Nové možnosti rozvoje vzdělávání na Technické univerzitě v Liberci
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The Geometrical Parameters of the Fibers and a Work with the Image Analysis NIS Elements

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Task:

1. Familiarize with the program of the image analysis NIS Elements.
2. Measure following parameters on the given images of various fibers'cross-sections – area of fiber cross-section s (FillArea), fiber equivalent diameter d_e (EqDiameter), fiber cross-section perimeter p (Perimeter), circulaity c (Cirkularity).
3. Theoretically define the fiber parameters – equivalent fiber diameter d_e [mm], fiber fineness t [tex], circularity c [-], shape factor of fibers cross-section according to Mrs. Malinowska q [-], specific surface of fiber a [m^2kg^{-1}].
4. Verify theoretical equations (see point 3 above) with help of measured values (point 2 above) and given densities of fibers ρ [kg m^{-3}].

Tab. 1: Overview of densities of chosen types of fibers

Type of fiber	Density ρ [kg m^{-3}]
WO - wool	1310
SE – natural silk	1370
LI - flax, HF - hemp	1420
CO - cotton	1520
CV - viscose	1500
PES - polyester	1360
PAN - polyacrylonitrile	1160

Tool:

- Image analysis NIS Elements

Information sources:

- Lectures of AOT – KTT, manual of the software of NIS Elements
- Internal standard IN 21-108-01/01 Definition. Geometrical properties of the fibers.
- Lectures of ST1 – KTT (Prof. Ing. Neckář, DrSc.)

Principle and procedure of the work with the image analysis:

The image analysis is generally based on the image capturing and its conversion to the digital form, further on the image transformation (the image adjustment), the identification (the image segmentation) of the objects or textures (fields) and finally on the quantification to finite number of data and measurements.

In the **practice 1** there are the prepared calibrated fibers' images (i.e. definition of one pixel length in real units) will be used.

A. Open the image.
B. Activate binary image editor through the key TAB (or in main menu – Binary – **Binary Editor**…).
C. Subjectively detect the boundary of fiber cross-section, i.e. trace the fiber cross-section – recommendation: Bezier's filled-in curve, line width – 3 pixels, then Exit editor.
D. Main menu – Measure
    1. Object Features… choose recommended parameters, see point 2 in Task.
    2. Perform measurement (or F5).
    3. Go back to the point A and repeat the same operations on the rest images.
E. After processing of all images activate **View** in main menu
    4. Docking Panes – Bottom
        - Right click in docking pane – Analysis Controls – Automated Measurement (you should see table with measured data).
        - Export – Clipboard, then again click on Export for data export confirmation.
F. Open Excel – Ctrl V.

Measured data processing:

1. Define relation for ***fiber equivalent diameter*** like the function of area cross-section $d_e = f(s)$, use measured values of s. Compare measured and calculated values of d_e. Realize comparison for all fibers.
2. Define relation for ***the fiber fineness*** $t = f(\rho, s)$, come from the original equation $t = \frac{m}{l}$. Use measured values of s and tabular values of ρ. Calculate fineness for all measured fibers.
3. Calculate ***the circularity*** according to $c = \frac{s}{s_{kruhu}} = \frac{4\pi s}{p^2}$ for all fibers, compare results with measured values. Range all fibers according to circularity from the most cylindrical to the least.
4. Calculate ***the shape factor*** according to $q = \frac{p}{\pi d_e} - 1$. Range all fibers according to circularity from the most cylindrical to the least. Compare the result with point 3 above, comment conclusion. Is there any relation between c and q?
5. Convert equation for ***fiber specific surface*** $a = \frac{p\,l}{m}$, where l is fiber length, for its calculation from measured fiber parameters.

6. Write the results in tables, for template see tab. 2, 3.

Tab. 2: Exemplary table for results

Fiber type	s_{meas} [μm^2]	p_{meas} [μm]	d_{e_meas} [μm]	d_e [μm]	t [tex]	c_{meas} [-]	c [-]	q [-]	a [m^2kg^{-1}]
01_1hollow_pes									
02_3star_pes									
03_4hollow_pes									
04_CO									
05_HF									
06_rabbit									
07_circle_pes									
08_LI									
09_SE									
10_sponge_pan									
11_heart_pan									
12_camel									
13_WO_guardH									
14_CV_shine									

Tab. 3: Exemplary table for results

Ordered fibers according to the values of c_{meas}	Ordered fibers according to the values of c	Ordered fibers according to the values of q