Experimentation on adsorption technology

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Universitat de Girona

UdG lequia ECO-INNOVATIVE ENVIRONMENTAL SOLUTIONS

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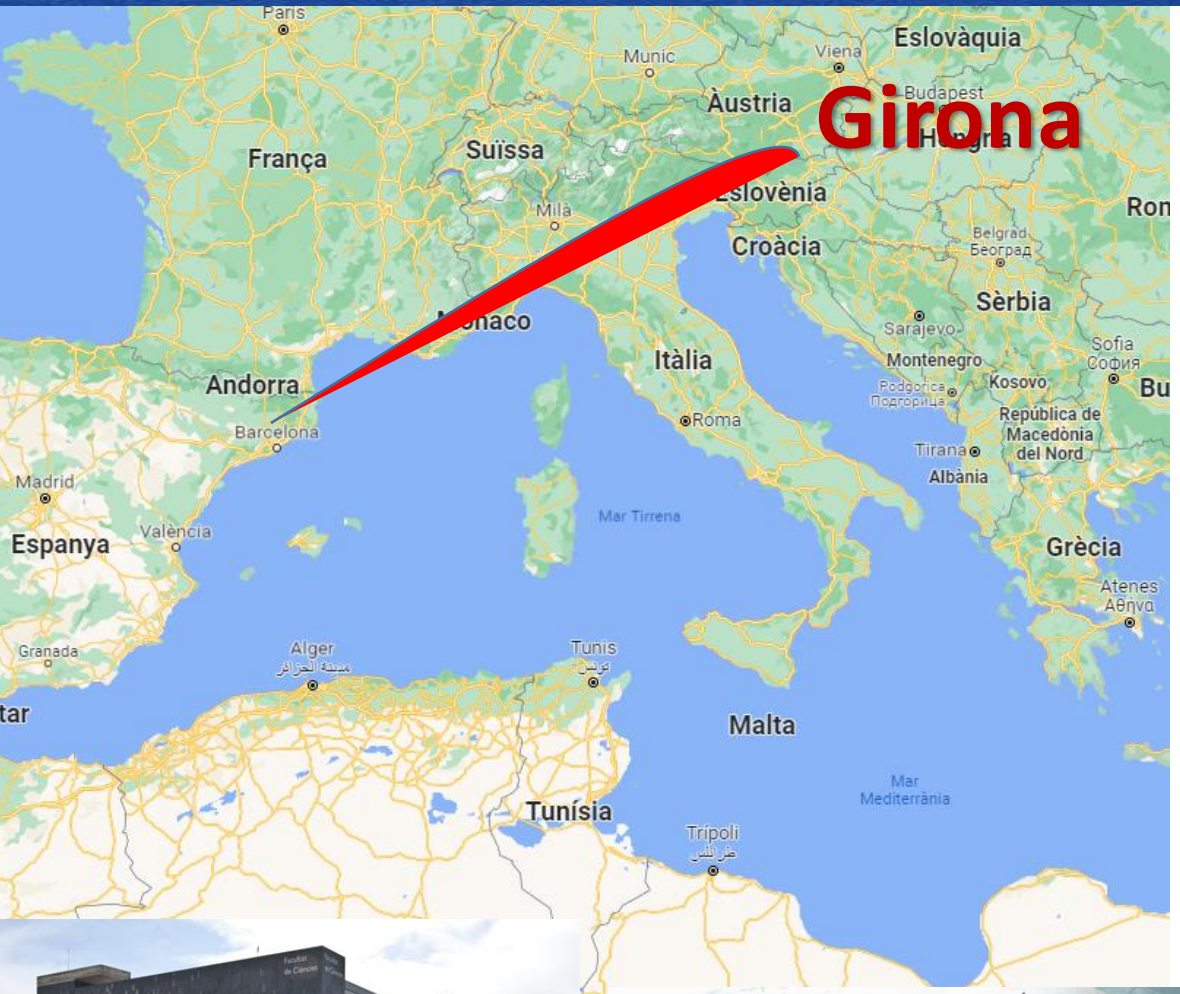
LEQUIA & University of Girona



Presentation

- Alba Cabrera Codony (alba.cabrera@udg.edu)
- Environmental engineering Post-doc researcher at University of Girona
- Technology transfer experience with several public and private companies
  - Activated carbon manufacturers
  - Drinking water treatment plants
  - Odor abatement in sewage sludge treatment plants

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Environmental engineering research topics:

Membrane bioreactors (MBR)

Bioelectrochemical Systems (BES)

Advanced adsorption and oxidation processes

Biological nutrient removal and recovery

Environmental Decision Support Systems (EDSS)

Environmental applications of adsorption technology

Adsorption

Adsorption A mass transfer process which involves the accumulation of atoms, ions or molecules from a gas or a liquid stream to the surface of a solid media and a separation is accomplished.

It occurs due to unbalanced forces, and it is affected by temperature, pressure and surface area of the adsorbent.

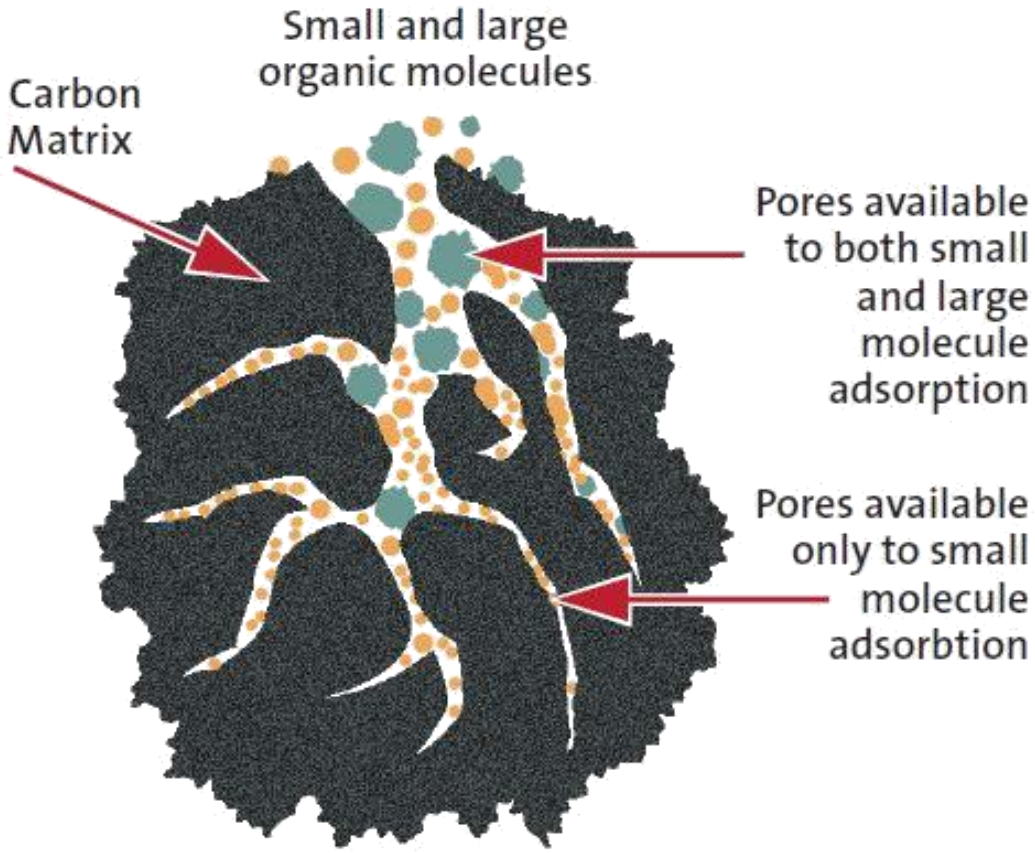
Physical The process by which one substance is attracted and held onto the surface of another

- Activated carbons
- Inorganic porous media

Chemisorption The result of chemical reactions on and in the surface of the adsorbent

- Impregnated media
- Chemically treated activated carbons

Catalysis Increasing the rate of a chemical reaction, where the catalyst is not consumed in the process



Activated carbon

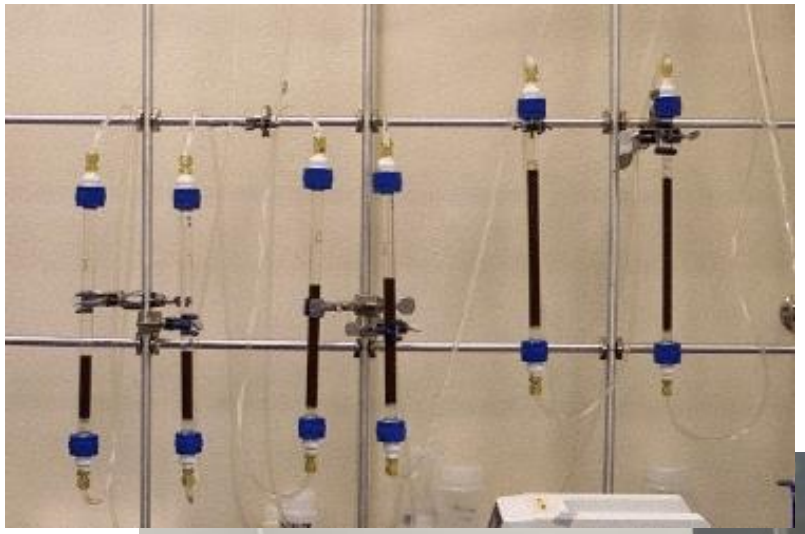
Activated carbons are versatile adsorbents of interest to many economic sectors and concern area.

Their adsorptive properties are due to their high surface area, a microporous structure and high degree of reactivity.

Preparation involves the carbonization of carbonaceous raw materials and the activation of the carbonized product.

The properties of the final product depend on the nature of the activation agent, the conditions of the carbonization and activation processes.
The development of the porous structure results in large internal surface, which in some cases may be as high as 2500 m^2/g.

Laboratory testing



Developing activated carbons with optimal surface features to improve the performance of filters for gas and water streams to remove target contaminants

REMOVAL EFFICIENCY

The fraction of the contaminant that, once in contact with the media, is removed by either physical or chemical means.

ADSORPTION CAPACITY

The amount of contaminant the media is capable of removing. This determines the life of the filter.

boratory testing

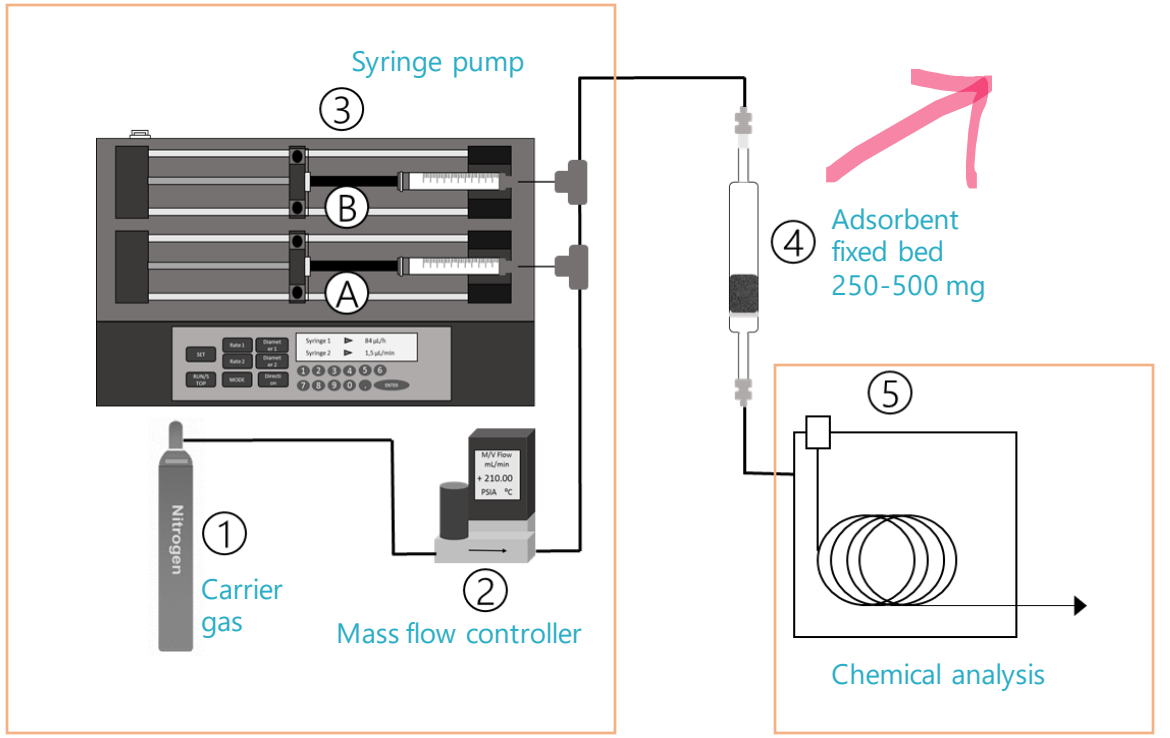
RAPID SMALL SCALE COLUMN TESTS

Easy test gas preparation

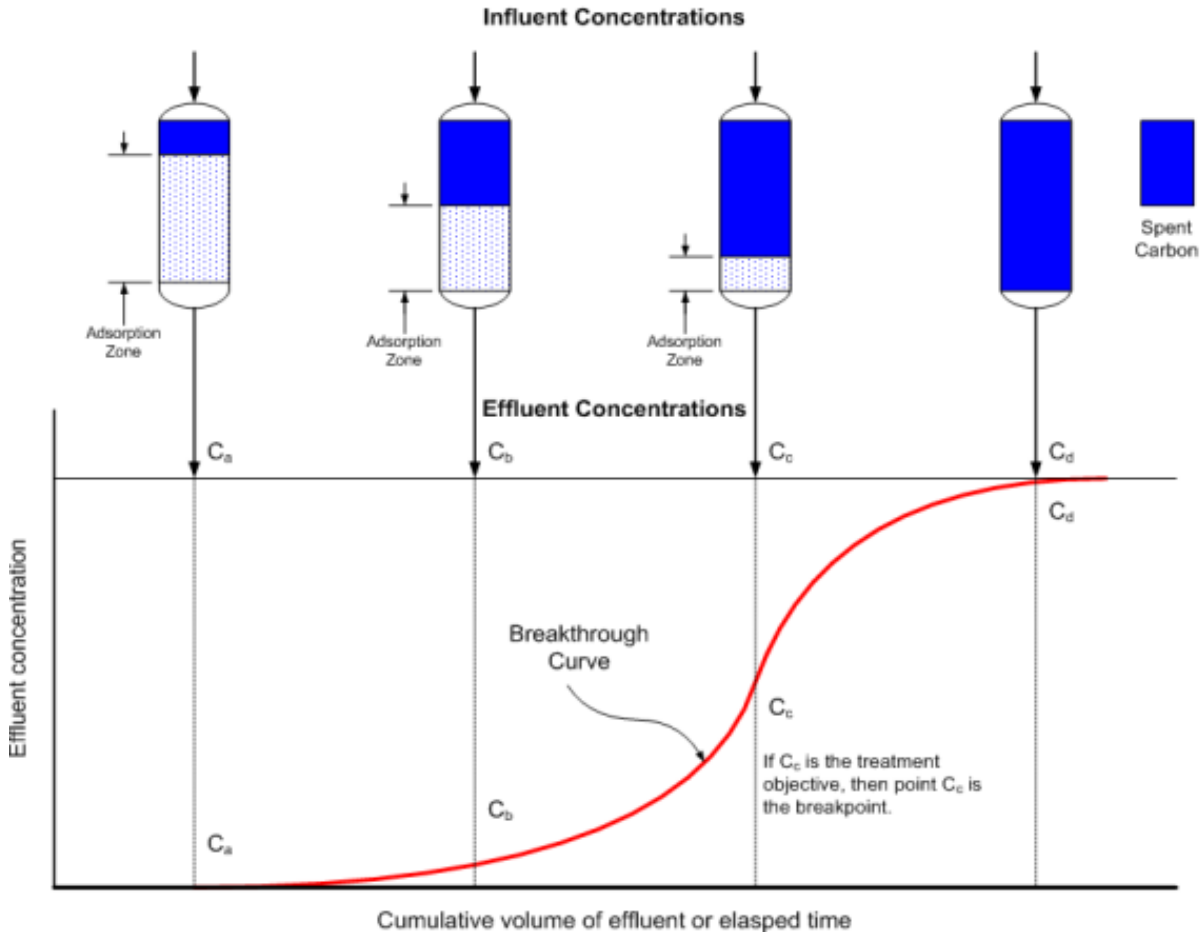
Affordable experimental time

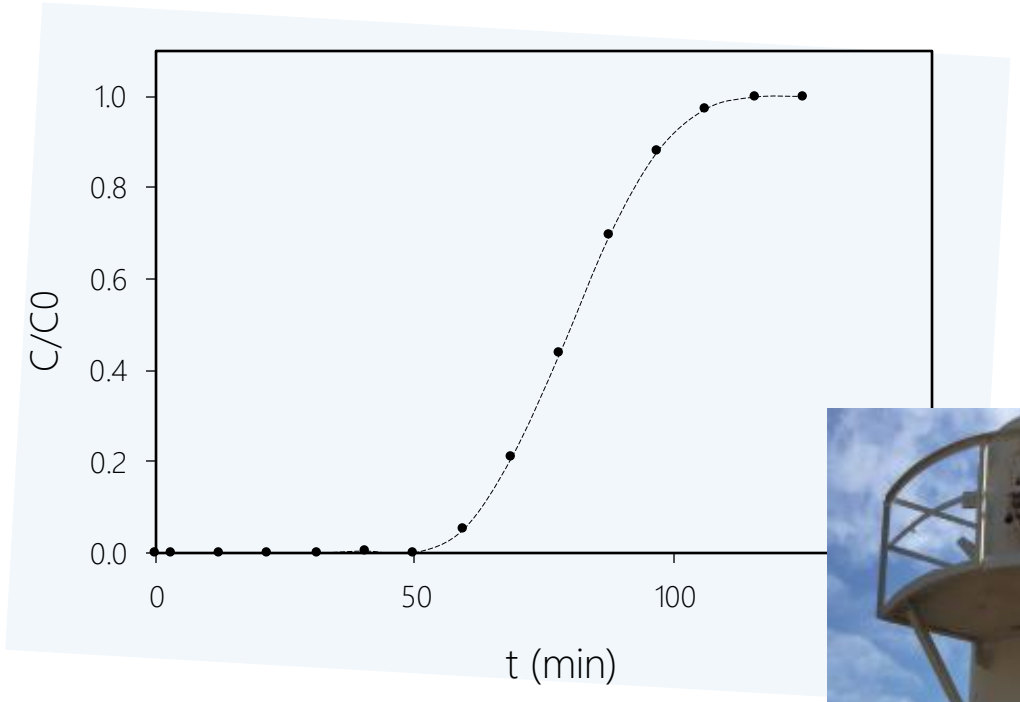
Simplified analytical procedures

By-product identification



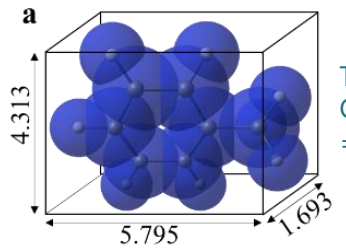
Laboratory testing



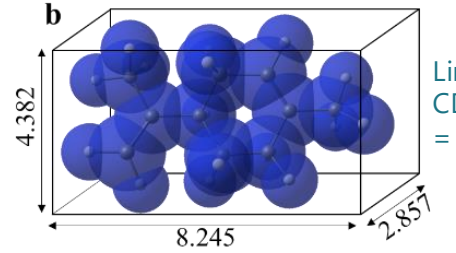


Laboratory testing

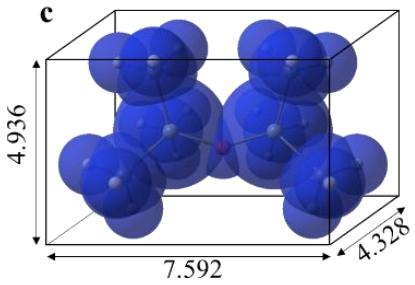
Contaminant's molecular size



Toluene
CD = 4.31 + 1.2x2
= 6.71 A = 0.67 nm

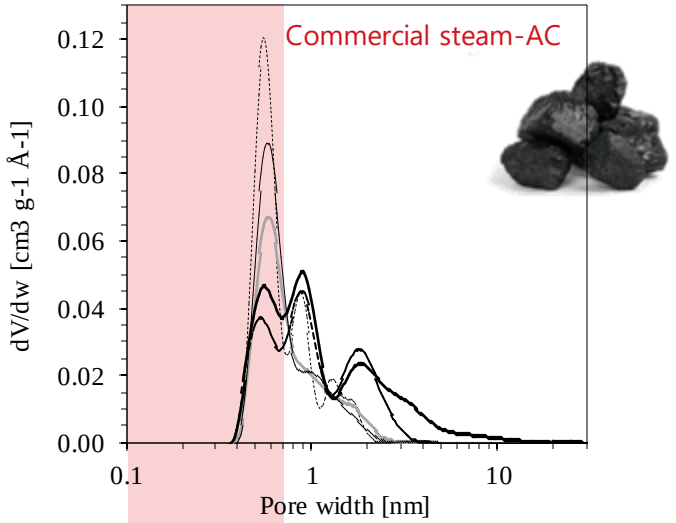


Limonene
CD = 4.38 + 1.2x2
= 6.78 A = 0.68 nm

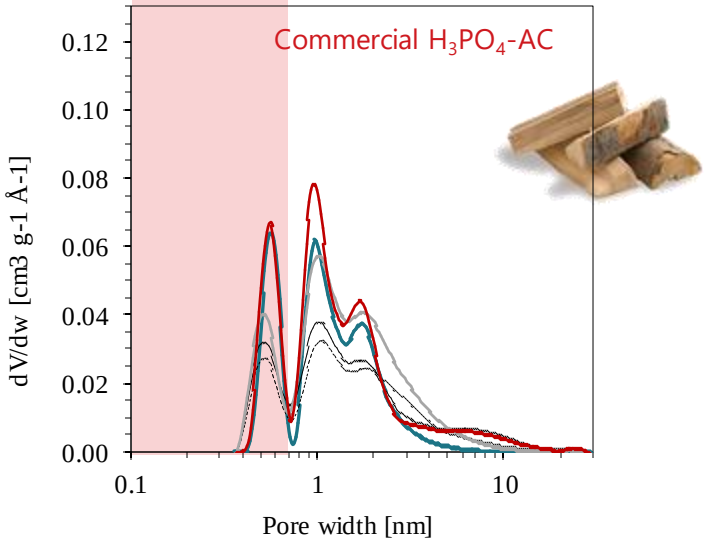


L2
CD = 4.94 + 1.2x2
= 7.34 A = 0.73 nm

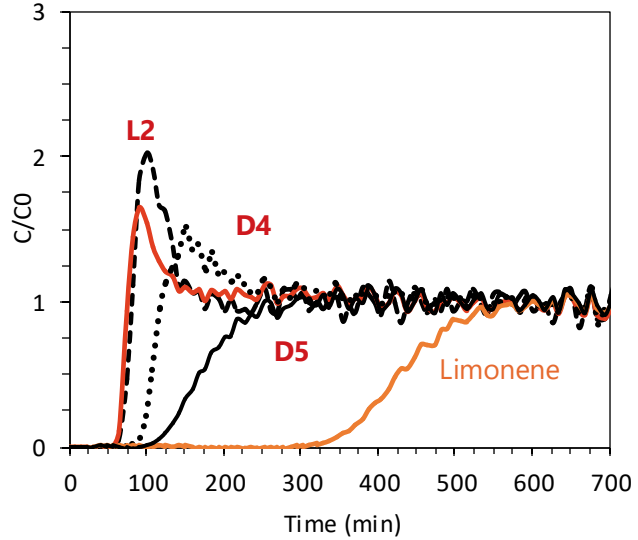
Adsorbent's pore size distribution

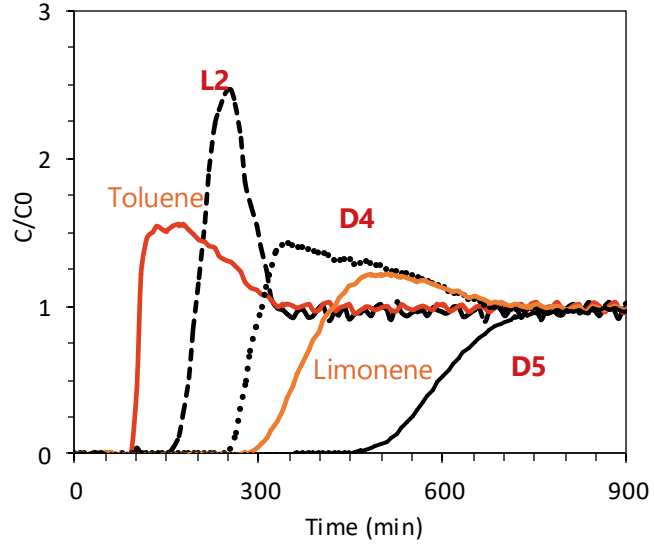


Not available porosity



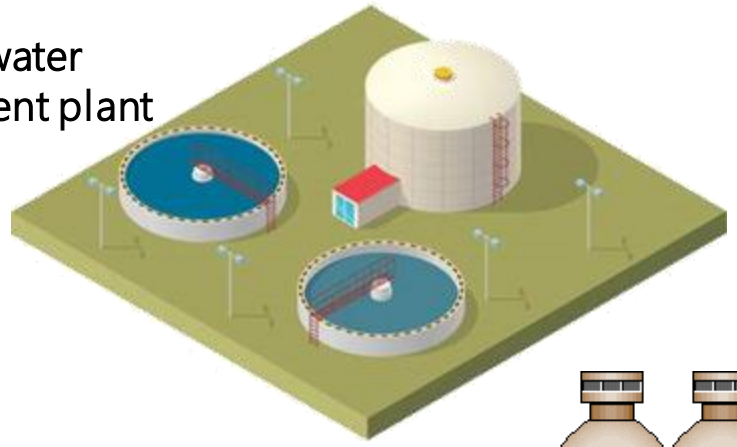
Breakthrough curves

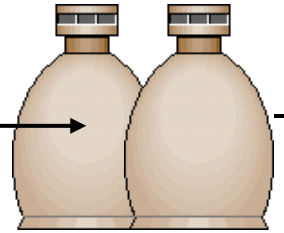




Biogas energy recovery

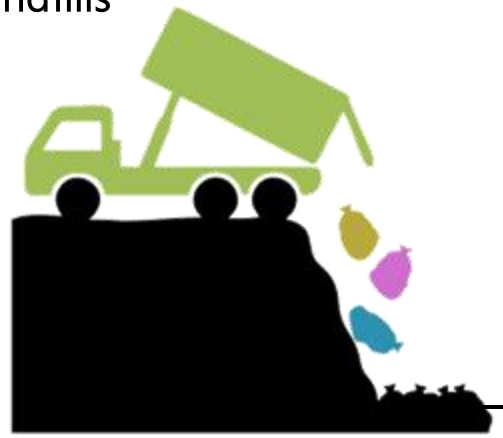
Wastewater treatment plant

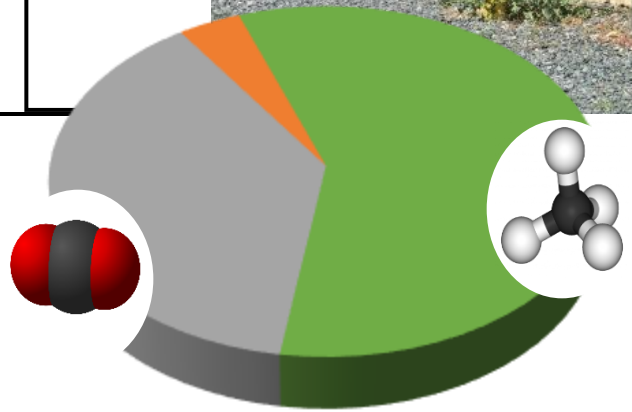




Anaerobic digestion

Landfills

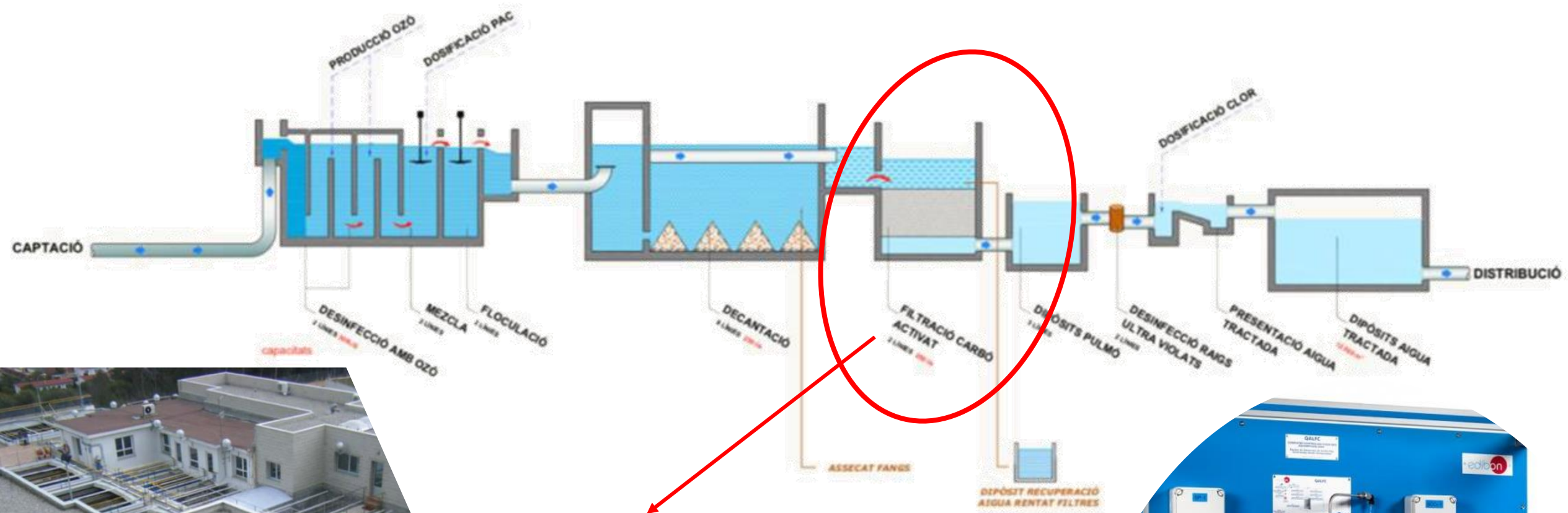




BIOGAS

Biogas flow rate 2500 m^3/h, 700 kg of AC in each vessel

Drinking Water filtration



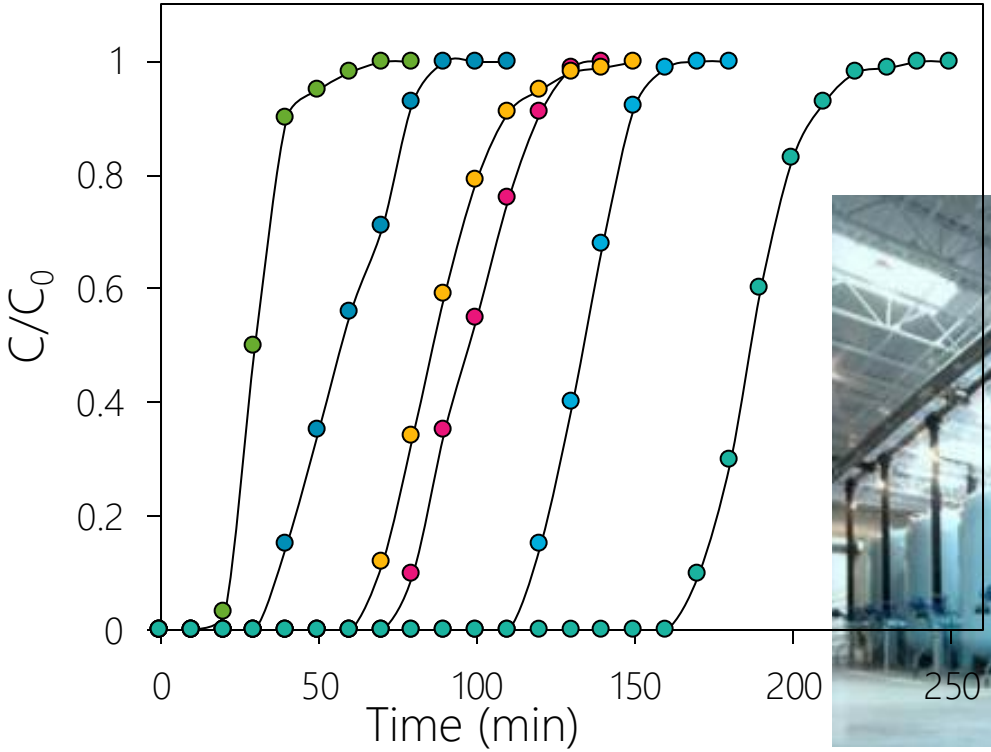
Water flow rate 1 m^3/s

Contact time AC filter: 9-30 min

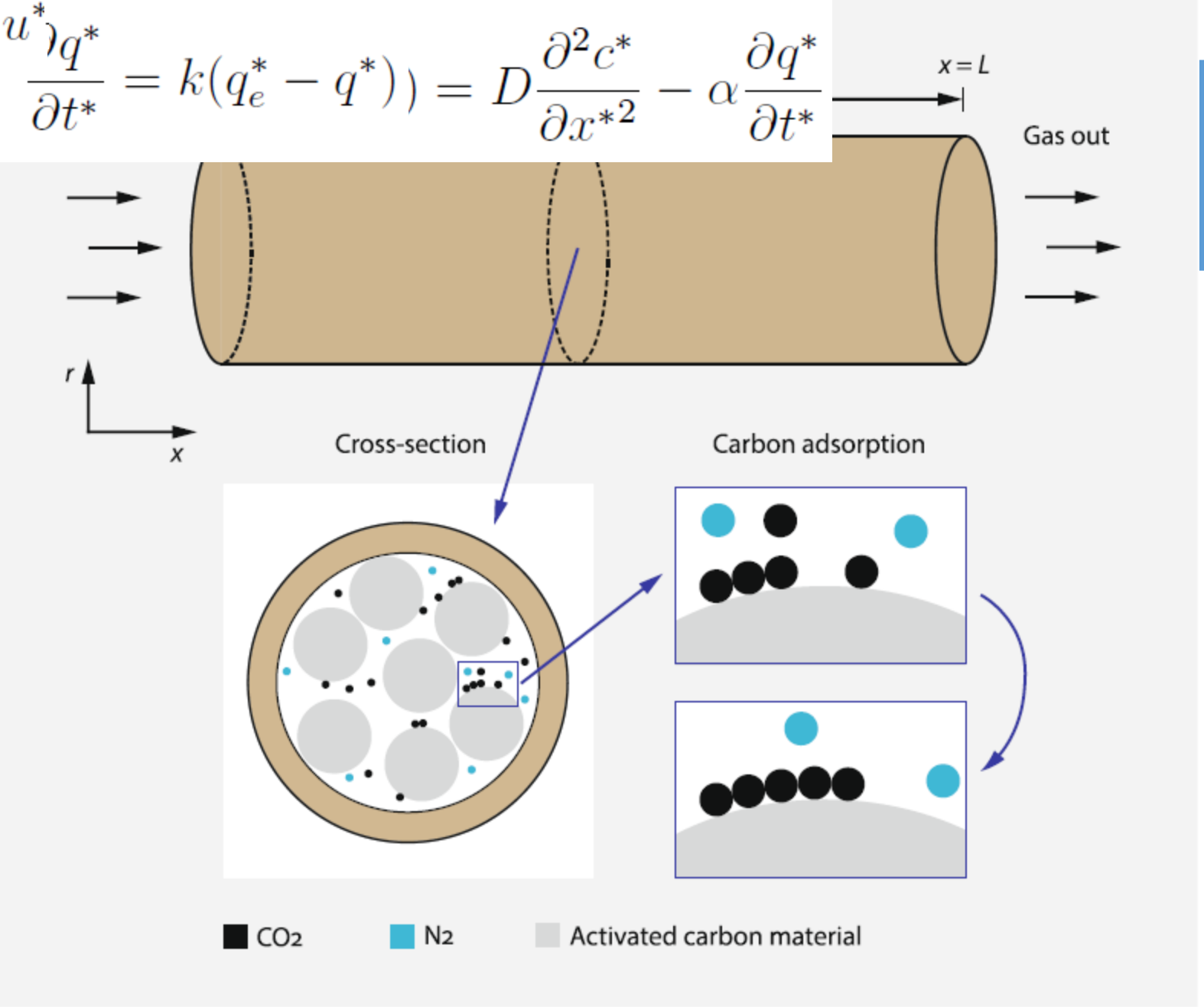
Drinking Water filtration

Rapid Small Scale Column Testing (RSSCT)

- RSSCT can be performed at bench (lab) scale with activated carbon and crushable adsorbents
- We are using RSSCT to evaluate GAC and novel adsorbents
- Objective: Screen products quickly to determine the best performing products



$$u^*)\frac{\partial q^*}{\partial t^*} = k(q_e^* - q^*)) = D\frac{\partial^2 c^*}{\partial x^{*2}} - \alpha\frac{\partial q^*}{\partial t^*}$$

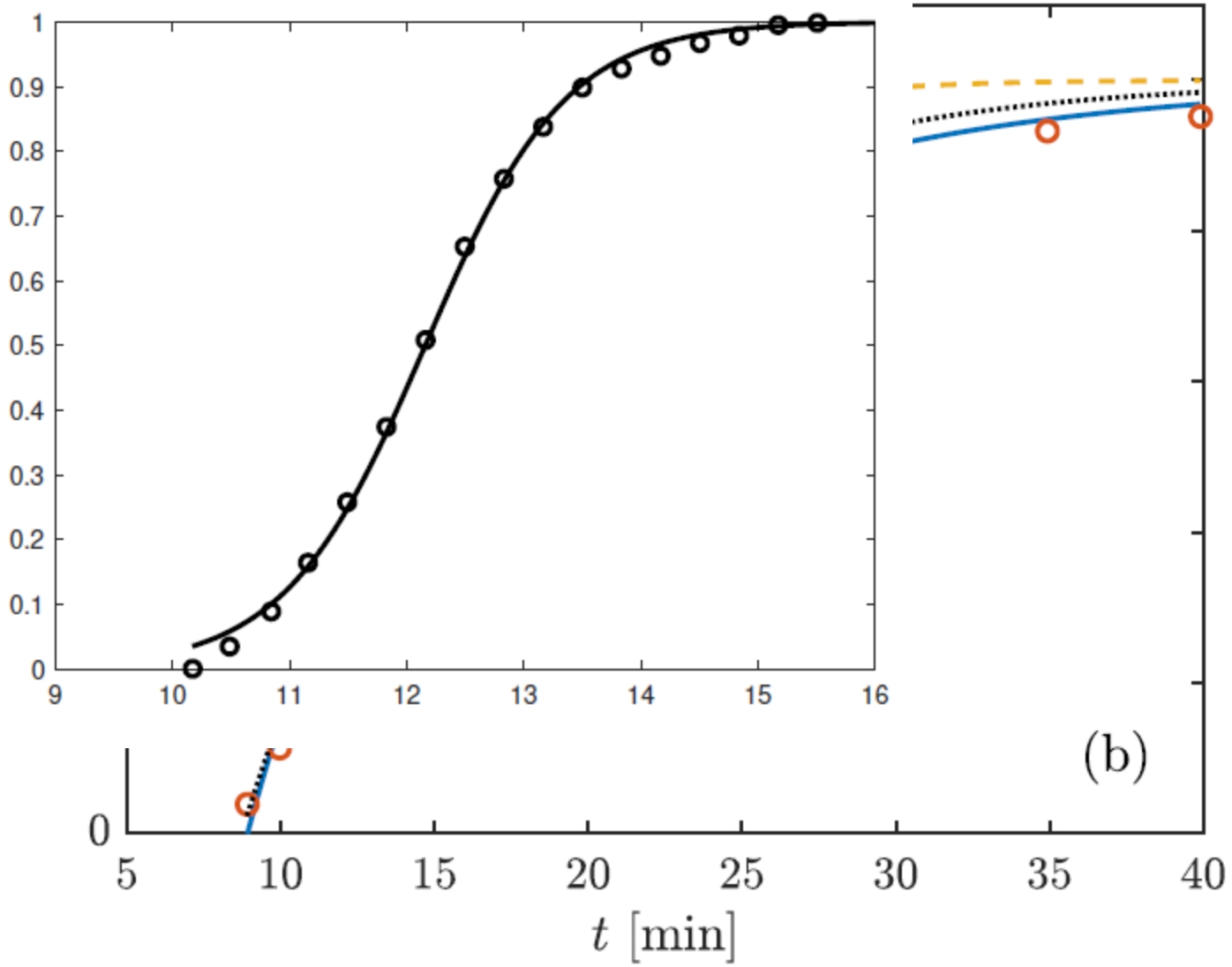


Kinetic coefficient

Maximum adsorption amount

Rate constant, depends on packing etc

Fluid velocity



Comparison of recent and past models against breakthrough curve for amoxicillin in water

Comparison of recent model against data for CO2 breakthrough

So?

Can obtain excellent agreement between models and laboratory experiments but results do not scale up to large scale experiments.

Why not?

1.Pellet size changes giving different surface area/different packing

2. Velocity profile is different, in narrow column almost parabolic, wide column plug flow.

3. Column wall, which does not adsorb, occupies different proportion of surface area

Goal of study group

- Analyse models to determine how size affects results

e.g. flow rates, concentrations, adsorbent size, wall effects

- Investigate literature in this or other fields to find analogous problems

Desired result: *a set of guidelines indicating how to apply results found in laboratory experiments to large scale industrial equipment and/or vice versa*