Adsorption Processes in WaterTAP

Hunter Barber[a], Fernando V. Lima[a], Kurban Sitterley[b]
[a]Department of Chemical and Biomedical Engineering, West Virginia University, Morgantown, WV, [b]National Renewable Energy Laboratory, Golden, CO

Granular Activated Carbon

Motivation: Granular activated carbon (GAC) is employed for dissolved organic carbon (DOC) and trace contaminant removal

Approach: Empirical constant pattern homogeneous surface diffusion model (CPHSDM) for single species adsorption

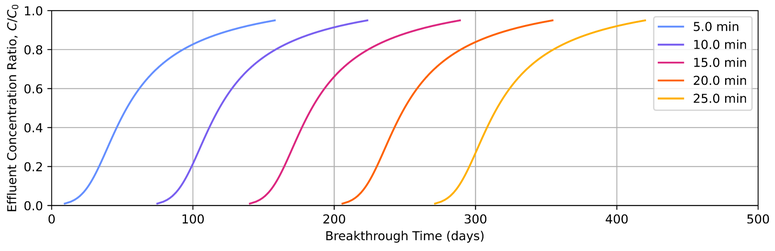
Key Inputs:

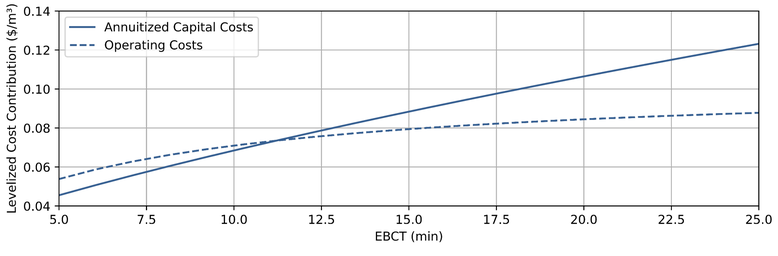
- Freundlich isotherm parameters
- Column design
- GAC media properties
- Mass transfer properties (fixed or determined from experimental breakthrough data)

Key Outputs:

- Breakthrough time for effluent targets
- GAC media usage rate
- Capital costs
- Operating costs

Example GAC Case Study:
Treating 0.5 mg/L trichloroethylene (TCE) influent for 90% breakthrough



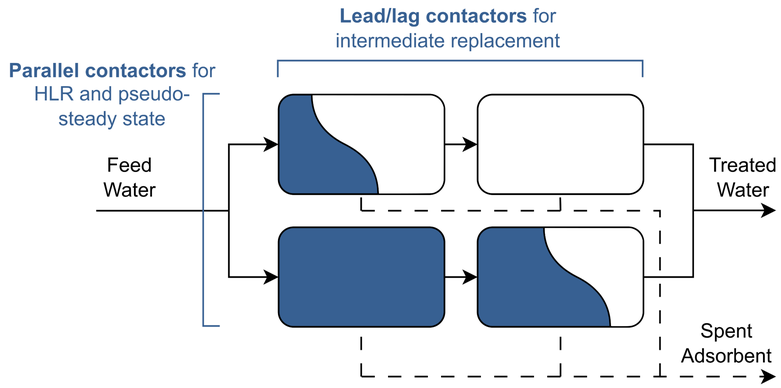


Adsorption Processes Overview

In adsorption processes, treatment is governed by mass transfer where contaminants are removed once adsorbed onto solid media.

Granular activated carbon and ion exchange adsorption models are available in WaterTAP.

An adsorption system design may include several contactors to manage operation.



Adsorption is an inherently dynamic process given the need for media replacement.

WaterTAP's adsorption models are structured with similar assumptions and methodologies:

- Single species adsorption
- Model parameters determined from breakthrough data or referenced in literature
- Steady state results obtained through numerical integration of the discretized breakthrough curve
- Energy consumption estimates
- Economy of scale costing

Contact: Kurban Sitterley, Kurban.Sitterley@nrel.gov

Ion Exchange

Motivation: Ion exchange (IX) is employed for hardness removal.

Approach: Kinetic Clark model for single species breakthrough accounting for mass transfer and varying equilibrium adsorption capacity

Key Inputs:

- Freundlich or Langmuir parameters
- Column design
- IX resin properties
- Mass transfer properties (fixed or determined from experimental breakthrough data)

Key Outputs:

- Breakthrough time for effluent targets
- IX resin and regenerant usage rate
- Capital costs
- Operating costs

Example IX Case Study:
Treating 100 mg/L calcium influent for 90% breakthrough