UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

Subject name: Design fundamentals of waste preparation techn. processes

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: 2nd

Contents

1. COURSE DESCRIPTION

Course Title: Design fundaments of waste preparation technological processes	**Credits: 5**
Type of course: compulsory	Neptun code: MFEET720018
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**	

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

- Less than 20 % class missing
- Presenting the laboratory measurements reports
- Presenting the assignment
- Successfully writing the classroom tests

Assessment of the exam: 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): **2nd**

Pre-requisites *(if any)*: -

Course Description:

Let the students know the theoretical and practical fundaments of the design of waste preparation unit operations and technological processes of waste management.

Fundamental terms and application fields of unit operations and process engineering. Production and consumption wastes. Characterization of coarse disperse systems. Characterization of waste materials in unit operations point of view. The unit operations and processes of changing of the disperse - and mixed state of multi-phase dispersed materials. The acting forces during the change of the state of the processed dispersed materials. The characterization and evaluation of comminution and agglomeration technological processes. Features of the change of the particle size and volume, rate of comminution and the breakage work. The material and energy transfer balances of material component separation technological processes. The unit operation features of the separation processes, evaluation of productivity (component content, yield and recovery, efficiency). Production of secondary raw materials and secondary fuels from municipal solid wastes (MSW). The comparison of different MSW processing technologies in respect of the material and energy balances.

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

- Lecture notes
- Drzymala J.: Mineral processing, foundations of theory and practice of metallurgy. Wroclaw University of Technology Publisher, 2007.
- Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai praktikum. Miskolci Egyetemi Kiadó. 2017.
- Csőke B. – Faitli J.: Basics of technological design of waste processing. Powerpoint slides. University of Miskolc. 2017.
- J Faitli, B Csőke, R Romenda, Z Nagy, S Németh: Developing the combined magnetic, electric and air flow (KLME) separator for RMSW processing. ***WASTE MANAGEMENT & RESEARCH* 2018:** pp. 1-9. (2018)

- J. Faitli[1], S. Nagy[1], R. Romenda[1], I. Gombkötő[1], L. Bokányi[1], L. Barna[2]: **Analysis of RMSW Deposited a Decade Ago for Later "Landfill Mining"** 6th International Conference on Sustainable Solid Waste Management, Naxos Island, Greece, 13–16 June 2018.

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 PhD, habilitated, professor

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

2. COURSE TOPICS

Course topics (WEEKLY SCHEDULE)
Actual semester: 2nd semester
Environmental Engineering MSc

Design fundamentals of waste preparation techn. processes

Week	Lecture topics
1.	The material- and energy balance of a component's separation technology. The process engineering features of a separation technological process, evaluation of its performance: component content, mass- and component yield, separation efficiency. Process engineering material characterisation of wastes. Definitions of process engineering, energy production, final products production. Fundaments of mechanical, chemical, thermal and biological processing.
2.	Mechanical processing: the examination of the fundamental gravitational, breakage mechanics, magnetic, electric, thermic, optical and adsorption-adhesion phenomena in coarse disperse systems; the examination of the fundamental particle motion and mixture flow phenomena in liquids and gases; the examination of the material-, and energy transfer processes of separation – mixing and comminution – agglomeration unit operations.
3.	Holiday
4.	Upgradability characterisation of separability at different physical parameters. Test methods of unit operations. Upgradability curves when the separation happens at density and magnetic susceptibility. Degree of liberation or intergrown.
5.	Crushing, crushers, crushed products. Grinding, mills, ground products. Comminution's stages. The aim of comminution. Properties changing during comminution. Reduction rate. Specific mass- and surface related comminution work.
6.	Types of mechanical loads. Characterisation of wastes regarding to comminution with mechanical loads. Aims of non-brittle wastes comminution. Comminution with shearing, pulling and cutting.
7.	Classification of comminution machines for non-brittle wastes. Rotary shears, construction, typical applications, main operational parameters. Rotary cutters, construction, typical applications, main operational parameters.
8.	Rotary shredders, construction, typical applications, main operational parameters. High speed rotary shredders, hammer shredders. Shredders sizing. Translatory shears. Guillotine shears, construction, typical applications, and main operational parameters. Alligator shears, construction, typical applications, and main operational parameters.
9.	Open and closed comminution and classification cycles. Balance equations. Fundaments of separation. Upgrading – sorting. Classification. Sieving, principle, conditions of sliding or swinging, equipment, separation function of sieves. Sieves for waste processing, drum sieves, cascade sieves.
10.	Separators on the basis of particle motion. Counter-current and cross airflow separators. Separation at a physical property, upgrading. Combined shape and size separators, ballistic separators.
11.	Mechanical – physical preparation technologies for selectively collected municipal solid wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.
12.	Mechanical – physical preparation technologies for residual municipal solid wastes. Different technological options, advantages – disadvantages. Utilisation of the

	products of such technologies. Hungarian examples, Miskolc, Zalaegerszeg.
13.	Typical preparation technologies for plastic wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies. Typical preparation technologies for wood wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.
14.	A typical preparation technology for composite materials wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

Week	**Practice**
1.	Calculations of component content, mass- and component yield and separation efficiency.
2.	Calculations of terminal settling velocities of particles and particulate bulks in air.
3.	Laboratory practice to carry out the density separation of a waste sample and to determine the upgradability curves.
4.	Determination of the upgradability curves.
5.	Demonstration comminution with a rotary shear machine. Estimation of the liberation degree of the product. Demonstration comminution with a rotary cutter machine. Estimation of the liberation degree of the product.
6.	Calculations of products of different open and closed comminution and classification cycles.
7.	National holiday (Easter Monday) No classes, no work.
8.	Calculations of products of different open and closed comminution and classification cycles.
9.	Demonstration with a laboratory crossflow airflow separator with air nozzle.
10.	National holiday (Labour Day) No classes, no work
11.	Calculations of different technological options for residual municipal solid waste mechanical processing on the basis of different measured waste size- and material composition tables.
12.	Written examination
13.	Supplementary written examination
14.	National holiday (Pentecost Monday) No classes, no work

3. SAMPLE Classroom test

Design fundamentals of waste preparation techn. processes

Classroom Test

Course: **Design fundaments of waste preparation technological processes**

2022

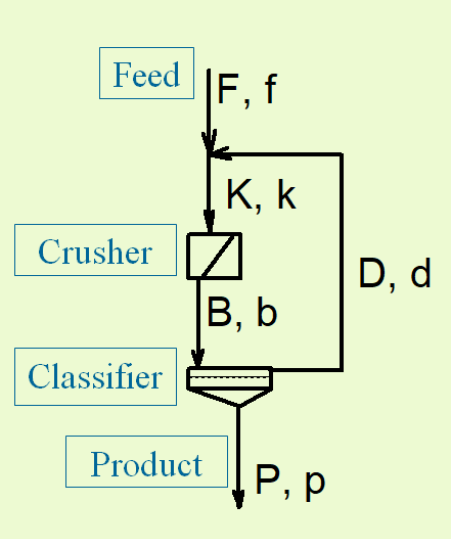
Name: …….

1. Laboratory upgradability analysis was done using a magnetic separator. A galena – quartz sample was separated into 4 density fractions by laboratory dense media method. The lead concentration of pure galena is 85 m/m%. The mass yield and galena content data of the 4 density fractions is as follows:

No. of fraction	Mass yield [m/m%]	Lead concentration [m/m%]
1	15	80
2	20	65
3	35	30
4	30	5

Plot the upgrading-, the tailing-, the concentrate-, the metal recovery- and the upgrading efficiency curves.

2. There is a crusher – classifier closed technological cycle of which feed (F) mass flow rate is 5 t/h. The total mass yield of the classifier is 72 % (P=0.72*B). Calculate the mass flow rates of material streams K, B, D and P.



4. EXAM QUESTIONS

Design fundamentals of waste preparation techn. processes

1. The material- and energy balance of a component's separation technology. Component content, mass- and component yield, separation efficiency. Upgradability curves.

2. Crushing, crushers, crushed products. Grinding, mills, ground products. Comminution's stages. The aim of comminution. Reduction rate. Specific mass- and surface related comminution work. Types of mechanical loads. Comminution with shearing, pulling and cutting.

3. Rotary shears, construction, typical applications, main operational parameters. Rotary cutters, construction, typical applications, main operational parameters. Rotary shredders, construction, typical applications, main operational parameters.

4. Translatory shears. Guillotine shears, construction, typical applications, and main operational parameters. Alligator shears, construction, typical applications, and main operational parameters.

5. Open and closed comminution and classification cycles. Balance equations.

6. Sieving, principle, conditions of sliding or swinging, equipment, separation function of sieves. Sieves for waste processing, drum sieves, cascade sieves.

7. Counter-current and cross airflow separators.

8. Mechanical – physical preparation technologies for selectively collected municipal solid wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

9. Mechanical – physical preparation technologies for residual municipal solid wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

10. Typical preparation technologies for plastic wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

11. Typical preparation technologies for wood wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

12. A typical preparation technology for composite materials wastes. Different technological options, advantages – disadvantages. Utilisation of the products of such technologies.

5. OTHER REQUIREMENTS

Assignment

Course: Design fundamentals of waste preparation technologies

On the basis of the evaluated results of the "**Sampling and qualification of wastes"** assignment, design a processing technology for the preparation of the sampled residual municipal solid waste. The capacity of the plant is 20 t/h. Take the characteristics of Your country into account! Select advantageous possible products (RDF, other thermal utilisation, materials for waste-to-material recycling, bio fraction, etc…) of this technology and think about the downstream utilisation of each product material stream of the technology.

- Plot the technological flowsheet of the technology.
- Calculate the balance equations; estimate the mass flow rate of each material stream.
- Select the type of each key machine in the technology.
- Estimate the capacity and power of each key machine.

Deadline for submission: 4th May 2022

Miskolc, 14th February 2022.

Prof. Dr. József Faitli
professor

Miskolc, 11th April 2023

Dr. Sándor Nagy
Head of Institute, Associate Professor

Prof. Dr. József Faitli
Professor