Enačbe za continuous solid phase model

1 Polnjenje

Za solid izhajamo iz enačbe:

$$(1-\varepsilon)(\rho c_p)^s \frac{\partial T^s}{\partial t} = \frac{\partial}{\partial z}\left(k_s \frac{\partial T^s}{\partial z}\right) + hA(T_f - T_s)$$

1.1 1. Robni pogoj - solid

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{s0} - T_{s0}^{k-1}}{\Delta t} = -k_s \frac{T_{s0} - T_{s1}}{\Delta z^2} + hA(T_{f0} - T_{s0})$$

$$((1-\varepsilon)(\rho c_p)^s \Delta z^2 + k_s \Delta t + hA\Delta z^2 \Delta t)T_{s0} - k_s \Delta t T_{s1} - hA\Delta z^2 \Delta t T_{f0} = (1-\varepsilon)(\rho c_p)^s \Delta z^2 T_{s0}^{k-1}$$

1.2 Vmesne enačbe

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{si} - T_{si}^{k-1}}{\Delta t} = k_s \frac{T_{si-1} - 2T_{si} + T_{si+1}}{\Delta z^2} + hA(T_{fi} - T_{si})$$

$$-k_s \Delta t T_{si-1} + ((1-\varepsilon)(\rho c_p)^s \Delta z^2 + 2k\Delta t + hA\Delta z^2 \Delta t)T_{si} - k_s \Delta t T_{si+1} - hA\Delta z^2 \Delta t T_{fi} = (1-\varepsilon)(\rho c_p)^s \Delta z^2 T_{si}^{k-1}$$

1.3 2. Robni pogoj

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{s-1} - T_{s-1}^{k-1}}{\Delta t} = k_s \frac{T_{s-2} - T_{s-1}}{\Delta z^2} + hA(T_{f-1} - T_{s-1})$$

$$-k_s \Delta t T_{s-2} + ((1-\varepsilon)(\rho c_p)^s \Delta z^2 + k_s \Delta t + hA\Delta z^2 \Delta t)T_{s-1} - hA\Delta z^2 \Delta t T_{f-1} = (1-\varepsilon)(\rho c_p)^s \Delta z^2 T_{s-1}^{k-1}$$

Za fluid izhajamo iz enačbe:

$$\varepsilon(\rho c_p)^f \left(\frac{\partial T^f}{\partial t} + u \frac{\partial T^f}{\partial z} \right) = \frac{\partial}{\partial z} \left(k_f \frac{\partial T^s}{\partial z} \right) + hA(T_s - T_f)$$

1.4 1. Robni pogoj - fluid

$$\varepsilon(\rho c_p)^f \left(\frac{T_{f0} - T_{f0}^{k-1}}{\Delta t} - u \frac{T_{fluid} - T_{f1}}{2\Delta z} \right) = k_f \frac{T_{fluid} - 2T_{f0} + T_{f1}}{\Delta z^2} + hA(T_{s0} - T_{f0})$$

$$-2hA\Delta z^2 \Delta t T_{s0} + (2\varepsilon(\rho c_p)^f \Delta z^2 + 4k_f \Delta t + 2hA\Delta z^2 \Delta t) T_{f0} + (\varepsilon(\rho c_p)^f u \Delta z \Delta t - 2k_f \Delta t) T_{f1} = (\varepsilon(\rho c_p)^f u \Delta z \Delta t + 2k_f \Delta t) T_{fluid} + 2\varepsilon(\rho c_p)^f \Delta z^2 T_{f0}^{k-1}$$

1.5 Vmesne enačbe

$$\varepsilon(\rho c_p)^f \left(\frac{T_{fi} - T_{fi}^{k-1}}{\Delta t} - u \frac{T_{fi-1} - T_{fi+1}}{2\Delta z} \right) = k_f \frac{T_{fi-1} - 2T_{fi} + T_{fi+1}}{\Delta z^2} + hA(T_{si} - T_{fi})$$

$$-2hA\Delta z^2 \Delta t T_{si} + (-\varepsilon(\rho c_p)^f u \Delta z \Delta t - 2k_f \Delta t) T_{fi-1} + (2\varepsilon(\rho c_p)^f \Delta z^2 + 4k_f \Delta t + 2hA\Delta z^2 \Delta t) T_{fi} + (\varepsilon(\rho c_p)^f u \Delta z \Delta t - 2k_f \Delta t) T_{fi+1} = 2\varepsilon(\rho c_p)^f \Delta z^2 T_{fi}^{k-1}$$

1.6 2. Robni pogoj

$$\varepsilon(\rho c_p)^f \left(\frac{T_{f-1} - T_{f-1}^{k-1}}{\Delta t} - u \frac{T_{f-2} - T_{f-1}}{\Delta z} \right) = k_f \frac{T_{f-2} - T_{f-1}}{\Delta z^2} + hA(T_{s-1} - T_{f-1})$$

$$-hA\Delta z^2 \Delta t T_{s-1} + (-\varepsilon(\rho c_p)^f u \Delta z \Delta t - k_f \Delta t) T_{f-2} + (\varepsilon(\rho c_p)^f \Delta z^2 + \varepsilon(\rho c_p)^f u \Delta z \Delta t + k_f \Delta t + hA\Delta z^2 \Delta t) T_{f-1} = \varepsilon(\rho c_p)^f \Delta z^2 T_{f-1}^{k-1}$$

2 Praznjenje

Za solid izhajamo iz enačbe:

$$(1-\varepsilon)(\rho c_p)^s \frac{\partial T^s}{\partial t} = \frac{\partial}{\partial z}\left(k_s \frac{\partial T^s}{\partial z}\right) - hA(T_f - T_s)$$

2.1 1. Robni pogoj - solid

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{s0} - T_{s0}^{k-1}}{\Delta t} = -k_s \frac{T_{s0} - T_{s1}}{\Delta z^2} - hA(T_{f0} - T_{s0})$$

2.2 Vmesne enačbe

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{si} - T_{si}^{k-1}}{\Delta t} = k_s \frac{T_{si-1} - 2T_{si} + T_{si+1}}{\Delta z^2} - hA(T_{fi} - T_{si})$$

2.3 2. Robni pogoj

$$(1-\varepsilon)(\rho c_p)^s \frac{T_{s-1} - T_{s-1}^{k-1}}{\Delta t} = k_s \frac{T_{s-2} - T_{s-1}}{\Delta z^2} - hA(T_{f-1} - T_{s-1})$$

Za fluid izhajamo iz enačbe:

$$\varepsilon(\rho c_p)^f \left(\frac{\partial T^f}{\partial t} + u\frac{\partial T^f}{\partial z}\right) = \frac{\partial}{\partial z}\left(k_f \frac{\partial T^s}{\partial z}\right) - hA(T_s - T_f)$$

2.4 1. Robni pogoj - fluid

$$\varepsilon(\rho c_p)^f \left(\frac{T_{f0} - T_{f0}^{k-1}}{\Delta t} - u\frac{T_{fluid} - T_{f1}}{2\Delta z}\right) = k_f \frac{T_{fluid} - 2T_{f0} + T_{f1}}{\Delta z^2} - hA(T_{s0} - T_{f0})$$

2.5 Vmesne enačbe

$$\varepsilon(\rho c_p)^f \left(\frac{T_{fi} - T_{fi}^{k-1}}{\Delta t} - u\frac{T_{fi-1} - T_{fi+1}}{2\Delta z}\right) = k_f \frac{T_{fi-1} - 2T_{fi} + T_{fi+1}}{\Delta z^2} - hA(T_{si} - T_{fi})$$

2.6 2. Robni pogoj

$$\varepsilon(\rho c_p)^f \left(\frac{T_{f-1} - T_{f-1}^{k-1}}{\Delta t} - u \frac{T_{f-2} - T_{f-1}}{\Delta z} \right) = k_f \frac{T_{f-2} - T_{f-1}}{\Delta z^2} - hA(T_{s-1} - T_{f-1})$$