STD 1. domača naloga

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$T = 27°C$
$\rho = 800 \frac{kg}{m^3}$
$E = 10^7 \frac{V}{m}$
$\chi_T = 2$
$C = 30\,K$
$V = konst.$
$c_p = 1700 \frac{J}{kg\,K}$

$c_E - c_p = ?$

$\chi_T - \chi_s = ?$

$$\frac{\chi}{\chi+3} = a\left(1+\frac{C}{T}\right) \qquad P = \chi \varepsilon_0 E$$

$$\chi = \frac{3a(1+\frac{C}{T})}{1-a(1+\frac{C}{T})} \qquad a = \frac{\chi_T}{(\chi_T+3)\ (1+\frac{C}{T})} = \frac{4}{11}$$

$$S = S(T, E) \Longrightarrow dS = \left(\frac{\partial S}{\partial T}\right)_E dT + \underbrace{\left(\frac{\partial S}{\partial E}\right)_T}_{-\left(\frac{\partial (PV)}{\partial T}\right)_E} \underbrace{dE}_{\cancel{\left(\frac{\partial E}{\partial (VP)}\right)_T d(VP)} + \left(\frac{\partial E}{\partial T}\right)_{VP} dT}$$

$$S = S(T, VP) \Longrightarrow dS = \left(\frac{\partial S}{\partial T}\right)_{VP} dT + \cancel{\left(\frac{\partial S}{\partial (VP)}\right)_T d(VP)}$$

npr. $P = konst.$

$$\left(\frac{\partial S}{\partial T}\right)_P \cancel{dT} = \left(\frac{\partial S}{\partial T}\right)_E \cancel{dT} - \left(\frac{\partial (PV)}{\partial T}\right)_E \left(\frac{\partial E}{\partial T}\right)_P \cancel{dT}$$

$$c_E - c_p = \frac{TV}{m}\left(\frac{\partial P}{\partial T}\right)_E \left(\frac{\partial E}{\partial T}\right)_P$$

$$\left(\frac{\partial P}{\partial T}\right)_E = -\varepsilon_0 E \frac{-3a\frac{C}{T^2}(1-a(1+\frac{C}{T})) - (3a+3a\frac{C}{T})(a\frac{C}{T^2})}{(1-a(1+\frac{C}{T}))^2} = -\frac{3\varepsilon_0 E a C}{T^2(1-a(1+\frac{C}{T}))^2}$$

$$\left(\frac{\partial E}{\partial T}\right)_P = -\frac{P}{\varepsilon_0}\frac{(3a+3a\frac{C}{T})(a\frac{C}{T^2}) + (3a\frac{C}{T^2})(1-a-a\frac{C}{T})}{(3a+3a\frac{C}{T})^2} = \frac{PC}{3T^2 a(1+\frac{C}{T})^2 \varepsilon_0}$$

$$c_E - c_p = -\frac{T}{\rho}\,\frac{3\varepsilon_0 E a C}{T^2(1-a(1+\frac{C}{T}))^2}\,\frac{PC}{3\varepsilon_0 T^2 a(1+\frac{C}{T})^2} = \frac{\varepsilon_0 \chi_T E^2 C^2}{\rho T^3 (1+\frac{C}{T})^2(1-a(1+\frac{C}{T}))^2} = \underline{\underline{0{,}000169 \frac{J}{kg\,K}}}$$

$$dP = \left(\frac{\partial P}{\partial T}\right)_E dT + \left(\frac{\partial P}{\partial E}\right)_T dE$$

$$\varepsilon_0 \chi_s = \left(\frac{\partial P}{\partial E}\right)_S$$

$$S(T, E) \Longrightarrow dS = \left(\frac{\partial S}{\partial T}\right)_E dT + \left(\frac{\partial S}{\partial E}\right)_T dE = 0$$

$$-\frac{m c_E}{T} dT = V\left(\frac{\partial P}{\partial T}\right)_E dE$$

$$S(T, P) \Longrightarrow dS = \left(\frac{\partial S}{\partial T}\right)_P dT + \left(\frac{\partial S}{\partial P}\right)_T dP = 0$$

$$-\frac{m c_p}{T} = -V\left(\frac{\partial E}{\partial T}\right)_P dP$$

$$\frac{c_E}{c_p} = -\frac{\left(\frac{\partial P}{\partial T}\right)_E}{\left(\frac{\partial E}{\partial T}\right)_P}\underbrace{\left(\frac{\partial E}{\partial P}\right)_S}_{\varepsilon_0 \chi_s} = \frac{3\cancel{T^2}a(1+\frac{C}{T})^2\cancel{\varepsilon_0}\cdot 3\cancel{\varepsilon_0}\cancel{E}aC}{C\cancel{P}\cancel{T^2}(1-a(1+\frac{C}{T}))^2\cancel{E}\chi\cancel{\varepsilon_0}}\,\frac{1}{\cancel{\varepsilon_0}}\chi_s$$

$$\chi_s = \frac{c_E}{c_p}\,\frac{9a^2(1+\frac{C}{T})^2}{\chi_T(1-a(1+\frac{C}{T}))^2} \Longrightarrow \chi_T - \chi_s = \underline{\underline{-1{,}99 \cdot 10^{-7}}}$$