UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

Subject name: Sampling and qualification of wastes

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: 2

Contents

1. COURSE DESCRIPTION

Course Title: Sampling and qualification of wastes	**Credits: 2**
Type of course: compulsory	Neptun code: MFEET720016
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**
Requirements of the practical mark:

- Less than 20 % class missing
- Presenting the assignment
- 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): **2nd**

Pre-requisites *(if any)*: -

Course Description:

Let the students know the engineering, mathematical statistics, physical – chemical - biological analytical and legal authorization knowledge by with they will be able to sample and qualify of wastes in waste management.

Summary of applied engineering knowledge of mathematical statistics and its theoretical and practical application for wastes. The 3+1 fundamental cases of waste sampling. The necessary minimum masses of different types of samples. The identification, classification and notation systems of wastes according to their origin and tax and customs clearance system. Types of waste landfills and limit values for the acceptable wastes. Waste characterization: basic characterization – examination of identity – examination of conformity – on-site inspection. Physical, chemical and biological analytical methods of waste characterization. Sampling methods for municipal solid wastes, biofuels, WEEE, construction and demolition wastes, rubber tyres, etc…

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

- J. Faitli: Sampling in Processing Plants. University of Miskolc, 2013.
- ASTM D5231-92 (2016), Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, ASTM International, West Conshohocken, PA
- EU Project Report: SWA-Tool, Development of a Methodological Tool to Enhance the Precision & Comparability of Solid Waste Analysis Data (SWA-Tool). Available at: https://cordis.europa.eu/project/rcn/54884/reporting/en
- French standard: NF X30-413: Constitution of a sample of Derived from the MODECOM™ methodology household waste contained in a waste collection vehicle.
- German standard: LAGA PN 98 Guideline for the handling of physical, chemical and biological investigations in connection with the recovery / disposal of waste.
- Hungarian standard: MSZ 21420-28, 2005, Characterization of wastes. Part 28: Investigation of municipal wastes. Sampling.
- Hungarian standard: MSZ 21420-29, 2005, Characterization of wastes. Part 29: Investigation of

municipal wastes. Preparation of sample, characterization of material composition by the selection of material categories.

- Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai
- praktikum. Miskolci Egyetemi Kiadó. 2017.
- Csőke B. - Bokányi L. - Bőhm J. – Buócz Z. - Faitli J. - Kiss T.: Szilárd települési hulladékok előkészítése és hasznosítása. Miskolci Egyetem Mérnöktovábbképző Központ. (215. p.) 1999.

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.
- Able to plan and conduct environmental sampling works, comprehensive laboratory testing and analysis, to apply monitoring systems, evaluate and document test results.
-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, habilitated professor, PhD

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

Sampling and qualification of wastes

1. The 3+1 fundamental cases of sampling. How to estimate the population mean of calorific value of a waste pile. How to estimate heterogeneity on concentration of multicomponent wastes. How to estimate the random variable distribution function of waste material stream. How to carry out contamination monitoring.
2. Notable distributions, the normal, the standard normal, the Student and the Chi square distributions.
3. The central limit theorem. Confidence interval for the population mean. The margin of error.
4. Confidence interval for the standard deviation. The accuracy of a sampling system.
5. Steps of a sampling process. Preparation and developing the sampling protocol, taking single or point samples, sample preparation, measurement, evaluation. The single samples – average sample concept. Stratified sampling, sub-population.
6. The necessary minimal masses of single samples, point samples and average samples. The Pierre Gy sampling theory.
7. The sample preparation and production of the analytical sample. The comminution – splitting type of sample preparation. The sieving – splitting type of sample preparation.
8. Sampling standards for different municipal solid waste streams sampling.
9. The EPR (extended producer responsibility) and DRS (deposit refund system) related MSW sampling method.
10. The identification, classification and notation systems of wastes according to their origin and tax and customs clearance system. Types of waste landfills and limit values for the acceptable wastes. Waste characterization: basic characterization – examination of identity – examination of conformity – on-site inspection.
11. Physical, chemical and biological analytical methods of waste characterization
12. Sampling of biofuels, practical determination of the sampling accuracy.
13. Sampling of WEEE, tyres, construction and demolition wastes.

3. SAMPLE Classroom test

Classroom Test

Sampling and qualification of wastes

1. The hazardous waste content [unit: % m/m] of the collected municipal solid wastes of a municipality had been measured 30 times. Results are:

2,14 2,22 2,26 2,28 2,32 2,33 2,35 2,36 2,38 2,39 2,41 2,42
2,42 2,42 2,45 2,46 2,47 2,47 2,48 2,49 2,52 2,52 2,54
2,56 2,58 2,63 2,64 2,64 2,68 2,74

a. Estimate the population mean and standard deviation of the hazardous waste content distribution of the given municipality.
b. Estimate the hazardous waste content distribution- and density functions.
c. Determine the confidence interval for the population mean at 95 % of confidence level.
d. At least how many measurements have to be carried out if the margin of error is 9/10th of the result of point c?

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

Sampling and qualification of wastes

A

Σ ~~24~~ 34 p.

a/

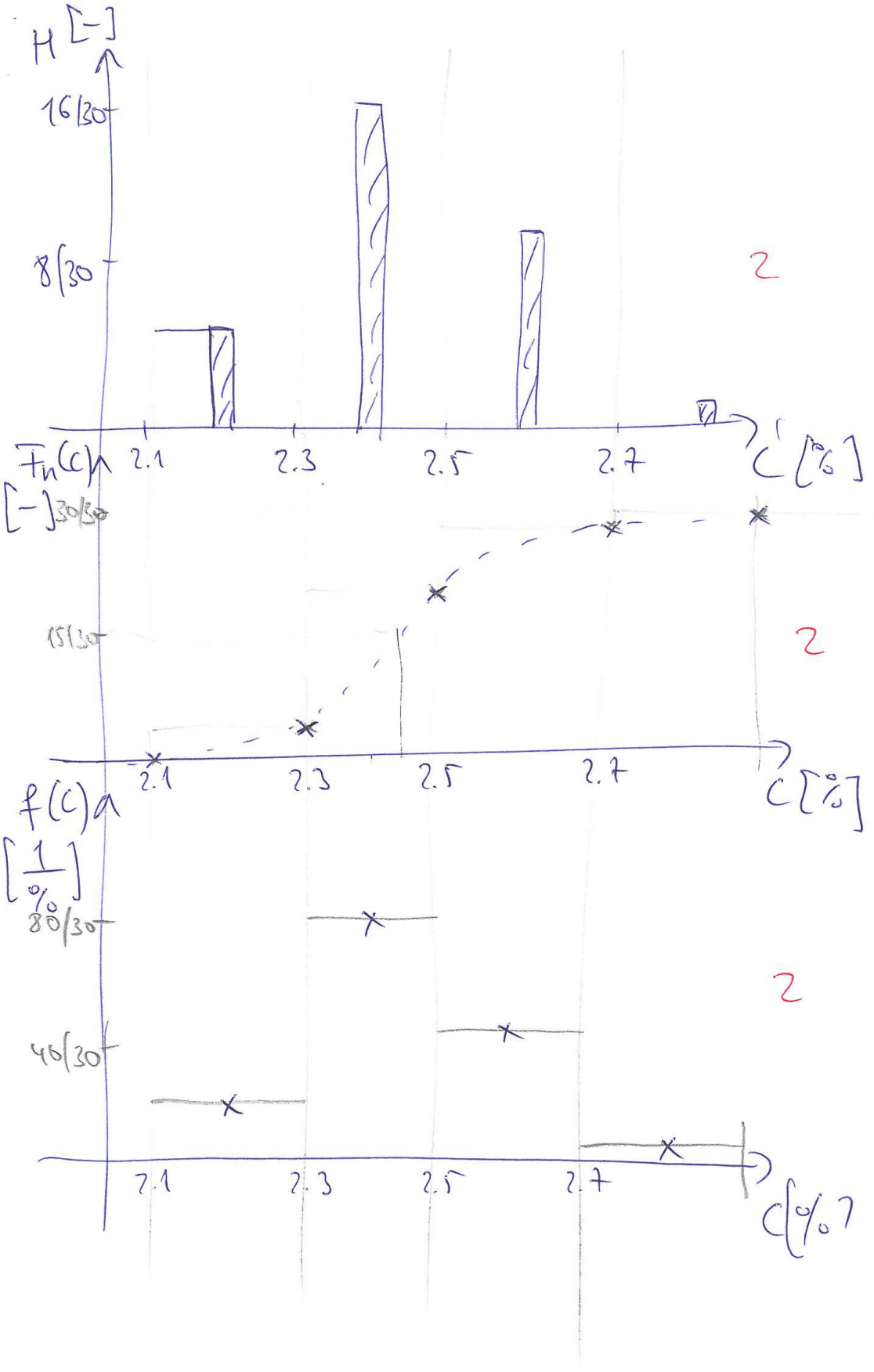
$\bar{C} = 2{,}452\ \%$ → M(c) 4

$\bar{s}_u^* = 0{,}14\ \%$ → D(c) 4

b/

c_i [%]	c_{i-1} [%]	Δc [%]	n_i [-]	$H_i = \frac{n_i}{n}$ [-]	$F_u(c)$ [-]	$f_u = \frac{H_i}{\Delta c}$ $\left[\frac{1}{\%}\right]$
2.3	2.1	~~0.2~~	4	4/30	~~[%]~~ 4/30	20/30
2.5	2.3	0.2	16	16/30	20/30	~~18~~ 80/30
2.7	2.5	0.2	9	9/30	29/30	~~14.5~~ /30
2.9	2.7	0.2	1	1/30	1	5/30
			Σ	1		

4


H [-]
16/30
8/30
2
2.1
2.3
2.5
2.7
c [%]
$F_n(c)$
[-]
30/30
15/30
2
2.1
2.3
2.5
2.7
c [%]
f(c)
$\left[\frac{1}{\%}\right]$
80/30
40/30
2
2.1
2.3
2.5
2.7
c [%]

c.)

$1-\varepsilon = 0.95$

$n = 30$

$t_{\varepsilon/2} = 2.045$

$$\alpha_1 = \bar{c} - t_{\varepsilon/2} \cdot \frac{s_n^*}{\sqrt{n}} = 2,452 - 2.045 \cdot \frac{0,14}{\sqrt{30}} = 2.4\%$$

$\alpha_2 = 2.504$ 4

$HM = 0.104\ \%$

d.) $n \Rightarrow 41$ ✓

$$HM = 2 \cdot t_{\varepsilon/2} \cdot \frac{s_n^*}{\sqrt{n}} = 2 \cdot 2.021 \cdot \frac{0.14}{\sqrt{41}} = 0.09 < 0,1$$

4

X

d) pl Rosin Rammler

$X_{50} = 2{,}44 \frac{m}{s}$, $m = 1{,}5$

$$0{,}97 = 1 - \exp\left\{-\ln 2 \cdot \left(\frac{2{,}7}{2{,}44}\right)^m\right\}$$

$$e^{-\ln 2 \cdot \left(\frac{2{,}7}{2{,}44}\right)^m} = 0{,}03$$

$$-\ln 2 \cdot \left(\frac{2{,}7}{2{,}44}\right)^m = \ln 0{,}03$$

4.

$$\left(\frac{2{,}7}{2{,}44}\right)^m = \frac{-3{,}5}{-0{,}693} = 5{,}05$$

$$1{,}1066^m = 5{,}05$$

$$m + \ln 1{,}1066 = \ln 5{,}05$$

$$m = 1{,}62 - 0{,}1 = 1{,}5$$

ell. $1 - \exp\left\{-\ln 2 \cdot \left(\frac{2{,}7}{2{,}44}\right)^{1{,}5}\right\} =$

9.1

$$\left(\frac{s_u^{*2}}{\chi_f^2} \cdot \nu < \sigma^2 < \frac{s_u^{*2}}{\chi_a^2} \cdot \nu\right) = 1 - \varepsilon$$

$\chi_f^2 = 15{,}574$ $\qquad$ $\chi_a^2 = 46{,}693$

$0{,}98,\ \nu = 29$ $\qquad$ $0{,}02,\ \nu = 29$

$$\frac{0{,}14^2}{15{,}574} \cdot 29 = 0{,}036 \frac{m}{s}$$ $\qquad$ σ^2

$$\sigma_f = 0{,}191 \frac{m}{s}$$

4

$$\frac{0{,}14^2}{46{,}693} \cdot 29 = 0{,}012$$

$$\sigma_a = 0{,}11 \frac{m}{s}$$

4. EXAM QUESTIONS

Sampling and qualification of wastes

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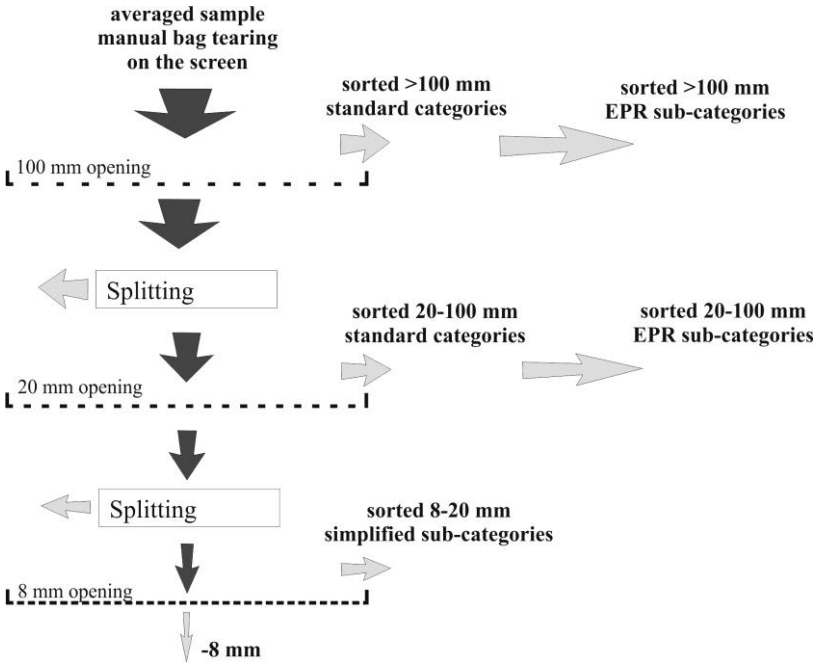
5. OTHER REQUIREMENTS

Assignment

Course: Sampling and qualification of wastes

The attached table contains the analysed data of a residual municipal solid waste average sample. The so called "EPR MSW" analysis procedure was as follows:



- Determine the wet composition (size fractions and material categories) of the sampled RMSW!
- What is the total packaging material content?
- What is the total plastic waste content?
- What is the total food waste content?

Deadline for submission: 23rd May 2023.

Miskolc, 14th March 2023.

Prof. Dr. József Faitli
professor

Mintavételezés helyszíne:	**Zalaegerszeg**	Átlagminta mérlegelt tömege:	478,463	kg	
Mintavételezés időpontja:	**2022.10.17**	Átlagminta becsült térfogata:	2500	liter	
Anyagáram megnevezése:	**VTSZH Zalaegerszeg belváros**	Átlagminta becsült halmazsűrűsége:	0,191	**t/m3**	
Mérlegjegy információk:	HB22104058				

Átlagminta ö

Mért nedves tömegek és a kiértékelés — **>100 mm**

1.1 Ételhull.	1.2 Zöld	1.3 Sütőolaj - zsír	2.1 Csomag. papír	2.2 Irodai papír	2.3 Reklám papír	2.4 NemEPR papír	3.1 Csomag. karton	3.2 NemEPR karton	4.1 3D kompozit	4.2 2D kompozit	5.1 Csomag. Textil	5.2 Ruházat textil	5.3 Lakás-textil	5.4 NemEPR textil	6.1 SUP kendő	6.2 NemEPR higiéniai	7.1 2D csomag. műany.	7.2 2D nemcsom. műany.	7.3 Italos DRS	7.4 Italos nemDRS		
6,050	11,750	0,000	11,550	2,550	4,755	13,600	7,200	0,000	3,500	0,050	0,000	6,200	5,850	0,000	0,014	11,700	32,322	0,351	10,450	0,000	kg	

7.5 3D csom. műany.	7.6 3D nemcsom. műany.	8.1 Fa csoma-goló	8.2 Fa bútor	8.3 Gumi abroncs	8.4 Öv és cipő	8.5 NemEPR égő.	9.1 DRS üveg	9.2 Csomag. üveg	9.3 NemEPR üveg	10.1 DRS Fe italos	10.2 DRS Alu italos	10.3 Fe csomag. és spray	10.4 Alu csomag. és spray	10.5 Egyéb fém	11 Inert	12.1 Elem akksi	12.2 Veszély. csomag.	12.3 Veszély. nemcsom.	14.1 WEEE	14.2 Egyéb		SUM >100 mm	
11,839	0,600	0,000	1,050	0,000	2,750	0,248	0,611	0,000	0,193	0,000	1,500	0,655	0,162	0,064	0,000	0,000	0,077	0,000	0,550	0,000	kg	148,191	kg
																	<100 mm kisebbített része:					305,750	kg

20-100 mm

1.1 Ételhull.	1.2 Zöld	1.3 Sütőolaj - zsír	2.1 Csomag. papír	2.2 Irodai papír	2.3 Reklám papír	2.4 NemEPR papír	3.1 Csomag. karton	3.2 NemEPR karton	4.1 3D kompozit	4.2 2D kompozit	5.1 Csomag. Textil	5.2 Ruházat textil	5.3 Lakás-textil	5.4 NemEPR textil	6.1 SUP kendő	6.2 NemEPR higiéniai	7.1 2D csomag. műany.	7.2 2D nemcsom. műany.	7.3 Italos DRS	7.4 Italos nemDRS		
4,800	0,243	0,000	1,300	0,021	0,120	5,150	0,000	0,000	0,115	0,186	0,000	0,159	0,096	0,000	0,183	0,950	1,131	0,000	0,277	0,028	kg	

7.5 3D csom. műany.	7.6 3D nemcsom. műany.	8.1 Fa csoma-goló	8.2 Fa bútor	8.3 Gumi abroncs	8.4 Öv és cipő	8.5 NemEPR égő.	9.1 DRS üveg	9.2 Csomag. üveg	9.3 NemEPR üveg	10.1 DRS Fe italos	10.2 DRS Alu italos	10.3 Fe csomag. és spray	10.4 Alu csomag. és spray	10.5 Egyéb fém	11 Inert	12.1 Elem akksi	12.2 Veszély. csomag.	12.3 Veszély. nemcsom.	14.1 WEEE	14.2 Egyéb		SUM 20-100 mm	
0,700	0,178	0,000	0,000	0,000	0,000	0,283	0,900	0,000	0,000	0,000	0,801	0,257	0,015	0,079	0,137	0,000	0,121	0,000	0,000	0,000	kg	18,229	kg
																	<20 mm kisebbített része:					4,000	kg

0-20 mm

13.1 8-20 mm MŰANYAG	13.2 8-20 mm PAPÍR	13.3 8-20 mm FÉM	13.4 8-20 mm SUP filter	13.5 8-20 mm BIO	13.6 8-20 mm EGYÉB	13.7 <8 mm		SUM	
0,041	0,114	0,013	0,012	1,239	0,076		kg	1,496	kg
						0,7962	kg	0,796	kg

Miskolc, 11th April 2023

Dr. Sándor Nagy
Head of Institute, Associate Professor

Prof. Dr. József Faitli
Professor