Adsorption – course content (for teacher)

Learning Competences

Student will:

- learn necessity and practices of adsorption approach for industrial and municipal applications;
- overview up-to-date technologies nutrient recovery and reuse;
- emerging pollutant removal techniques (including organic and pharmaceutical restudies, toxic metals, and microplastics).

Study materials:

Study materials are composed from online open access sources (text and video), presentations, and supervisors' instructions.

Also good information can be found from:
https://www.lenntech.com/water-treatment.htm
Adsorption Processes for Water Treatment and Purification, 2017
Adsorption Technology in Water Treatment Fundamentals, Processes, and Modeling, 2012
Application of Adsorbents for Water Pollution Control, 2012
Water and Wastewater Treatment: A Guide for the Nonengineering Professional, 2012
Novel Water Treatment and Separation Methods: Simulation of Chemical Processes, 2017

Course content

The basic knowledge on adsorption will be given as open-source lectures in order to refresh and deepen the attainments. Two presentations devoted to adsorbent types and applications of adsorption in industrial and municipal water treatment practices will be allocated for independent study hours. Course assignments will include the choice of an absorption approach for the particular case and some technical calculations for its implementation. Students will be following up state-of-the-art adsorption techniques based on waste-to-value and circular economy concepts in accordance with principles of sustainable development.

Assignments

Assignment 1.

Multiple choice task: test of basic knowledge on adsorption technique
Quiz: Choose what matters!

1. Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a SURFACE. **True**/False.

Feedback for the response 'True'. **Ad**sorption is a surface phenomenon, while **ab**sorption involves the whole volume of the material. https://www.youtube.com/watch?v=oGb2wV09mso

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2. Desorption is the reverse of **ad**sorption. True/**False.**

Desorption is a phenomenon whereby a substance is released FROM or THROUGH a surface. Desorption is the opposite of sorption (that is, either adsorption or absorption).

3. Chemisorption is a process resulting from chemical strong interaction between the adsorbent and the adsorbate. Choose characteristics which meet this process.
    - **a. Chemical bonding by reaction**
    - **b. Not specific (in most cases)**
    - c. Reversible
    - **d. Slow (in most cases)**
    - e. Weak bonding by Van der Waals forces
4. Water treatment and purification by adsorption technology: YES/NO
    - a. has high Capital Expenditures?
    - b. has low maintenance needs?
    - c. has low Operational Expenditures?
    - d. has hard principles to understand?
    - e. always has low selectivity?
5. You need to purify an influent containing non-polar pharmaceutical residues. Choose the right adsorbent.
    - a. Synthetic Zeolite
    - **b. GAC**
    - c. Silica
    - d. Red mud
    - e. Ion-exchange resin
6. Which parameter could help you to choose the adsorbent?
    - a. Capacity
    - b. Selectivity
    - c. Chemical properties
    - d. Efficiency
    - e. Energy consumption of a technological layout
    - f. Various options for implementation
7. The most frequently used adsorbtive media in wastewater treatment sector is...
    - a. Zeolites
    - b. Ion-exchange resins
    - **c. Forms of activated carbon**
    - d. Biochar
    - e. Inorganic polymers
8. Activated alumina is used **only** for gas purification purposes. True/**False**.

    Water purification:

    •Removal of fluoride

    •Removal of arsenic, selenium, lead, and sulfur

    •Removal of organic pollutants and dyes

9. Adsorption can be used for wastewater management **ONLY** in small communities and remote areas. True/**False**.

    Adsorption is a competitive technology for the treatment and purification of wastewater, groundwater, and industrial effluents (either as large or small facilities).

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10. There is no need to develop new adsorbents anymore. True/**False**.

    Despite the fact that various commercial adsorbents are available on the market, their widespread use is often limited by high cost, lack of versatility, and finite accessibility.
    Therefore, researchers have been attempting to develop alternative low-cost yet efficient adsorbents.

Assignment 2.

Multiple choice task: cost-effective adsorbents for water treatment

1. Examples of adsorption in our daily life? Short answer
2. How temperature and pressure will influence on adsorption? Short answer
3. What does it mean – CAPEX? Short answer
4. What does it mean – OPEX? Short answer
5. Which parameter could help you to choose the adsorbent?
    1. Crystalline/amorphous
    2. Hydrophobic/Hydrophilic
    3. Surface area
    4. Pore size
6. Adsorption of zinc onto developed adsorbent has been reported to obey the following Freundlich isotherm equation, where C is in mg/L and q is in mg/g: $q= 25.1C^{0.8}$. A solution containing 5.0 mg/L zinc is to be treated in a batch process to reduce the concentration to less than 0.05 mg/L. Calculate the capacity of developed adsorbent.
7. Adsorption of zinc onto developed adsorbent has been reported to obey the following Freundlich isotherm equation, where C is in mg/L and q is in mg/g: $q= 25.1C^{0.8}$. A solution containing 5.0 mg/L zinc is to be treated in a batch process to reduce the concentration to less than 0.05 mg/L. Calculate mass of developed adsorbent needed to treat 50 m^3 of wastewater per day.

Overall instructions for assignments

80% pass for each “Multiple choice task”

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