



Kedy zabili tetku Helgu?

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Osoby a obsadenie

Tetka Helga



(Až moc) živá:
37°C

Parametre

- výška 150 cm
- miery 99-99-99
- váha 99 kg
- IQ 99
- agresivita vysoká

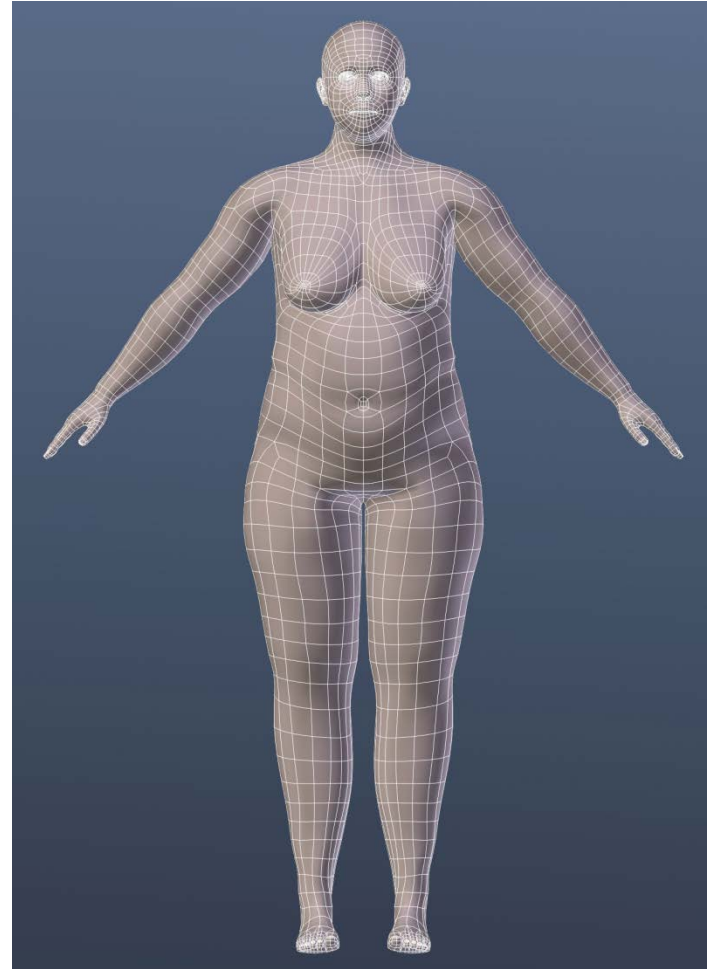


9:00 am:
28°C

Tetka Helga: Modelová predstava



3D scan



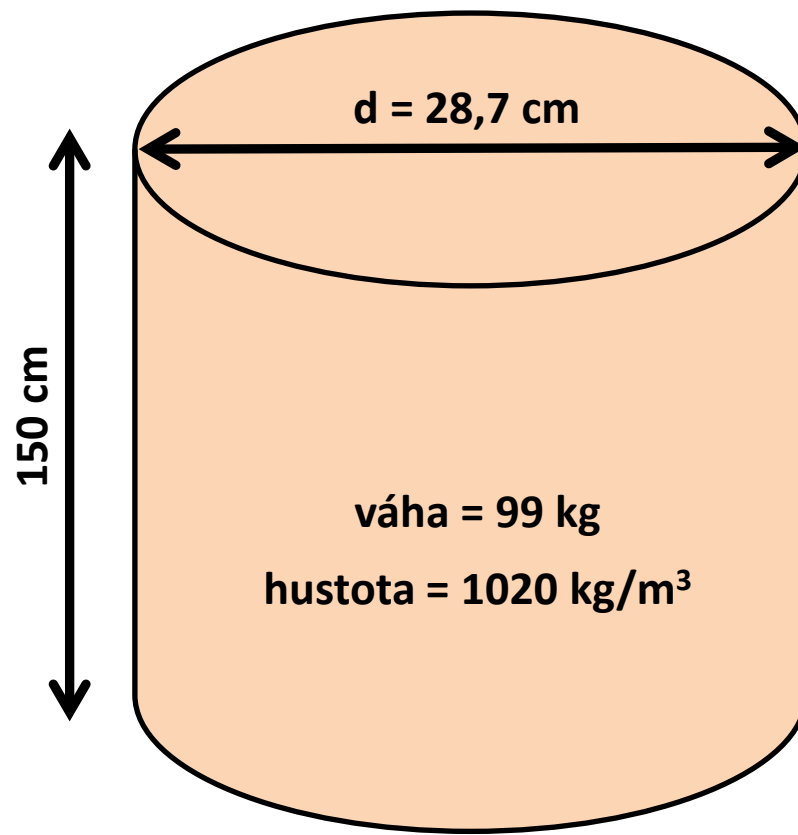
Leonard Hofstadter, PhD



Tetka Helga: Modelová predstava



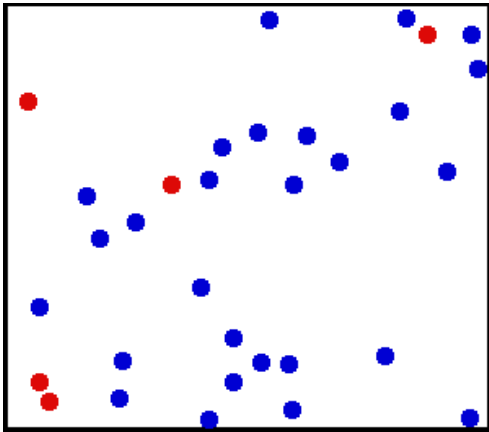
Typ postavy:
Cylindroid



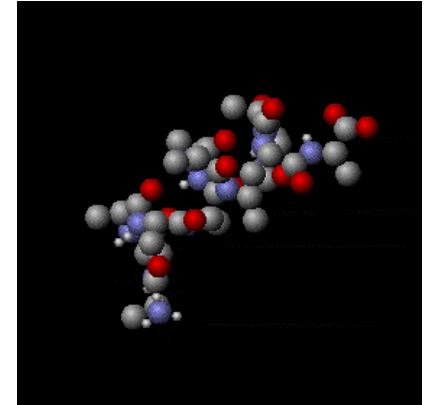
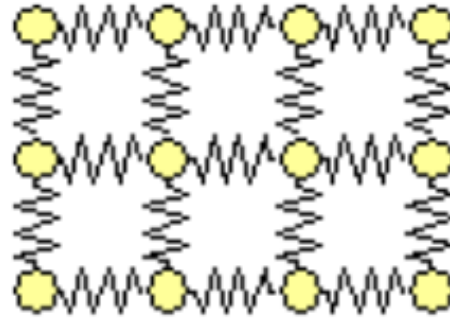
Počiatočná teplota: 37°C

Vzduch: 20°C

Teplota a přestup tepla

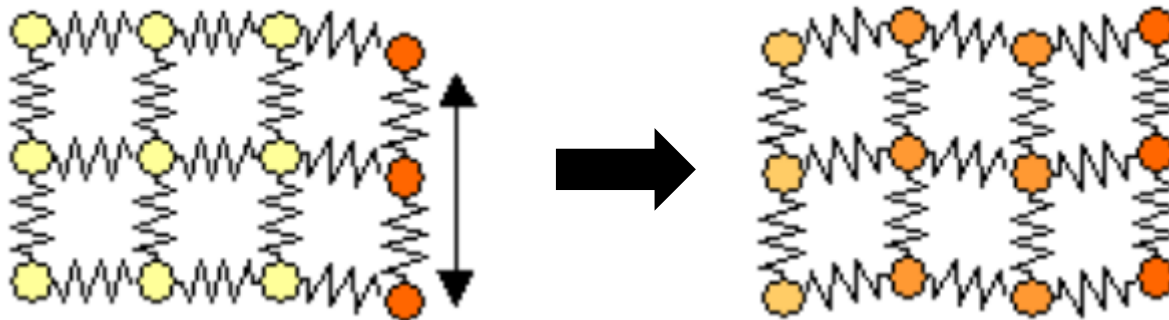


Plyn / kvapalina



Tuhá látka

Přestup tepla VEDENÍM (kondukcí)



Tepelná kapacita a tepelná vodivost'

10°C → 20°C

Tepelná kapacita

$$c_p$$
$$[\text{J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}]$$



1 kg vody: 41 800 J



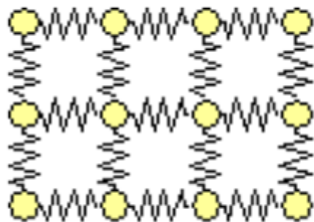
1 kg zlata: 1290 J

Tepelná vodivost'

$$\lambda$$
$$[\text{W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}]$$



voda: 0,6 W·m⁻¹·K⁻¹



zlato: 314 W·m⁻¹·K⁻¹

(vláknitý azbest: 0,14 W·m⁻¹·K⁻¹, diamant: 1000 W·m⁻¹·K⁻¹)

Fourierov zákon



Jean-Baptiste Joseph Fourier
(1768 – 1830)

$$\vec{q} = -\lambda \nabla T$$

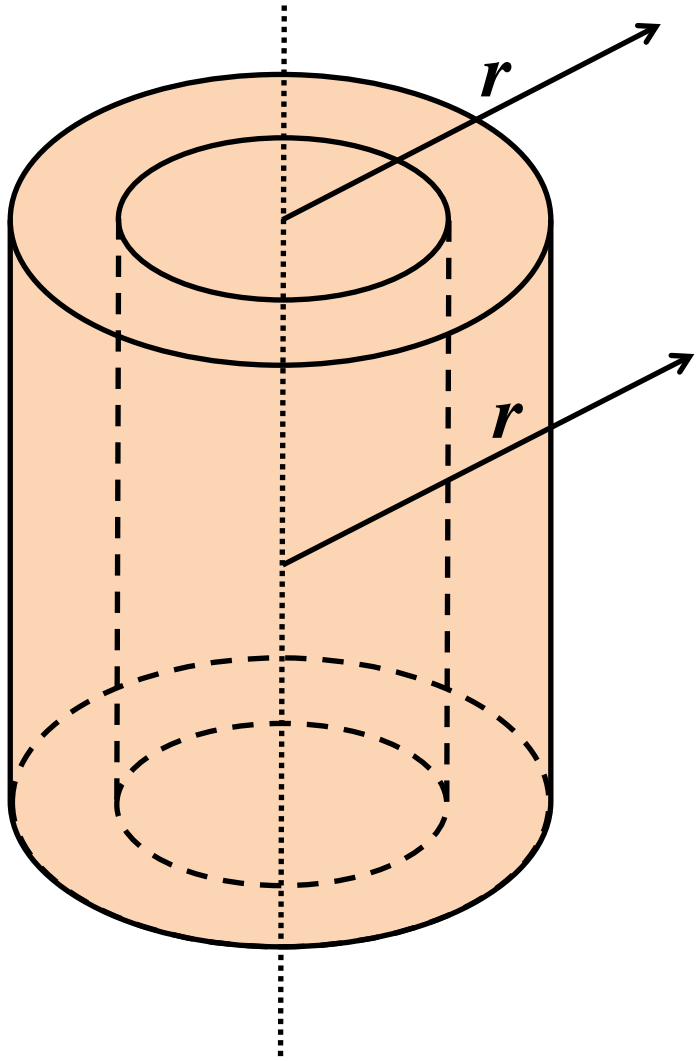
\vec{q} - hustota toku tepla [W·m⁻²]

λ - tepelná vodivost' [W·m⁻¹·K⁻¹]

∇T - gradient teploty [K·m⁻¹]

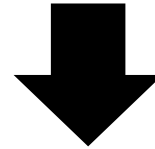
$$\nabla T = \frac{\partial T}{\partial x} + \frac{\partial T}{\partial y} + \frac{\partial T}{\partial z}$$

Symetria vo valci



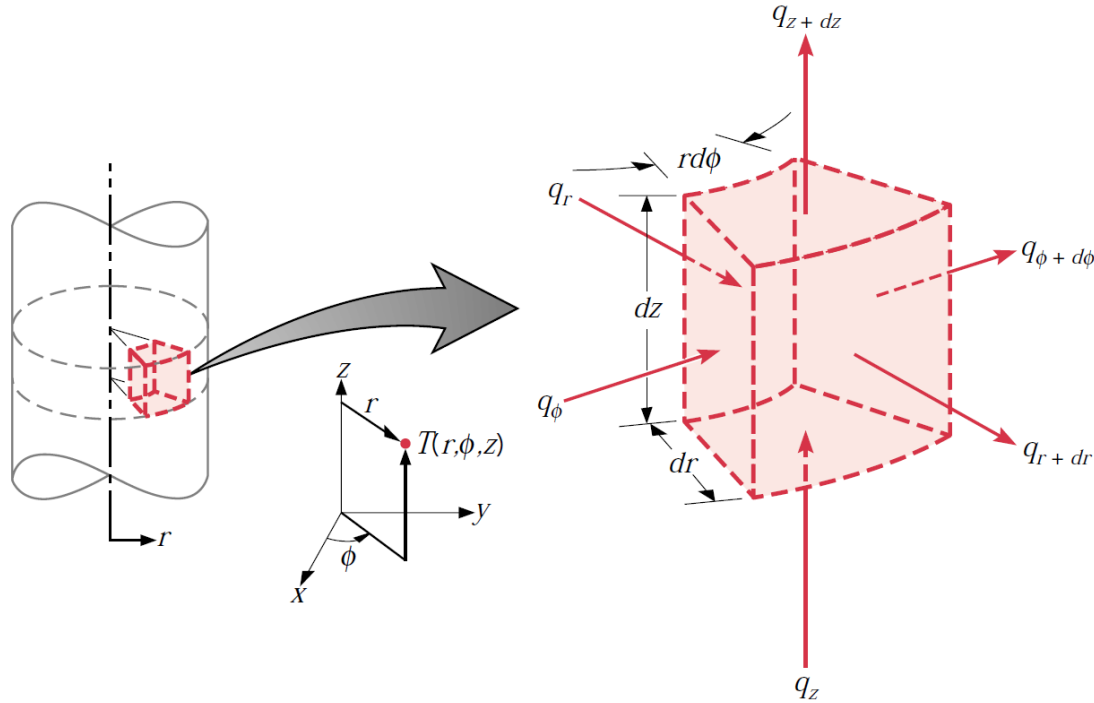
$$\vec{q} = -\lambda \nabla T$$

$$\nabla T = \frac{\partial T}{\partial x} + \frac{\partial T}{\partial y} + \frac{\partial T}{\partial z} = \frac{\partial T}{\partial r}$$



$$\vec{q}_r = -\lambda \frac{\partial T}{\partial r}$$

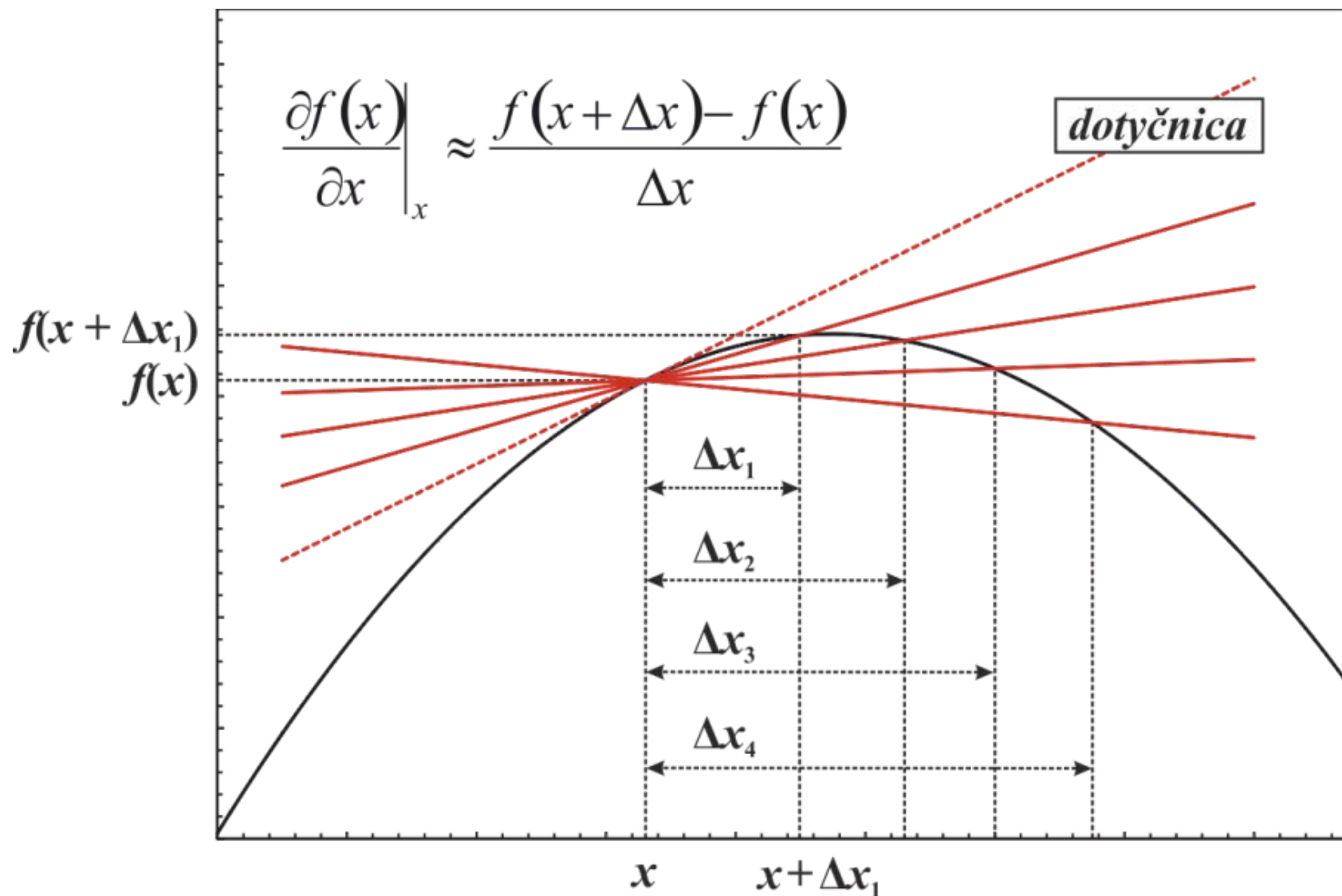
Energetická bilancia veľmi malého elementu valca



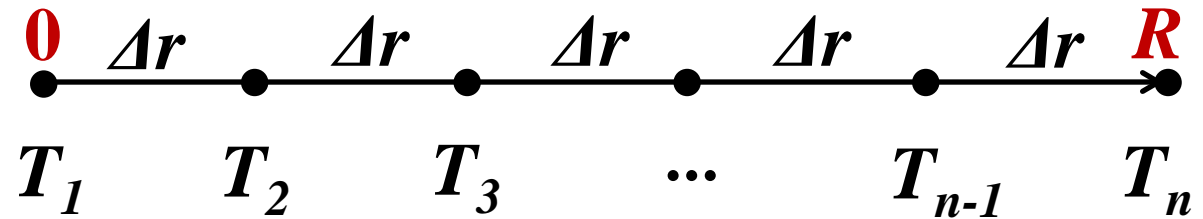
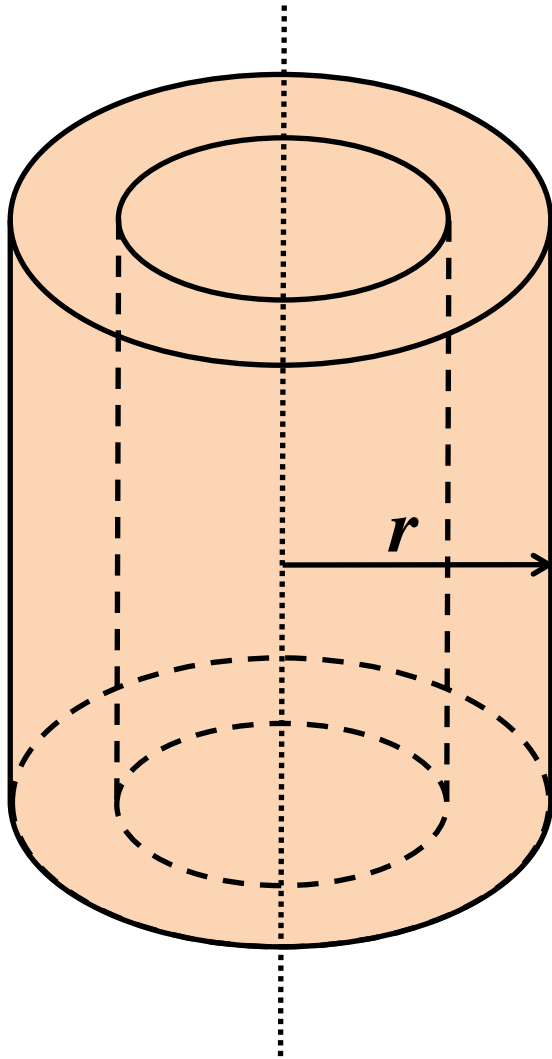
$$\left\{ \begin{array}{l} \text{vstup tepla} \\ \text{do elementu} \\ \text{za čas } dt \end{array} \right\} - \left\{ \begin{array}{l} \text{výstup tepla} \\ \text{z elementu} \\ \text{za čas } dt \end{array} \right\} = \left\{ \begin{array}{l} \text{akumulácia tepla} \\ \text{v elemente} \\ \text{za čas } dt \end{array} \right\}$$

$$\frac{\partial T}{\partial t} = \frac{\lambda}{\rho c_p} \left(\frac{1}{r} \frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial r^2} \right)$$

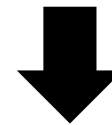
Numerická náhrada derivácie



Metóda sietí a uzlové body



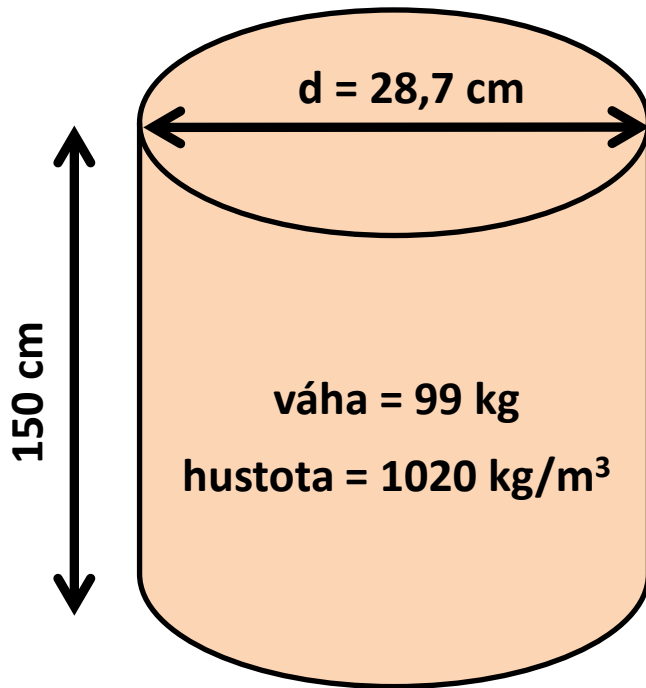
$$\frac{\partial T}{\partial t} = \frac{\lambda}{\rho c_p} \left(\frac{1}{r} \frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial r^2} \right)$$



$$\frac{\Delta T_t}{\Delta t} = \frac{\lambda}{\rho c_p} \left(\frac{1}{r} \frac{\Delta T_r}{\Delta r} + \frac{\left(\frac{\Delta T_{r_1}}{\Delta r} - \frac{\Delta T_{r_2}}{\Delta r} \right)}{\Delta r} \right)$$

Termodynamické a iné parametre tetky Helgy

Tetka Helga



Materiálové parametre

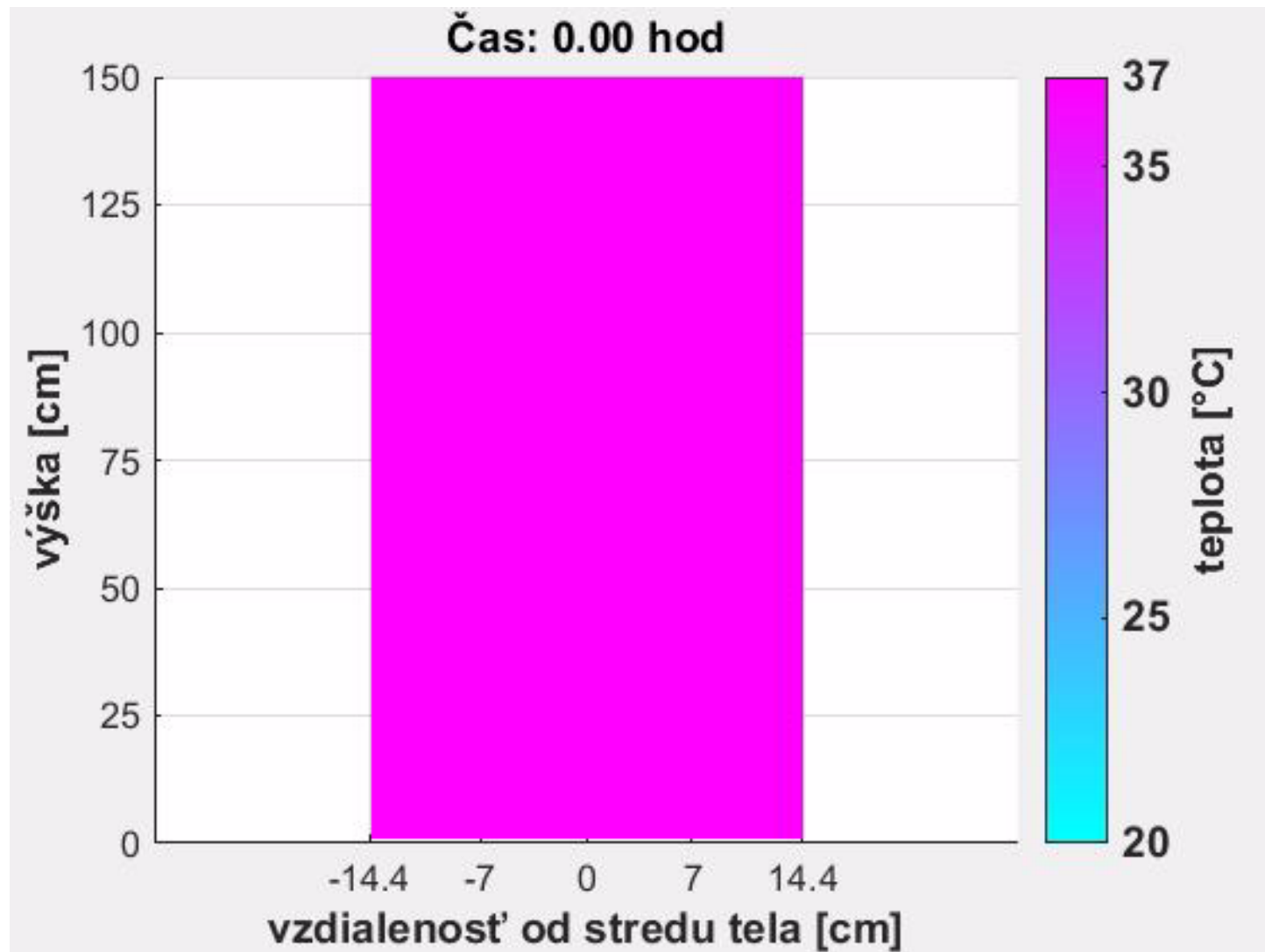
tepelná vodivosť $0,5 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$
tepelná kapacita $4000 \text{ J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$

Procesové parametre

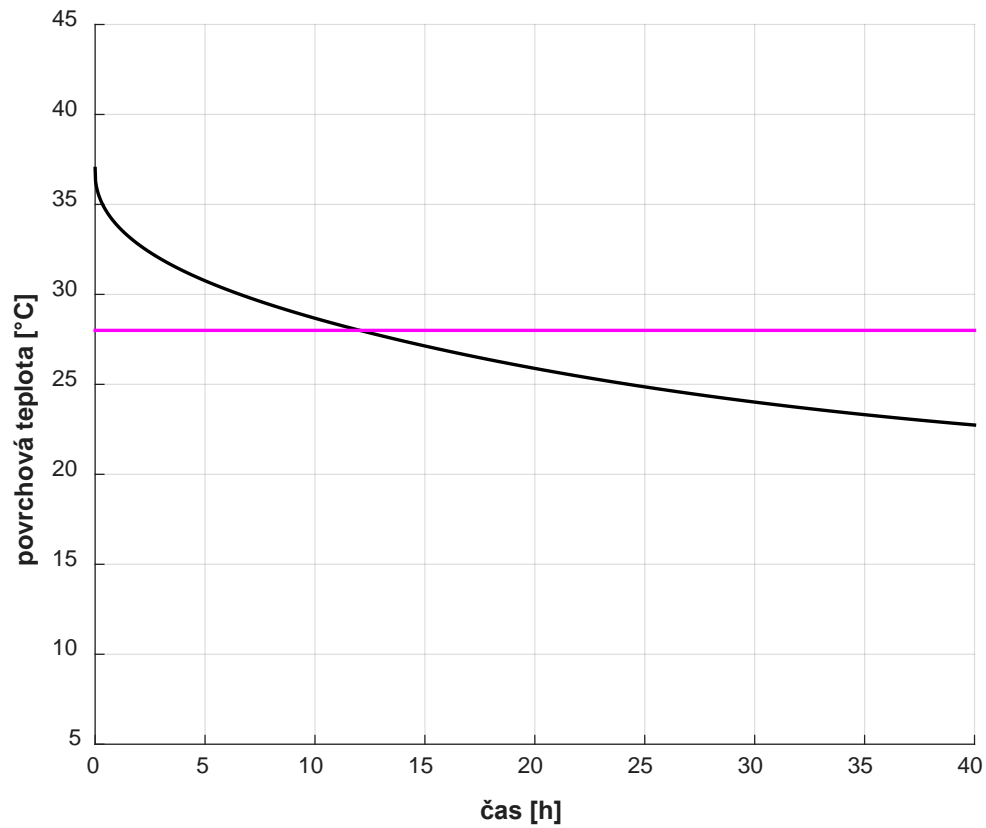
počiatočná teplota Helgy 37°C
teplota okolitého vzduchu 20°C

nehybný vzduch – voľné prúdenie
koeficient prestupu tepla z povrchu tela do
okolitého vzduchu: $4 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$

Chladnutie tetky Helgy

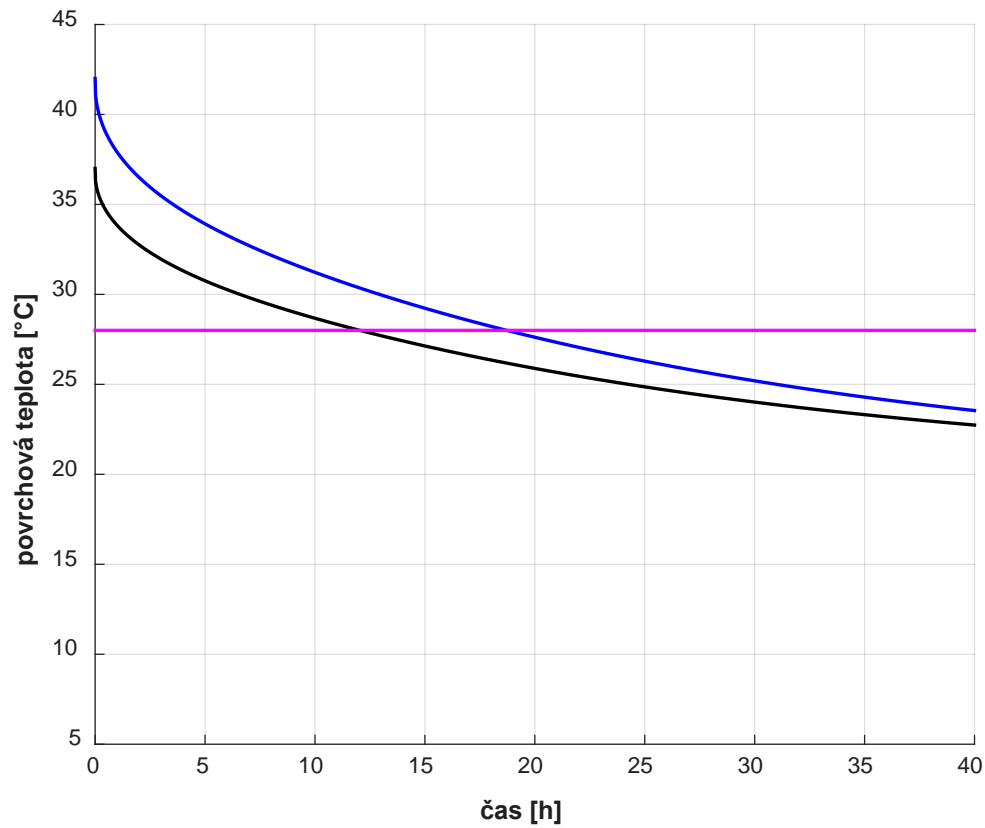


Chladnutie tetky Helgy



pôvodná situácia

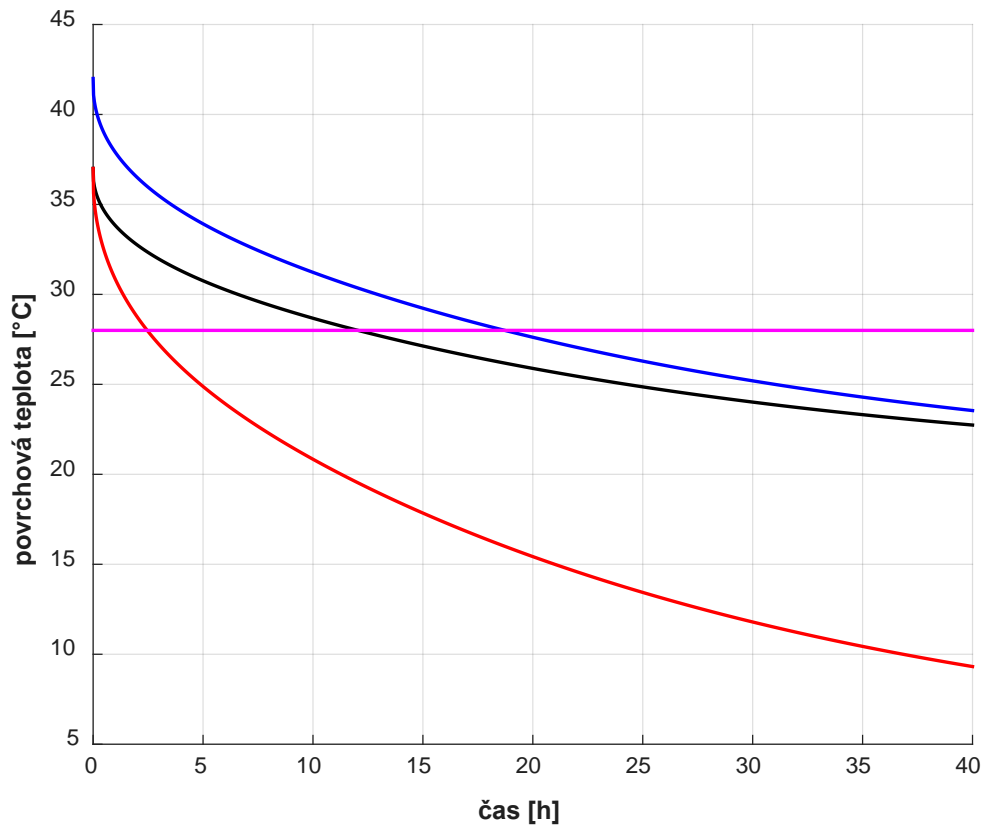
Chladnutie tetky Helgy



pôvodná situácia

tetka Helga mala horúčku 42°C

Chladnutie tetky Helgy

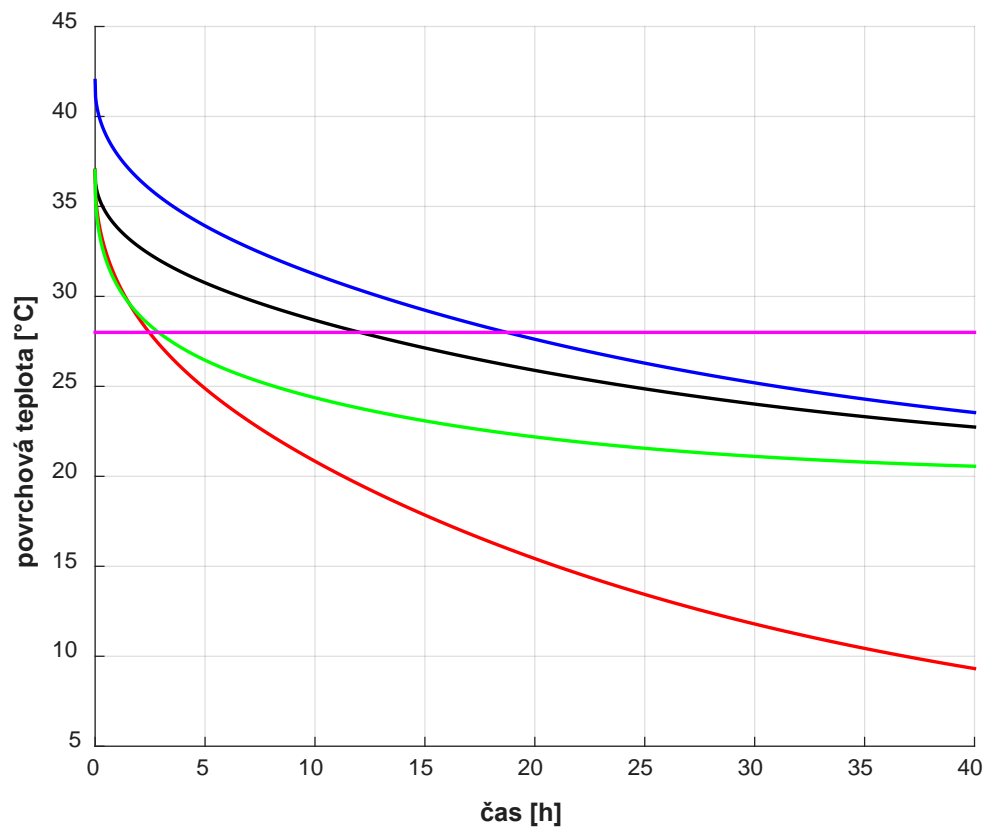


pôvodná situácia

tetka Helga mala horúčku 42°C

tetka Helga bola v chladničke pri 4°C

Chladnutie tetky Helgy



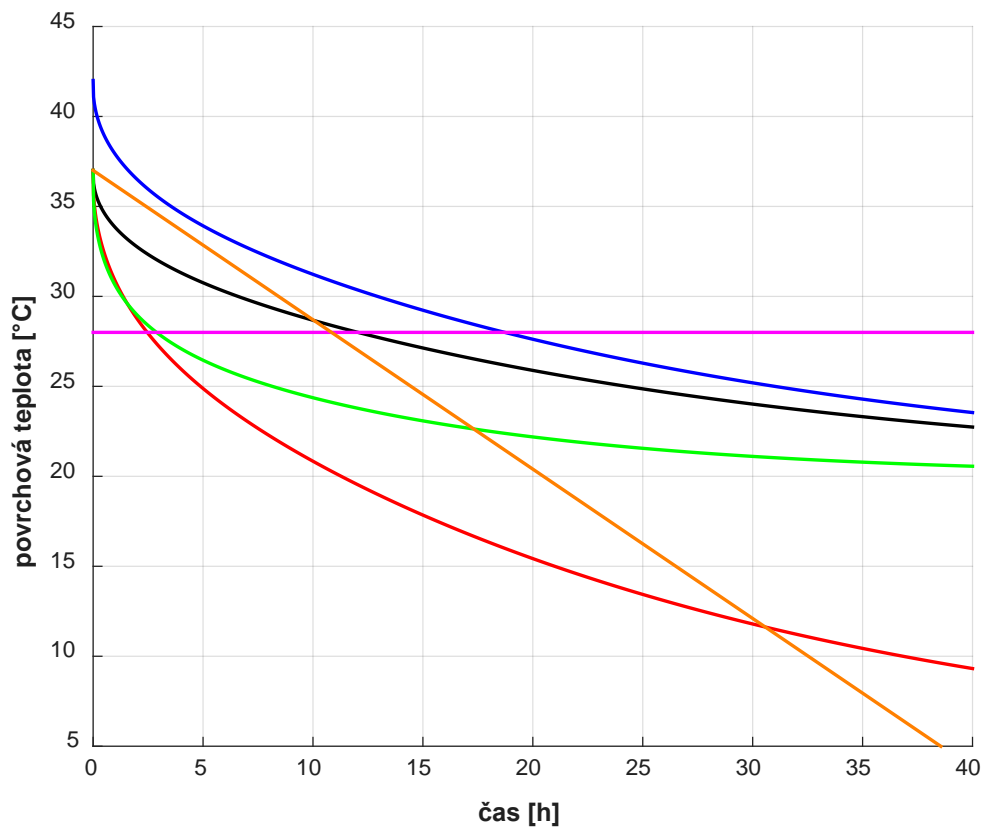
pôvodná situácia

tetka Helga mala horúčku 42°C

tetka Helga bola v chladničke pri 4°C

v dome bol prievan

Chladnutie tetky Helgy



pôvodná situácia

tetka Helga mala horúčku 42°C

tetka Helga bola v chladničke pri 4°C

v dome bol prievan

klasický policajný odhad

Thank you for your attention!

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