to } -30 \text{ kJ/mol}$$



**Spontaneous physisorption**



# Conclusions

- Adsorption behaviour in accordance with literature
- Char best worked at **low** dye concentration and **higher** mass
- Suitable solution in **conjunction** with other **removal** methods

→ Viable **valorization path** of industrial **waste** char



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# Thank you for your attention

Q&A



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