UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

Subject name: BASICS OF ENVIRONMENTAL PROCESSING

FACULTY OF EARTH AND ENVIRONMENTAL SCIENCES & ENGINEERING
MSc education

Course communication dossier

UNIVERSITY OF MISKOLC
FACULTY OF EARTH AND ENVIRONMENTAL SCIENCES & ENGINEERING
Institute of Raw Materials Preparation and Environmental Technology

Recommended semester: 1

Contents

1. COURSE DESCRIPTION

Course Title: Basics of environmental processing		**Credits: 2**
Type of course: compulsory	Neptun code: MFEET710005	
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec + 1 sem**		

Type of Assessment (exam. / pr. mark. / other): **pr. mark**

Assessment and grading
Requirements of the practical mark: Less than 20 % class missing; Presenting the laboratory measurements reports; Writing the classroom test successfully

Assessment: Five grades scale
Assessment according to a five grade scale:
- Missing basic knowledge – unacceptable
- Student demonstrates basic knowledge – acceptable
- Student demonstrates basic knowledge and can apply it in practice – intermediate
- Student demonstrates system level knowledge in contexts – good
- Student demonstrates outstanding system level knowledge in contexts - excellent

Assessment: 88 – 100: excellent (5), 75 – 87: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).

Position in Curriculum (which semester): **1st**

Pre-requisites *(if any)*: -

Course Description:

Aim of the course:
Environmental processing deals with the processes, machines and technologies of cleaning and keeping clean the air, water and soil. The aim of the course is let the students learn the mainly mechanical processing theoretical and practical fundamental knowledge necessary for the design, sizing and operation of the processes, machines and technologies of environmental processing.

Course description:
Physical characterization of coarse disperse systems. Rheological properties of one- and multiphase media. Steady-state and unsteady-state particle motion in Newtonian and non-Newtonian media. Motion of particles bulks. Flow through a particles bulk. Permeability tests. Particle motion in electrostatic field. Particle motion in centrifugal field. Forming of bubbles in liquids and their motion. Forming of droplets in gases and their motion. *Phase separation of solid – liquid coarse disperse systems.* Liquid bonds in particulate materials. Solid – liquid phase separation by mechanical processes. Settling in gravitational and centrifugal fields. Filtration in gravitational and centrifugal fields and by pressure difference supplied by pumps. Solid – liquid phase separation by pressing. *Phase separation of solid – gas coarse disperse systems* in gravitational, centrifugal and electrostatic fields. Phase separation of solid – gas coarse disperse systems by the application of filtering media and the wet dust separation.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Lecture notes

- Tarján I.: A mechanikai eljárástechnika alapjai. Miskolci Egyetemi Kiadó, 1997.
- Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai praktikum. Miskolci Egyetemi Kiadó, 2017.
- Faitli J. - Tarján I.: Mérési Gyakorlatok (A mechanikai eljárástechnika alapjai II.) Jegyzet. Miskolc, 1997. ME Eljárástechnikai Tanszék
- Stieβ, M: Mechanische Verfahrenstechnik 1,2. Springer (Lehrbuch) 1995.
- Tarján G.: Mineral Processing (Vol. 1, 2). AK. Bp.1981.
- Faitli J. Continuity theory and settling model for spheres falling in non-Newtonian one- and two-phase media. ***INTERNATIONAL JOURNAL OF MINERAL PROCESSING*** 169:(1) pp. 16-26. (2017)

Competencies to evolve:

a) Knowledge

- Knows and applies scientific and technical theory and practice related to the profession of environmental engineering.

- Has a comprehensive knowledge of measurement technology and measurement theory related to the field of environmental engineering.

- Knows the operation of environmental protection facilities (especially water and wastewater treatment plants, hazardous and communal landfills, waste incinerators), their structures and the possibilities of their development.

b) Skills

- Can apply the acquired general and specific mathematical, natural and social science principles, rules, connections and procedures in solving problems arising in the field of environmental protection.

-During work, examines the possibility of setting research, development and innovation goals and strives to achieve them.

- Able to plan in a complex way, implement and maintain engineering interventions in the fields of soil, subsurface, water, air, noise and vibration protection, wildlife protection, remediation and waste reduction, treatment, and processing.

c) Competence in terms of attitude

- Open and receptive to the knowledge and acceptance of professional, technological development and innovation in the field of environmental protection, and its authentic mediation.

-Strives to carry out the required work in a complex approach based on a systems-based and process-oriented way of thinking.

d) Competence in terms of autonomy and responsibility

- Can solve environmental engineering tasks independently, takes decisions carefully, in consultation with the representatives of other (mainly legal, economic, energy) fields, independently, takes responsibility for the decisions.

Responsible Instructor (*name, position, scientific degree):*

Prof. Dr. József Faitli, professor, habilitated PhD

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

2. COURSE TOPICS

Course topics (WEEKLY SCHEDULE)
Actual semester: 1st semester
Environmental Engineering MSc

Week	Topics of Lectures
1	Physical characterization of coarse disperse systems. Solid – liquid, solid – gas and liquid – gas disperse systems. Colloid- and coarse disperse systems and the limit between them. Different definitions of the concentration. Mass and volumetric concentrations. The transport and the in-situ concentrations.
2	The physical characterisation of the solid dispersed phase. The particles size, density and shape distribution, and frequency functions.
3	Rheological properties of one- and multiphase media. Summary of different rheological behaviours: time dependent and independent, viscous and viscoelastic, Newtonian and non-Newtonian. The Newtonian, the Bingham Plastics and the Power Law constitutive equations and rheological models, typical fluids examples.
4	The Höppler viscometer. The rotational rheometers, structure, principles, evaluation of tests.
5	The tube rheometers, structure, principles, evaluation of tests.
6	Flow through a particles bulk. Different models for the flow through porous media. Permeability tests. Measuring briquette permeability by air outflow through the briquette from a vessel.
7	Particle motion of a spherical particle in a single phase Newtonian media, in gravity without a wall. Different settling regimes. Continuum and discrete element like media behaviour.
8	Particle motion of a spherical particle in a single phase non-Newtonian media, in gravity without a wall.
9	Particle motion of bulks of particles. The settling column experiment and its simplified evaluation (Kynch).
10	Process engineering aims of dewatering. Thickening – clarifying. Dewatering of particulate aggregates. Dewatering tanks, conveyors, elevators. Dewatering screens. The arch sieve. Dewatering centrifuges.
11	Dewatering and clarification of fine pulps. Thickening, filtration and filtration by mechanical pressing. The Rod – lamella thickener (Faitli et al. 2007).
12	Solid – gas phase separation. Technical characterisation of the separation, the cut size, the Tromp function and the total mass yield. Main equipment of de-dusting. Dust cyclones, structure, and principle.
13	Wet gas washers, structure, and principle. Electrostatic gas filters, structure, and principle. Bag filters, structure, and principle.
14	

Week	Topics of Practical Classes
1	Concentration calculations.
2	Calculations with particles size, density and shape distribution, and frequency functions.
3	Practice with a Höppler viscometer.
4	Practice with a rotational rheometer.
5	Practice with a tube rheometers.
6	Briquette permeability test.

7	Particles settling calculations.
8	Particles settling calculations.
9	Particles settling calculations.
10	Settling column test.
11	Evaluation of settling column test.
12	Practice with a dust cyclone.
13	Evaluation of dust cyclone test.
14	

3. SAMPLE Classroom test

Classroom Test

Course: **Basics of Environmental Processing**

2017

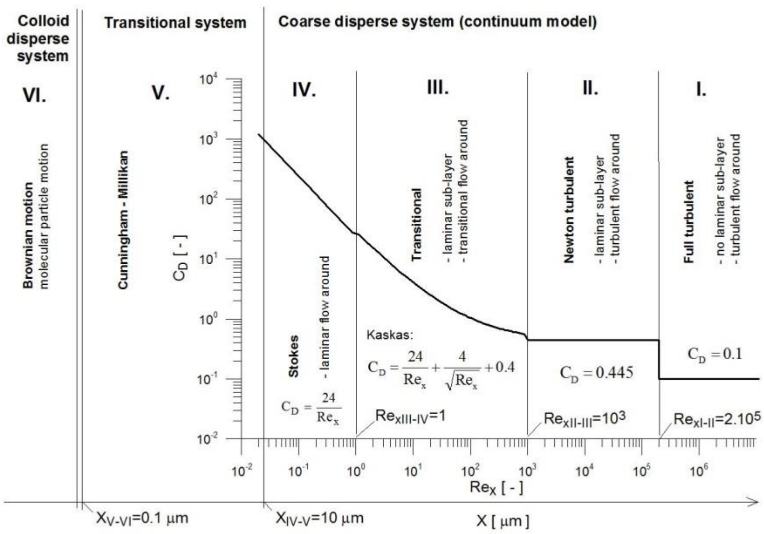
Name: ……………………………………………….

1. Laboratory sieve analysis was done using three sieves (4 mm, 1 mm, 0.2 mm mesh) producing four size fractions. The mass of each size fraction is 12 grams. a. Plot the empirical particle size distribution-, the empirical particle size density- and the histogram functions! b. Estimate the 80 % particle size!

2. The fly-ash dust emission was measured in a chimney. Particle density of the fly-ash is 2650 kg/m^3, the temperature of the air is 20 °C. The measured fly-ash concentration was 8 mg/m^3. a. Calculate the volumetric concentration of the dust – air dispersion! b. Calculate the mass concentration of the dust – air dispersion!

3. The diameter of a rubber ball is 12 cm. The thickness of the rubber is 1.2 mm and the material density of the rubber is 0.96 kg/dm^3. a. Calculate the terminal settling velocity of the ball in quiescent normal state air!

Data of 20 °C, 1 bar air: 1.18 kg/m^3 density, 1.5 10^{-5} Pas absolute viscosity.



SOLUTION OF A CLASSROOM TEST AS AN EXAMPLE. (points for good answers are indicated)

Basics of Environmental Processing

1./

Σ 20 p.

$D_k = 8\,cm = 80\,mm = 0{,}8\,dm$ $\qquad \rho = \frac{m}{V}$

$D_b = 78\,mm = 0{,}78\,dm$

$V_k = \frac{D_k^3 \pi}{6} = \frac{0{,}8^3 \cdot \pi}{6} = 0{,}268\,dm^3$

$V_b = \frac{0{,}78^3 \pi}{6} = 0{,}248\,dm^3$

$V_G = V_k - V_b = 0{,}02\,dm^3$

$m_G = \rho_G \cdot V_G = 1{,}3 \cdot 0{,}02 = 0{,}026\,kg$

$\rho_{labda} = \frac{0{,}026}{0{,}268} = 0{,}097\,kg/dm^3$ 4

$X = 80\,mm$

$\rho_s = 0{,}097\,kg/dm^3$

levegőben

$v_o = ?$

fell. II. Newt.

$v_o = \sqrt{\frac{4}{3} \cdot \frac{g \cdot X}{C_D} \cdot \frac{\rho_s - \rho_e}{\rho_e}}$

$v_o = \sqrt{\frac{4 \cdot 9{,}81 \cdot 0{,}08 \cdot (97 - 1{,}2)}{3 \cdot 0{,}445 \cdot 1{,}2}}$

$v_o = 13{,}7\,\frac{m}{s}$ 4

$Re_x = \frac{v \cdot D \cdot \rho}{\mu} = \frac{13{,}7 \cdot 0{,}08 \cdot 1{,}2}{1{,}8 \cdot 10^{-5}} = 7{,}3 \cdot 10^4$ 2

1.)

$$X_c = 3\sqrt{\frac{\nu_e}{3\left(\frac{\rho_s}{\rho_e}-1\right)}} \cdot 0{,}65^{u} \cdot \sqrt{\frac{b}{v_{be}}}$$

$$X_c = 3 \cdot \sqrt{\frac{1{,}5\cdot 10^{-5}}{\pi\left(\frac{1450}{1{,}2}-1\right)}} \cdot 0{,}65^{0{,}8} \cdot \sqrt{\frac{0{,}04}{20}}$$

~~1.10~~ $6{,}29 \cdot 10^{-5}$

4

$d =$ ~~0,01~~ $0{,}1\,m$

$b = 0{,}04\,m$

a.) $X_c = 5{,}98 \cdot 10^{-6}\,m \hat{=} 6\,\mu m$

b.) $\dot{Q} = A \cdot v = 0{,}04 \cdot 0{,}12 \cdot 20 = 0{,}096\,\frac{m^3}{s}$

$\dot{Q} = 346\,\frac{m^3}{h}$ 2

c.) $T(18\,\mu m) = 1 - \exp\left\{-\ln 2 \cdot \left(\frac{18}{6}\right)^{0{,}9}\right\}$

$T(18\,\mu m) =$ ~~1-...~~ $= 0{,}84 \Rightarrow \sim 84\,\%$

4

4. EXAM QUESTIONS

Basics of Environmental Processing course

1. Physical characterization of coarse disperse systems. Solid – liquid, solid – gas and liquid – gas disperse systems. Colloid- and coarse disperse systems and the limit between them. Different definitions of the concentration. Mass and volumetric concentrations. The transport and the in-situ concentrations.

2. The particles size, density and shape distribution, and frequency functions.

3. Time dependent and independent, viscous and viscoelastic, Newtonian and non-Newtonian rheological behaviour. The Newtonian, the Bingham Plastics and the Power Law constitutive equations and rheological models.

4. The rotational rheometers, structure, principles, evaluation of tests.

5. The tube rheometers, structure, principles, evaluation of tests.

6. The capillary flow model for the flow through porous media.

7. Particle motion of a spherical particle in a single phase Newtonian media, in gravity without a wall. Different settling regimes. Continuum and discrete element like media behaviour.

8. Particle motion of a spherical particle in a single phase non-Newtonian media, in gravity without a wall.

9. Process engineering aims of dewatering. Thickening – clarifying. Dewatering of particulate aggregates. Dewatering tanks, conveyors, elevators. Dewatering screens. The arch sieve. Dewatering centrifuges.

10. Dewatering and clarification of fine pulps. Thickening, filtration and filtration by mechanical pressing. The Rod – lamella thickener (Faitli et al. 2007).

11. Solid – gas phase separation. Technical characterisation of the separation, the cut size, the Tromp function and the total mass yield.

12. Dust cyclones, structure, and principle.

13. Wet gas washers, structure, and principle.

14. Electrostatic gas filters, structure, and principle.

15. Bag filters, structure, and principle.

5. OTHER REQUIREMENTS

-

Miskolc, 11th April 2023

Dr. Sándor Nagy Head of Institute, Associate Professor	Prof. Dr. József Faitli Professor