MISKOLCI EGYETEM

MŰSZAKI FÖLD- ÉS KÖRNYEZETTUDOMÁNYI KAR

Tantárgy neve: Waste processing machines and their operation

MŰSZAKI FÖLD- ÉS KÖRNYEZETTUDOMÁNYI KAR MSc KÉPZÉS
(nappali munkarendben)

TANTÁRGYI KOMMUNIKÁCIÓS DOSSZIÉ

MISKOLCI EGYETEM
MŰSZAKI FÖLD- ÉS KÖRNYEZETTUDOMÁNYI KAR
NYERSANYAGELŐKÉSZÍTÉS ÉS KÖRNYEZETTECHNOLÓGIA INTÉZET

Ajánlott félév: 3. félév

Tartalomjegyzék

1. TANTÁRGYLEÍRÁS - *Descripition*

<table>
<tr><td>Curse Title: Waste processing machines and their operation
Instructor: Ádám Rácz, PhD</td><td>Code: MFEET730020
Responsible department/institute:
Institute of Raw Material Preparation and Environmental Technology</td></tr>
<tr><td>Position in curriculum (which semester): 3.</td><td>Pre-requisites (if any): -</td></tr>
<tr><td>No. of contact hours per week (lecture + seminar): 2 l +2 s</td><td>Type of Assessment (examination/ practical mark / other): examination</td></tr>
<tr><td>Credits: 5</td><td>Course: full time</td></tr>
<tr><td colspan="2">Course Description:

The aim of the subject is to learn knowledge about the design, operation and selection of machines used in waste processing (comminution machines, classifiers, separators, biological, thermal and chemical processing equipment (eg reactors).

Comminution machines for brittle and non-brittle materials, design, operation and selection. Classifier (screens, grizzly) design, operation and selection. Separator (magnetic, eddy current, electrostatic, air-flow separators) design, operation and selection. Biological thermal and chemical processing equipment (eg reactors) design, operation and selection.</td></tr>
<tr><td colspan="2">Assessment and grading
Requirements of the signature:
- Less than 20 % class missing
- Presenting the laboratory measurements reports
- Writing the classroom test successfully

Examination: Written and oral 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: 85 – 100: excellent (5), 75 – 84: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).</td></tr>
<tr><td colspan="2">Compulsory or recommended literature resources:
• Lecture presentation slides and notes
• Ernst Worrell And Markus A. Reuter Handbook Of Recycling State-Of- The-Art For Practitioners, Analysts, And Scientists ISBN: 978-0- 12-396459- 5
• Tarján G.: Mineral Processing (Vol. 1, 2). AK. Bp.1981.</td></tr>
<tr><td colspan="2">Competences All</td></tr>
</table>

2. TANTÁRGYTEMATIKA – *Schedule of lectures*

Waste processing machines and their operation
Tantárgytematika (ÜTEMTERV)
Aktuális tanév tavaszi félév
Environmental Engineering MSc, 3. félév, törzsanyagos tárgy

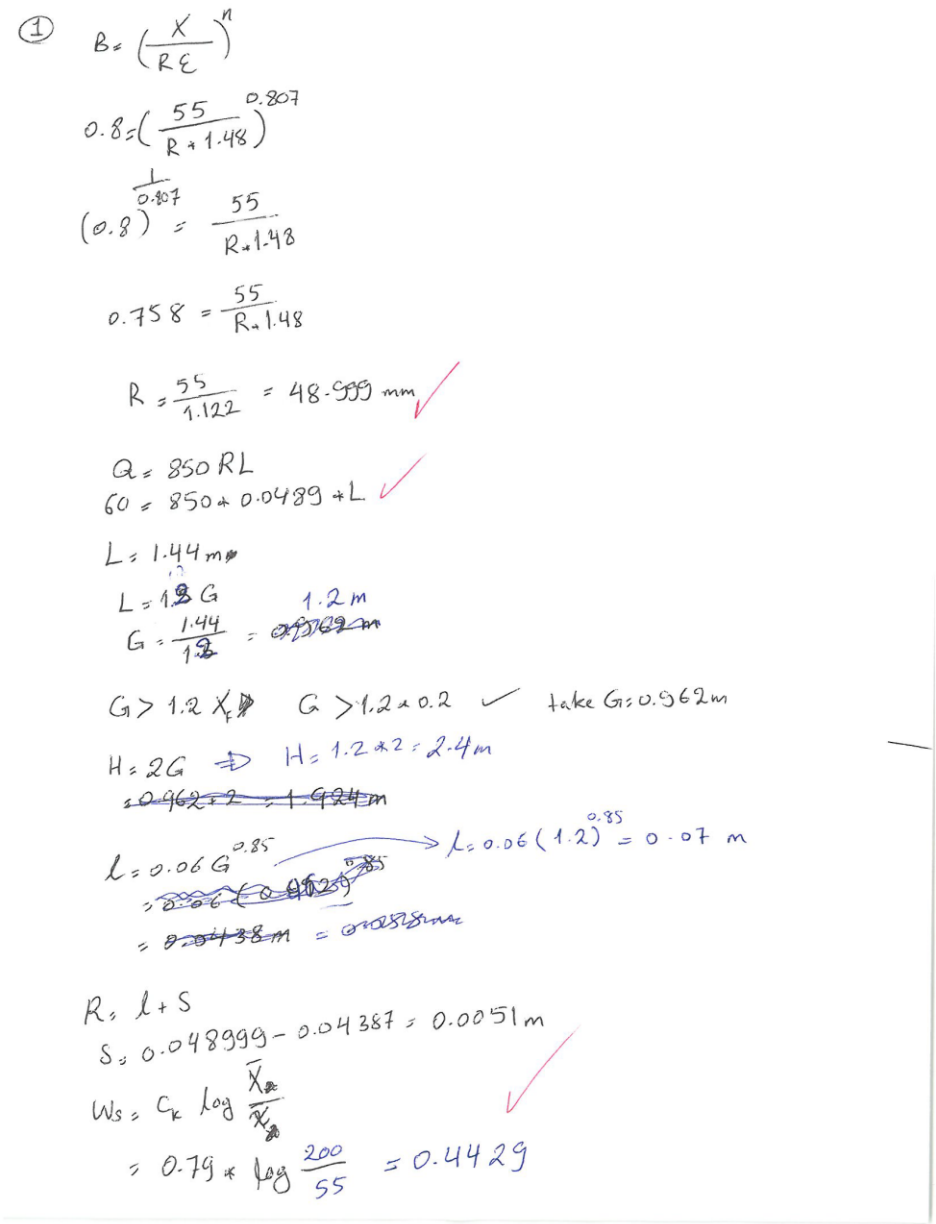
Hét	Gyakorlat - *Seminar work*
1.	Accident and work safety education
2.	Laboratory work with jaw crusher – determination of the empirical breakage function of different demolition waste types I.
3.	Laboratory work with jaw crusher – determination of the empirical breakage function of different demolition waste types II.
4.	Laboratory work with impact and roll crusher and with ball mill
5.	Laboratory work with axial gap rotary shear – determination of the breakage probability of different waste particles
6.	Laboratory work with hammer shredder – comminution of electrical wastes
7.	Laboratory work with cutting mill – fine comminution of wood and different type of plastics
8.	Laboratory work with classifiers - determination of the vibration frequency and amplitude of a Mogensen sieve
9.	Laboratory work with magnetic and eddy current separator – effect of the separation parameters on the performance of the separator
10.	Laboratory work with magnetic and eddy current separator – effect of the separation parameters on the performance of the separator
11.	Laboratory work with electrostatic separator– effect of the separation parameters on the performance of the separator
12.	Laboratory work with electrostatic separator– effect of the separation parameters on the performance of the separator
13.	Examination
14.	Examination

Hét	Előadás – *Lecture*
1.	Introduction to waste processing machines
2.	Waste comminution machines for brittle materials I.
3.	Waste comminution machines for brittle materials II.
4.	Waste comminution machines for non-brittle materials I.
5.	Waste comminution machines for non-brittle materials II.
6.	Design of hammer and rotary shredders
7.	Educational break
8.	Educational break
9.	Waste classifiers - machinery, operation, design
10.	Waste separators I - machinery, operation, design
11.	Waste separators II - machinery, operation, design
12.	Waste separators III - machinery, operation, design
13.	Biological waste processing equipment operation and selection
14.	Thermal waste processing equipment operation and selection

3. MINTA ZÁRTHELYI – *Written examination example*

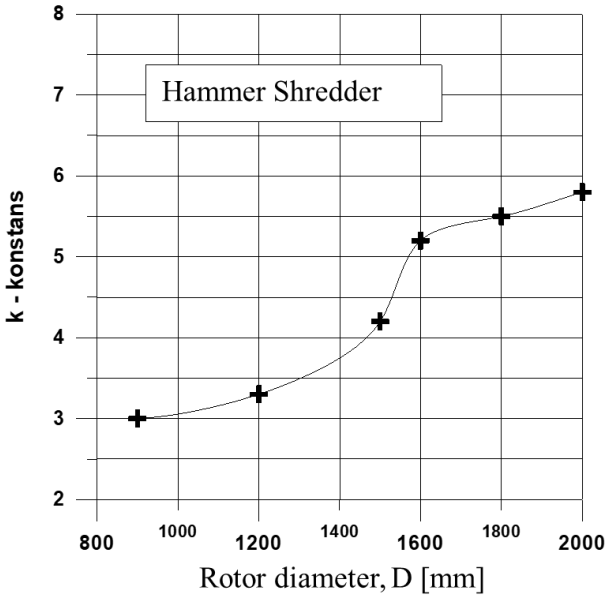
Waste processing machines and their operation
First written exam for signature
V1

1. Jaw crusher design: Calculate H, G, L, R, l, s, P, W_{spec}, of a jaw crusher if the required capacity is 50 t/h, the maximal particle size of the feed is 300 mm; X_{80}=200 mm. The x_{80} of the product should be 60 mm. (ck=0.79, ξ_{max}=1.48; n=0.807). 5p



2. Swing-Hammer shredder design: Calculate the L, D, P of a swing hammer shredder if the feed is a metal scrap (W_{spec}=25 kWh/t, η=0.5, v=40 m/s). The required capacity is 5 t/h. The k constant can be seen in the graph: 5 p

k constant as a function of the rotor diameters



Hammer shredders with one rotor:
D/L = 0.8 ... 1.2 .

$P = C_L W_s$

$= 60 * 0.4429$

$= 26.575$ KW ✓

2- L, D, P_s ?

$W_{spec} = 25$ KW/tf $\eta = 0.5$ $V = 40$ m/s $Q = 4$ t/h

$$W_s = \frac{W_{spec}}{\eta} = \frac{25}{0.5} = 50$$

$P = K L D V$

$P = Q W_s = 4 * 50 = 200$ kw

$\frac{L}{D} = 1$ $D = 1000$ mm , $K = 3.1$

$200 = 3.1 D^2 * V$

$$D = \sqrt{\frac{200}{3.1 * 40}}$$

$= 1.27$ m

$D_g \neq D_{calculation}$

$K = 3$ $D = 0.9$

$$D = \sqrt{\frac{200}{3 * 40}} = 1.29 \neq D_{graph}$$

$K = 3.4$ $D = 1.2$

$$D = \sqrt{\frac{200}{3.4 * 40}} = 1.21 \text{ m}$$ ✓

$L = D = 1.21$ m

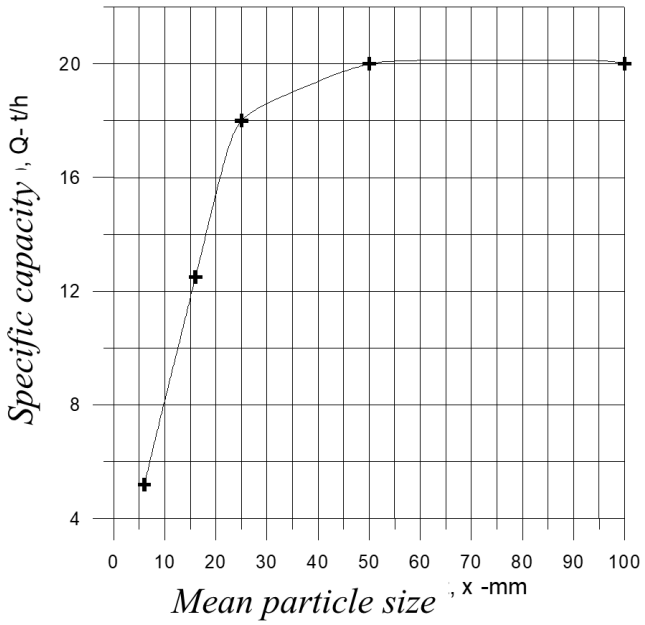
$P = 200 * 1.2 = 240$ kw ⇐ For safty

3. Design a trommel screen for the following purpose: 5 p

feed: municipal solid waste
capacity: 10 t/h
opening size: 50 mm
bulk density: 0.15 t/m^3
q=0.2 m^3/h m^2mm

4. Calculate the necessary width of the eddy current separator if the feed is 10-30 mm size fraction from electrical waste processing and the required capacity is 10 t/h. 3p

1 m width eddy current separator capacity



3- $Q = 12$ t/h $X = 60$ mm $\rho = 0.15$ t/m³ $q = 0.3$ m³/h.m².mm

$$Q_v = q * X * A_{eff}$$

$$\frac{12}{0.15} = 0.3 * 60 * A_{eff}$$

$$A_{eff} = 4.44 \text{ m}^2$$

$$A_{total} = 10 * A_{effective}$$

$$= 10 * 4.444 = 44.44 \text{ m}^2$$

assume $\frac{L}{D} = (2-4)$

$$\frac{L}{D} = 3$$

$$A = \pi D L$$

$$A = \pi * 3 * D^2$$

$$D = \sqrt{\frac{44.44}{3 * \pi}}$$

$$D = 2.17 \text{ m}$$

$$L = 3D \Rightarrow L = 3 * 2.17 = 6.51 \text{ m}$$

4-

$$B = \frac{Q}{Q_{spec}}$$

$X_{mean} = 35 \Rightarrow Q_{spec}$ from graph $= 19$ t/h

$$B = \frac{15}{14} = 0.789 \text{ m}$$

5. Design a dry open circuit ball mill for glass grinding! 8p

$W_{i,B}$=23 kWh/t
Q= 5 t/h
$X_{max,\ feed}$=20 mm
$X_{80,\ feed}$=12 mm
$x_{80,\ product}$=100 µm

$$P = 7{,}33\, e\, \varphi_t\, \rho_t\, (1 - 0{,}937\varphi)\left(1 - \frac{0{,}1}{2^{9-10e}}\right) LD^{2,3}$$

k_1 — *factor of dry grinding*; k_1 = 1.3

k_2— *open circuit factor*;

Mass ratio of < 100 µm in the ground material [%]	k_2
50	1.035
60	1.05
70	1.10
80	1.20
90	1.40
95	1.57
98	1.70

k_3 — *diameter factor*; if D ≠ 2.44 m,

$$k_3 = \left(\frac{2{,}44}{D}\right)^{0,2}$$

k_4 — *factor of coarse feed*; if

$$X_{80} > X_{opt} = 4000\sqrt{\frac{13}{W_{i(mert)}}}$$

r = X80/x80

$$k_4 = \frac{r + (W_i - 7)\left(\frac{X_{80}}{X_{opt}} - 1\right)}{r}$$

k_5 – *factor of fine grinding*; if $x_{80} < 75$ μm,

$$k_5 = \frac{x_{80} + 10{,}3}{1{,}145\ x_{80}}$$

k_6 – *small comminution degree, if* r < 6,

$$k_6 = 1 + \frac{0{,}13}{X_{80} / x_{80} - 1{,}35}$$

5- $W_{iB} = 23$ kwh/t $Q = 6$ t/h $X_{max} = 10$ mm $X_{80} = 5$ mm $X_{80\ product} = 100\ \mu m$

$K_1 = 1.3$ dry grinding

$K_2 = 1.035$

$K_3 = \left(\frac{2.44}{D}\right)^{0.2}$

$K_4 \Rightarrow X_{opt} = 4000\sqrt{\frac{13}{23}} = 3007.23$

$r = \frac{5000}{100} = 50$

$K_4 = \frac{r + (W_i - 7)\left(\frac{X_{80}}{X_{opt}} - 1\right)}{r}$

$= \frac{50 + (23-7)\left(\frac{5000}{3007.23} - 1\right)}{50}$

$K_4 = 0.68$

$K_5 = \frac{X_{80} + 10.3}{1.145\, X_{80}} = \frac{100 + 10.3}{1.145 * 100} = 0.96$

$K_s = K_4 K_2 K_3 K_4 K_5$

$= 1.3 * 1.035 * \left(\frac{2.44}{D}\right)^{0.2} * 0.68 * 0.96$

$= \frac{1.05}{D^{0.2}}$

$P = Q W_s$

$W_s = W_{iB} * k\left(\frac{10}{\sqrt{X_{80}}} - \frac{10}{\sqrt{X_{80}}}\right)$

$= 23 * \frac{1.05}{D^{0.2}} * \left(\frac{10}{\sqrt{0.1}} - \frac{10}{\sqrt{5}}\right)$

$= \frac{655.687}{D^{0.2}}$

$P = Q W_s$

$= 6 * \frac{655.687}{D^{0.2}}$

$= 3934.128 / D^{0.2}$

$\frac{3934.128}{D^{0.2}} = 7.33\, e\, \phi\, f_t\, (1 - 0.937\, q)\left(1 - \frac{0.1}{2^{9-10+0.8}}\right) * L D^{2.3}$

$\frac{3934.128}{D^{0.2}} = 7.33 (0.8 * 0.4 * 7.8)(1 - 937 * 0.4)\left(1 - \frac{0.1}{2^{9-10+0.8}}\right) L D^{2.3}$

$\frac{3934.128}{D^{0.2}} = 10.866\, L D^{2.3}$

$\frac{3934.128}{10.866} = L D^{2.5}$

$L D^{2.5} = 362.0406$

455mm

$\frac{L}{D} = 1.5$

$1.5 D * D^{2.5} = 362.0406$

$D^{3.5} = \frac{241.36}{4.794}$

$D = 4.794$ m

$L = 4.794 * 1.5$

$= 7.191$ m

$P = 2875.47$ kw

$W_s = 479.24$

5. EGYÉB KÖVETELMÉNYEK - *Other requirements*

ZH írása közben mobiltelefon nem használható! - *Using mobile phones during the exam is forbidden.*

Miskolc, 2023. április 12.

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Dr. Nagy Sándor	Dr. Rácz Ádám
intézetigazgató egyetemi docens	*egyetemi docens*