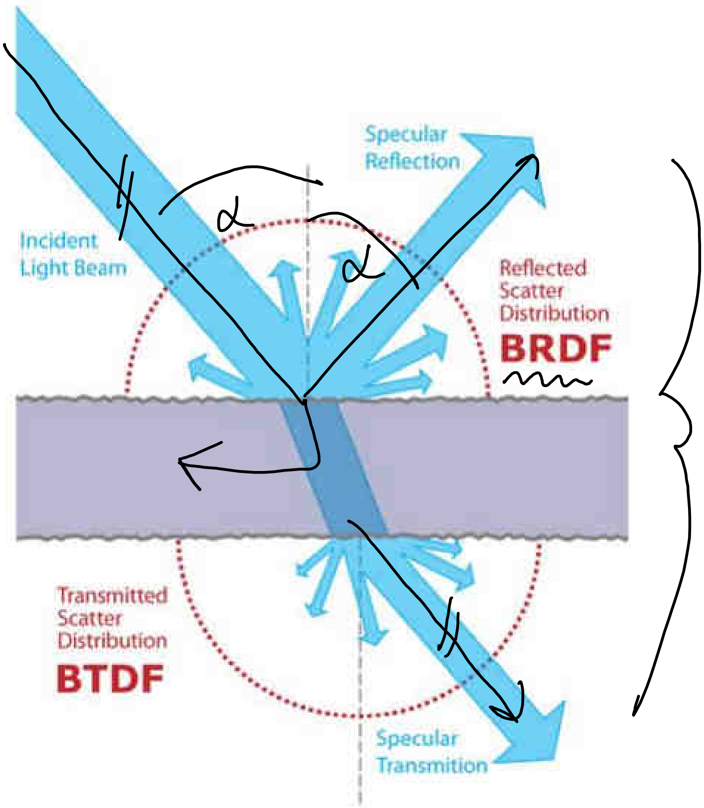
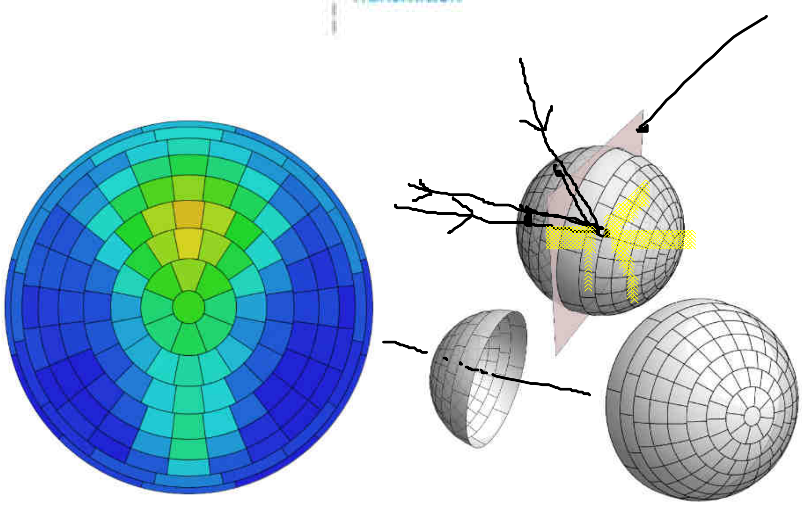
Optikai tulajdonságok

2018. november 15.
14:28



BSDF

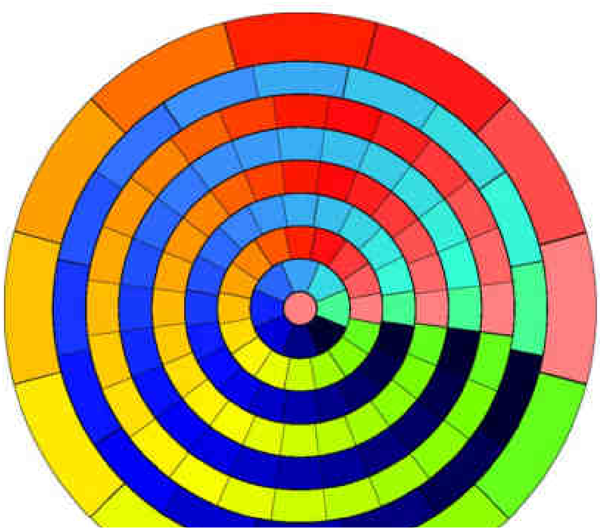
scattering



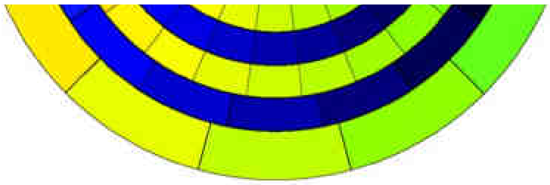
Klems

Klems patches

- **subdivision of hemisphere into** **145 patches**
- **approx. equal illuminance from each patch if luminance is constant in hemisphere**
- **9 θ ranges** **{0°-5°, 5°-15°, 15°-25°, 25°-35°, 35°-45°, 45°-55°, 55°-65°, 65°-75°, 75°-90°}**
- ~~**φ subdivisions per θ range**~~



45°-55°, 55°-65°, 65°-75°, 75°-90°}

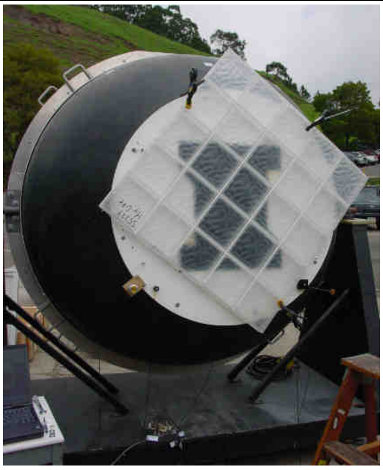


- ϕ subdivisions per θ range

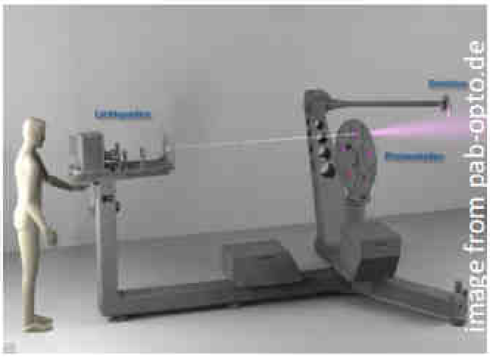
  {1, 8, 16, 20, 24, 24, 24, 16, 12}

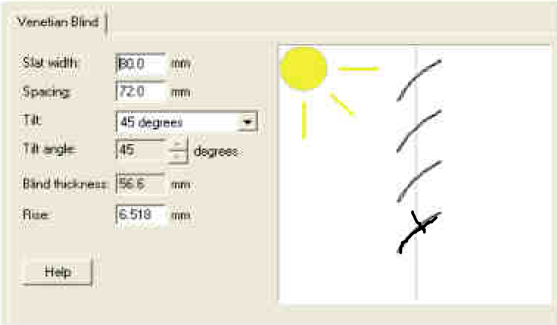
- average solid angle $2\pi/145$ = 0.0433 sr,

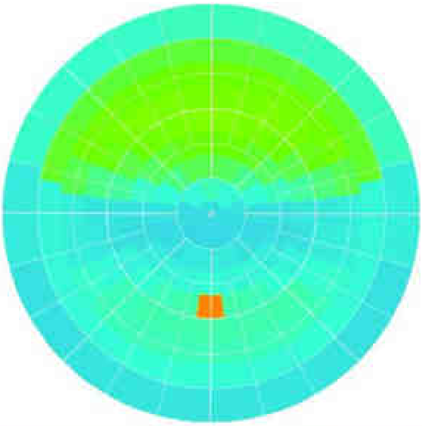
  i.e. cone with 2 x 6.73° apex angle [$2\pi*(1-\cos(\alpha/2)) = 2\pi/145$]



classical goniometers

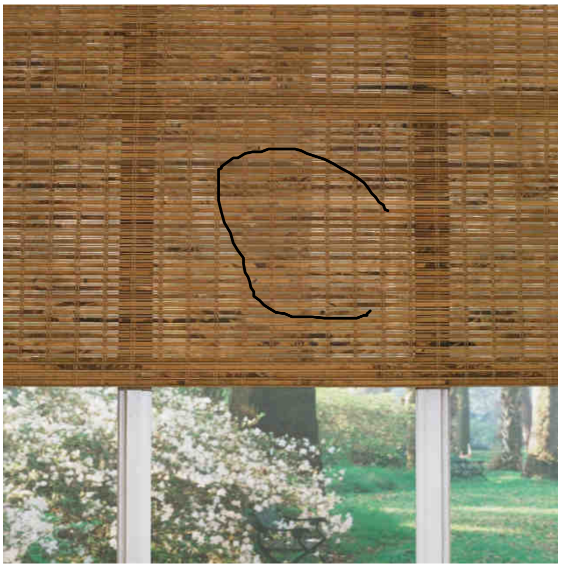




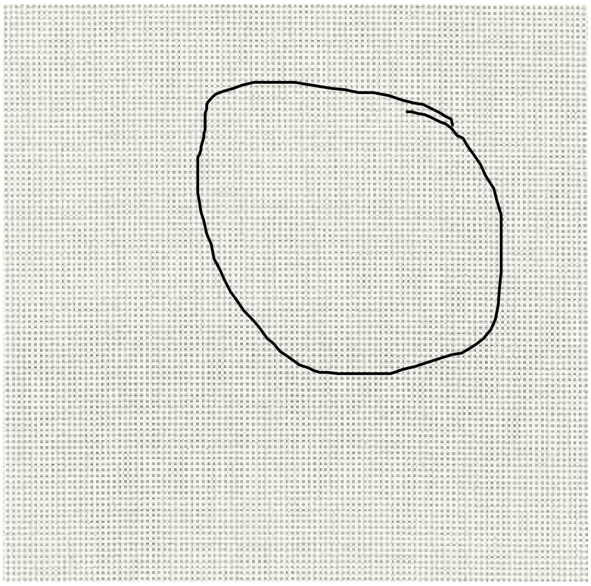


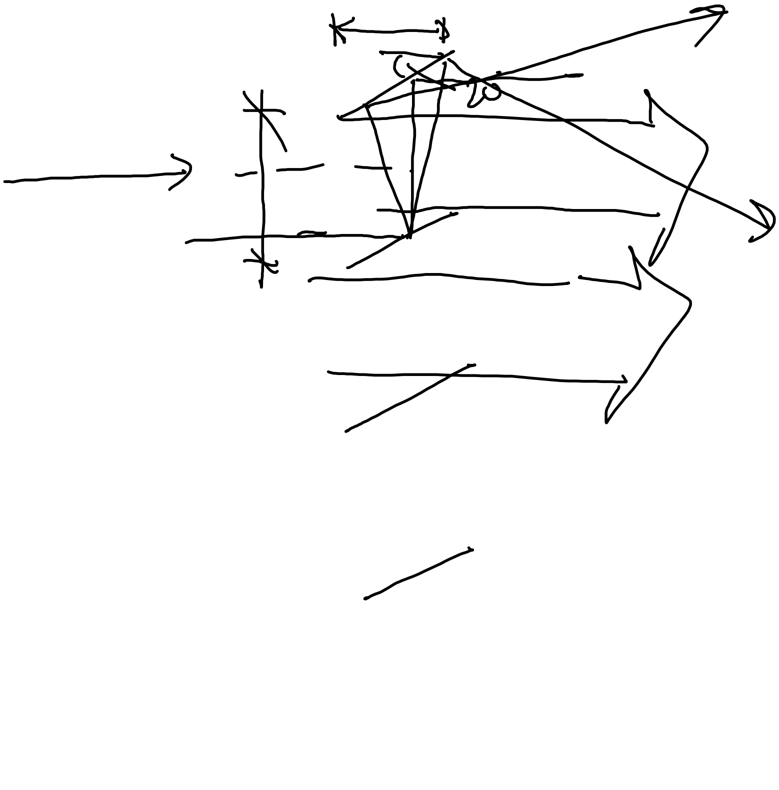
BSDF

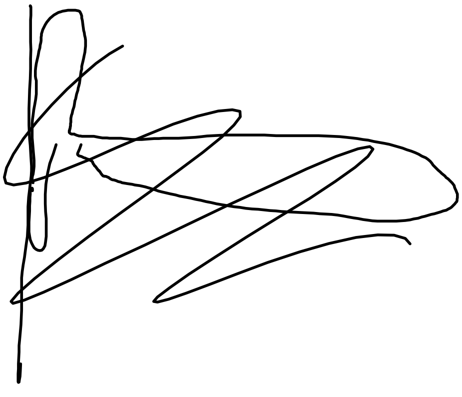
Levolor Origami   2014-SC42.xml

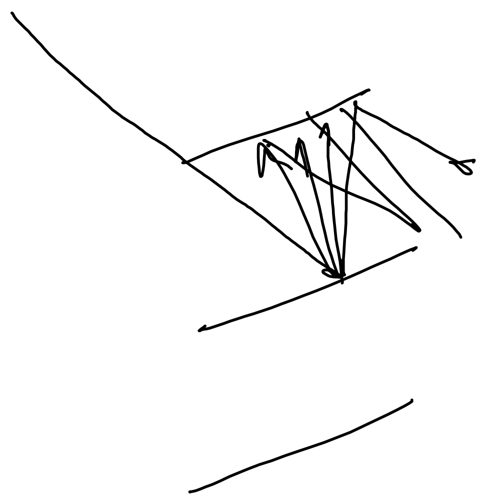


Mermette Natte White 2014-SA24.xml









Konvektív hőátadás

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$$Nu = \frac{\text{konvektív hőátadás}}{\text{konduktív} \ -\text{"}-} = \frac{h_{conv}}{h_{cond}} = \frac{h_{conv}}{\frac{\lambda}{d}}$$

$$\rightarrow \boxed{h_{conv} = Nu \left(\frac{\lambda}{d}\right)}$$

Prandtl szám

$$Pr = \frac{\text{viszkózus diffúzió}}{\text{termikus diffúzió}} = \frac{\text{sebesség határréteg vtg.}}{\text{termikus} \ -\text{"}-} =$$

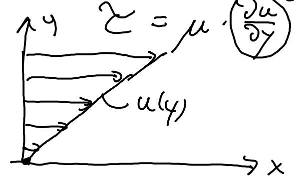
$$= \frac{\nu}{\alpha} = \frac{\nu}{\frac{\lambda}{\rho \cdot c_p}} = \frac{\frac{\mu}{\rho}}{\frac{\lambda}{\rho \cdot c_p}} = \boxed{\frac{c_p \cdot \mu}{\lambda}} \ [-]$$

μ - dinamikus viszkozitás [Pas] [Ns/m²] [kg/ms]

ν - kinematikus viszkozitás $\frac{\mu}{\rho}$ [m²/s]

Newton-féle viszkozitási törvény:

$$\tau = \mu \cdot \frac{\partial u}{\partial y}$$



$Pr \cong 0.7$ - legtöbb gáza

7 - víz

$100 - 40000$

Grashof szám

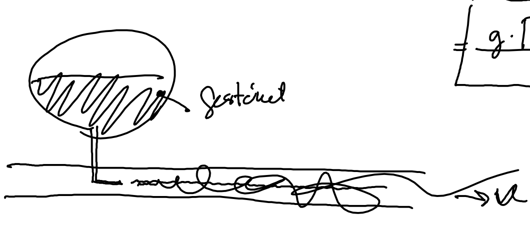
$$Gr = \frac{\text{felhajtóerő}}{\text{viszkózus erő}} = \frac{L^3 (\rho - \rho_0) g}{\mu \cdot \frac{u}{\ell} \ell^2} = \frac{L^3 \beta \rho \cdot \rho_0 \Delta T}{\nu^2 \rho} =$$

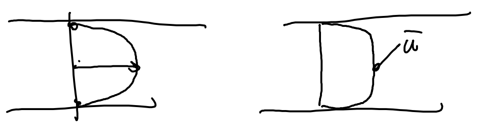
$Gr \ll 1 \rightarrow$ szabad áramlás $\emptyset$

$\gg 1 \rightarrow$ szabad áramlás ✓

$$\beta = \frac{1}{T}$$

$$= \boxed{\frac{g \cdot \beta \cdot (T - T_\infty) L^3}{\nu^2}}$$





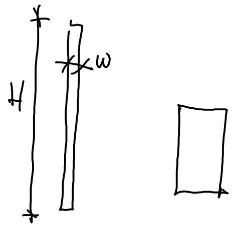
Rayleigh szám

$$Ra = Gr \cdot Pr = \frac{g \cdot \rho_0^2 \cdot \beta \cdot \Delta T \cdot L^3 \cdot c_p}{\mu \cdot \lambda}$$

$$Ra = Gr \cdot Pr = \frac{g \cdot \rho_0^2 \cdot \beta \cdot \Delta T \cdot L \cdot c_p}{\mu \cdot \lambda}$$

Karcsúság

$$A_r = \frac{H}{W} \quad [-]$$



$$\Pi_1 = f(\Pi_2, \Pi_3, \Pi_4)$$

$$Nu = f(Pr, Gr, A_r)$$

$$\boxed{Nu = f(Ra, A_r)}$$

Nu - korrelációk :
- empirikus képletek
- kísérlet és/vagy szimuláció alapján

Wright

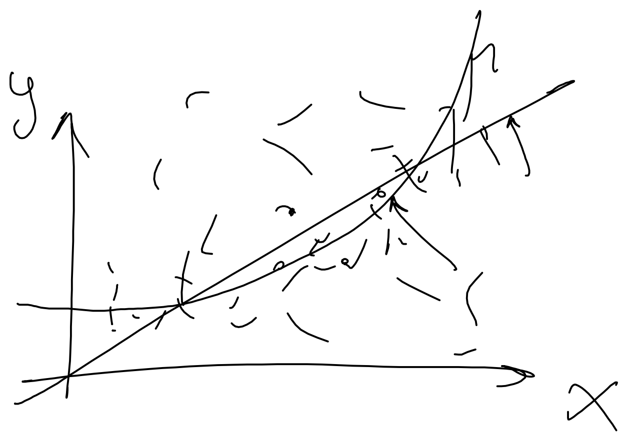
$$Nu_1 = 0.0605 \cdot Ra^{1/3}$$

$$Nu_2 = \left[1 + \left(\frac{0.104 \cdot Ra^{0.293}}{1 + \left(\frac{6310}{Ra}\right)^{1.36}}\right)^3\right]^{1/3}$$

$$Nu_3 = 0.242 \left(\frac{Ra}{Ar}\right)^{0.272}$$

$$Nu = \max \begin{cases} Nu_1 \\ Nu_2 \\ Nu_3 \end{cases}$$

$$h_{conv} = Nu \cdot \frac{\lambda}{H}$$



Illusztráció

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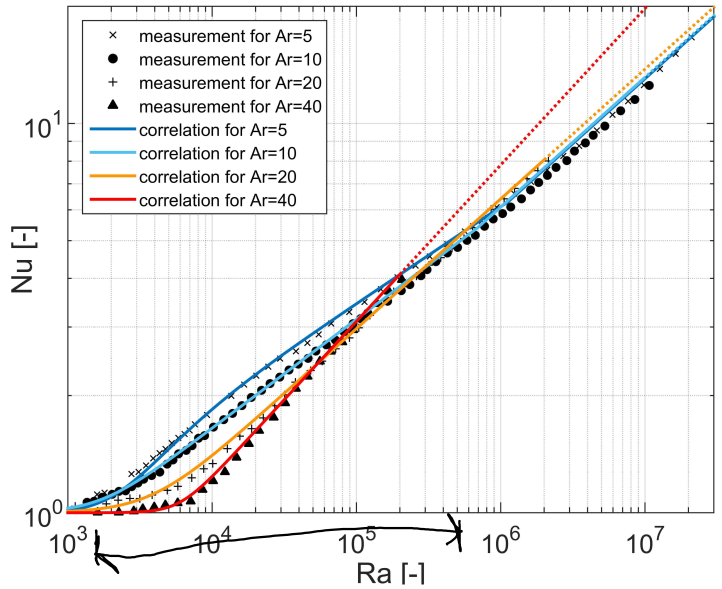
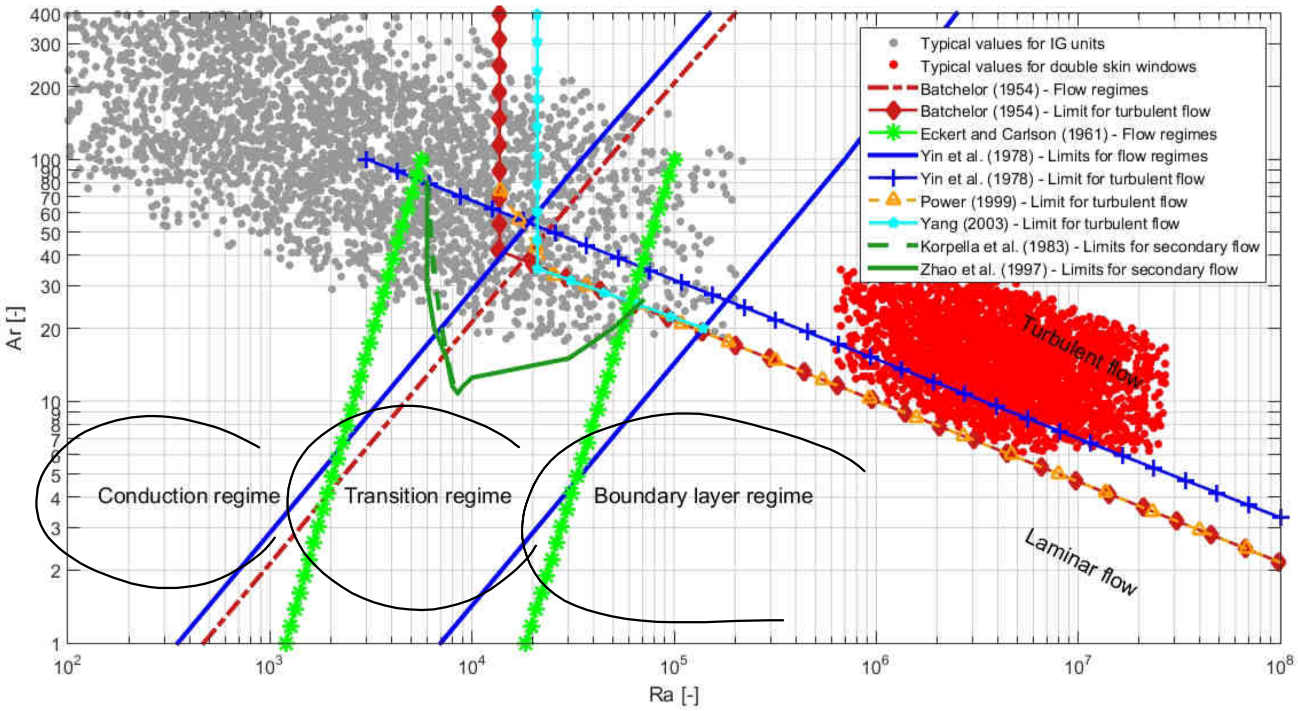
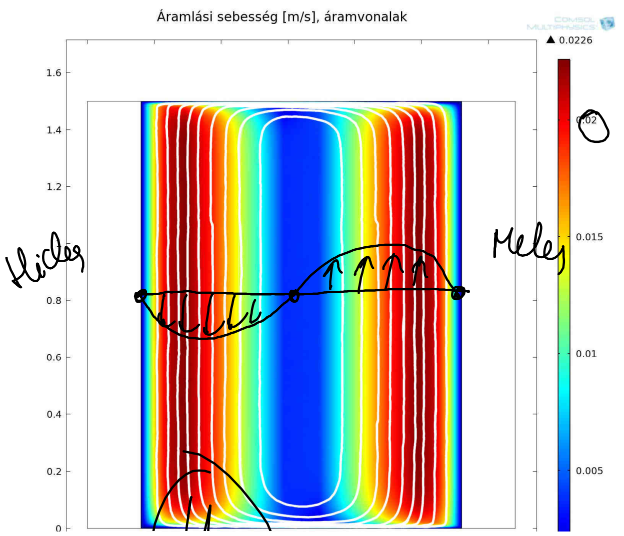
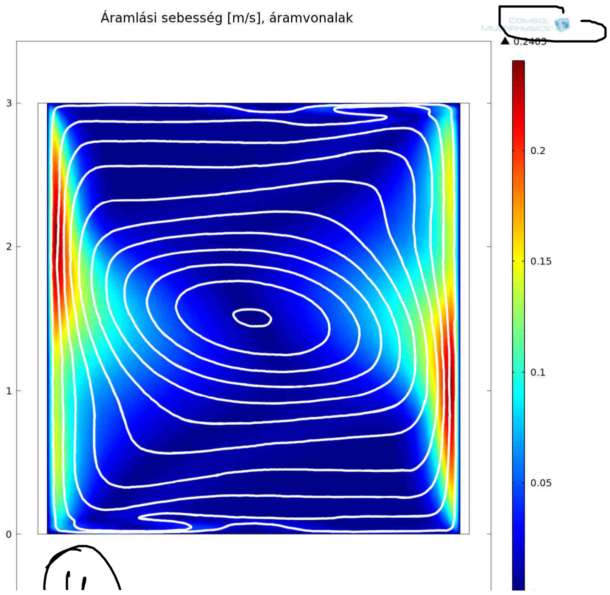
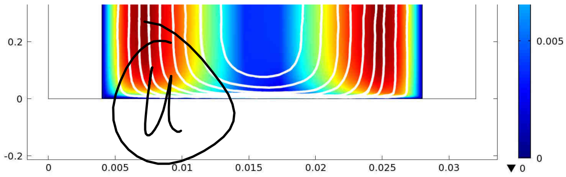
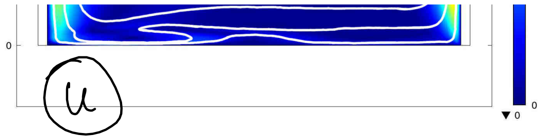


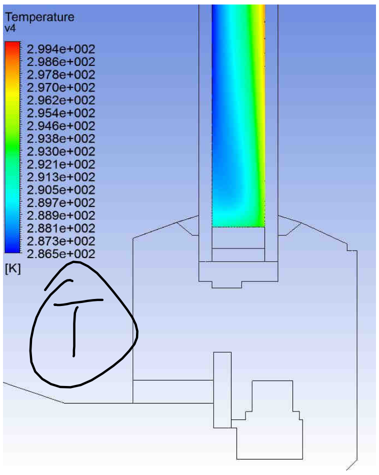


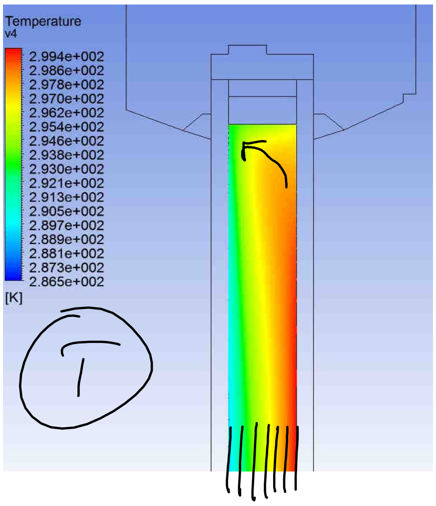





0.2
0
-0.2
0
0.005
0.01
0.015
0.02
0.025
0.03
0.005
0
u


0
0
u


Temperature
v4
2.994e+002
2.986e+002
2.978e+002
2.970e+002
2.962e+002
2.954e+002
2.946e+002
2.938e+002
2.930e+002
2.921e+002
2.913e+002
2.905e+002
2.897e+002
2.889e+002
2.881e+002
2.873e+002
2.865e+002
[K]
T


Temperature
v4
2.994e+002
2.986e+002
2.978e+002
2.970e+002
2.962e+002
2.954e+002
2.946e+002
2.938e+002
2.930e+002
2.921e+002
2.913e+002
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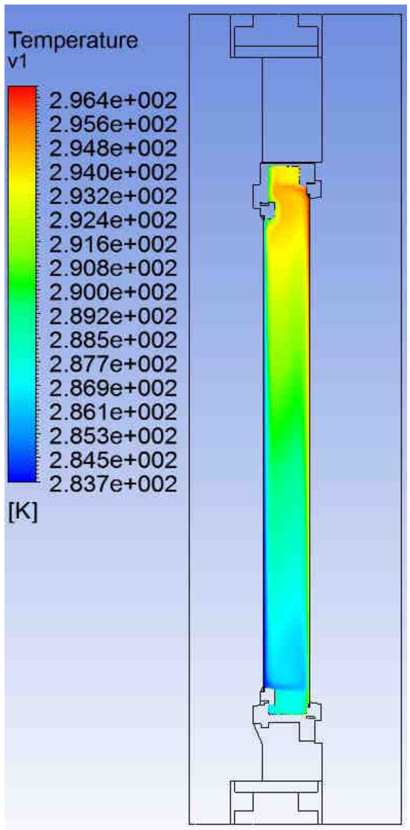
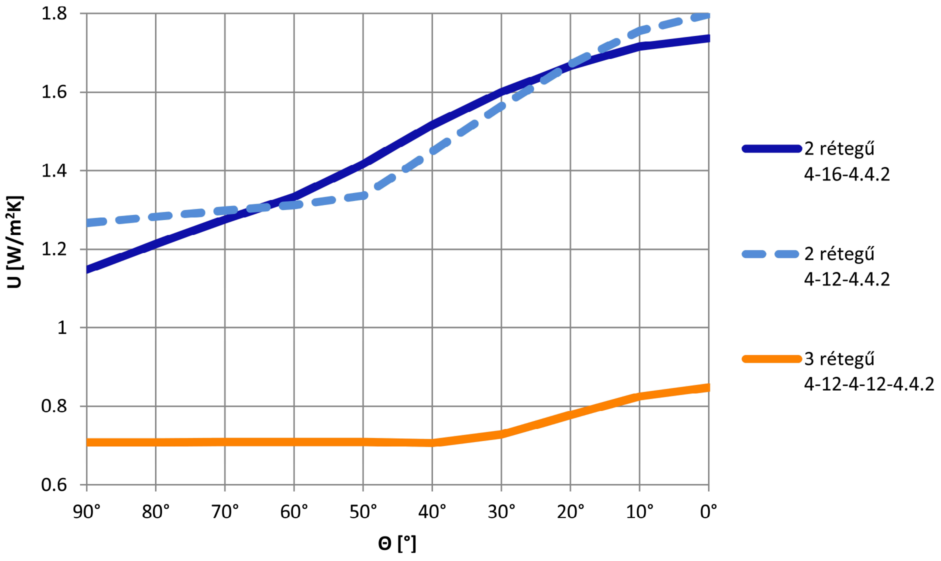
2.881e+002
2.873e+002
2.865e+002
[K]
T


Temperature
v1
2.964e+002
2.956e+002
2.948e+002
2.940e+002
2.932e+002
2.924e+002
2.916e+002
2.908e+002
2.900e+002
2.892e+002
2.885e+002
2.877e+002
2.869e+002
2.861e+002
2.853e+002
2.845e+002
2.837e+002
[K]


1.8
1.6
1.4
1.2
1
0.8
0.6
U [W/m²K]
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
Θ [°]
2 rétegű 4-16-4.4.2
2 rétegű 4-12-4.4.2
3 rétegű 4-12-4-12-4.4.2

Mérlegegyenletek

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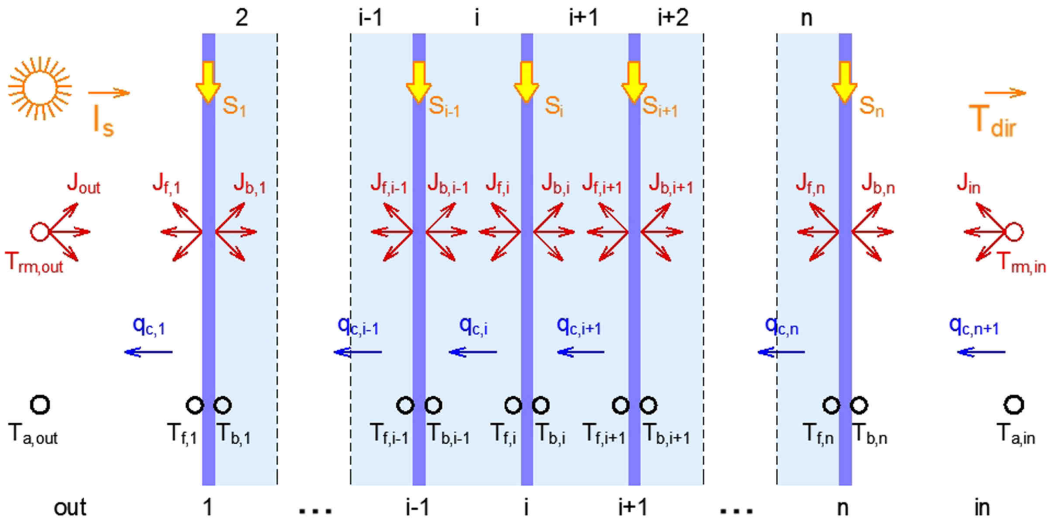
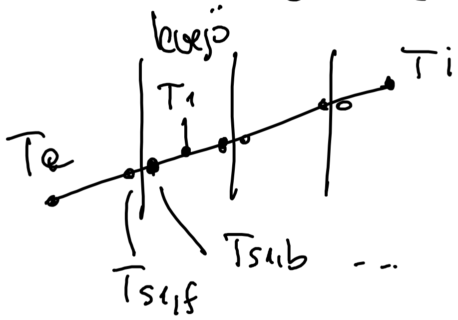


Mit csinál a program?

1. szolár-optikai számítás

→ $I_{s,dir}$, S_1, S_2, ... S_n

2. kezdeti becslés a T eloszlásra



3. anyagtulajdonságok frissítése

→ λ, ϱ, c_p, ...

4. konvektív hőátadási tényező számítása

→ $h_{c,1}$, $h_{c,2}$, ... $h_{c,n}$

→ $h_{c,1}, h_{c,2}, \ldots h_{c,n}$

5. egyenletrendszer felírás

6. egyenlet megoldása → $T_{s1,f}, T_{s2,b}, \ldots$

7. konvergencia ellenőrzés

8. THE END: $T_s \ldots$

$$U_g = q_i / \Delta T = 1 / \left(R_{se} + \sum R_{gl} + \sum R_{cav} + R_{si} \right)$$

$$R_{se} = \frac{1}{h_e} = \frac{1}{h_c + h_r}, \quad R_{gl} = \frac{t_{gl}}{\lambda_{gl}}, \quad R_{cav} = \frac{1}{h_c + h_r}, \quad R_{si} = \frac{1}{h_c + h_r}$$

direkt átbocsátás
w/m²

$$g = \frac{I_{tr,dir} + \overbrace{\left(q_i(I_{sol}) - q_i(I_{sol} = \emptyset)\right)}^{w/m^2}}{I_{sol} \leftarrow w/m^2} = [-]$$