THE DYNAMICS OF THE SUPERCRITICAL EXTRACTION.

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A problem of the extraction dynamics is ? searching for the partition function of a component concentration along the extractor. For this purpose let's take following assumptions:

1. a density of the liquid phase is constant at working parameters;
2. a concentration of the extracted component in a solvent is small, so that a solvent density may be considered as constant;
3. a solvent moves in one direction with a constant velocity.

The material and thermal balance equation , equation of extraction kinetics from the separate granules and heat transfer equation are used to describe the extraction dynamics.

Since a mass of supercritical fluid is significantly larger than a mass of the extracted component the thermal effect of solution and swelling can be neglected. The extraction dynamics can be described by the material balance equation only:

$$\frac{\partial C_1}{\partial t} - d\frac{\partial a}{\partial t} + divq = 0$$

(1)

$$q = UC_1 - D\frac{\partial C_1}{\partial x}$$

where $d = 1 - e$; $a = \frac{(1 - m/m_0)}{r_{01}}$ is equation of extraction kinetics; C_1 is a component concentration in intergranular space; τ is a time; e denotes a porosity, mass of extracted component; U- a liniar velocity; D- a diffusion coefficient in intergranular space.

Introducing new variables one obtains

$$\frac{\partial \tilde{C}_1}{\partial \tilde{t}} - d\frac{\partial \tilde{a}}{\partial \tilde{t}} + div\tilde{q} = 0$$

(2)

$$\tilde{q} = \tilde{U}\tilde{C}_1 - \tilde{D}\frac{\partial \tilde{C}_1}{\partial \tilde{X}}$$

where $\tilde{C}_1 = C_1/r_{01}$ $\tilde{X} = x/L$ $\tilde{U} = Ut_0/L$ $\tilde{D} = Dt_0/L^2$ $\tilde{t} = t/t_0$ $\tilde{a} = 1 - m/m_0$, L denotes an extracting length, X -current coordinate. Original conditions are

$$\tilde{C}_1(\tilde{X},\tilde{t})\big|_{\tilde{t}=0} = 0 \quad \tilde{a}(\tilde{X},\tilde{t})\big|_{\tilde{t}=0} = 0 \quad \tilde{q}(\tilde{X},\tilde{t})\big|_{\tilde{t}=0} = 0 \qquad (3)$$

Boundary conditions for the extraction problem reads as

$$\tilde{C}_1(\tilde{X},\tilde{t})\big|_{\tilde{X}=0} = 0, \; \tilde{a}(\tilde{X},\tilde{t})\big|_{\tilde{X}=0} = 0,$$

$$\tilde{C}_1(\tilde{X},\tilde{t})\big|_{\tilde{X}=1}=0,\ \tilde{a}(\tilde{X},\tilde{t})\big|_{\tilde{X}=1}=0 \qquad (4)$$

$$\tilde{C}_1(\tilde{X},\tilde{t})=\tilde{C}_1(\tilde{X},\tilde{t})\big|_{\tilde{X}=1}-\frac{\tilde{D}\partial\tilde{C}_1}{\tilde{U}\partial\tilde{X}}\Big|_{\tilde{X}=1}$$

Zero conditions at the bound $\tilde{X}=1$ is explained by that in a separator, following an extractor, occurs the isolation of extracted component.

For the extractor of 1,5 m length and 0,35 m diameter are used the substance granules of ≈10^{-3}m radius at D=10^{-9}-$10^{-10}$$m^2$/s, D^*=10^{-11}-10^{-13} m^2/s. Therefore $\tilde{D}=\frac{R^2D}{6L^2D^*}$ will change in limits 10^{-5}-10^{-8} m^2/s

So that Eq. (2) can be simplified to

$$\frac{\partial}{\partial\tilde{t}}(\tilde{C}_1-d\tilde{a})+\tilde{U}\frac{\partial\tilde{C}_1}{\partial\tilde{X}}=0 \qquad (5)$$

The solution of boundary – value problem is searched at $\tilde{U}$ =1, 10, 50, 100.

A change of concentration of extracted component in the intergranular space $\tilde{C}_1(\tilde{X},\tilde{t})$ at $\tilde{U}=10$ is shown in Fig. 1. At $\tilde{t}=0{,}551$ the extraction practically comes to an end.

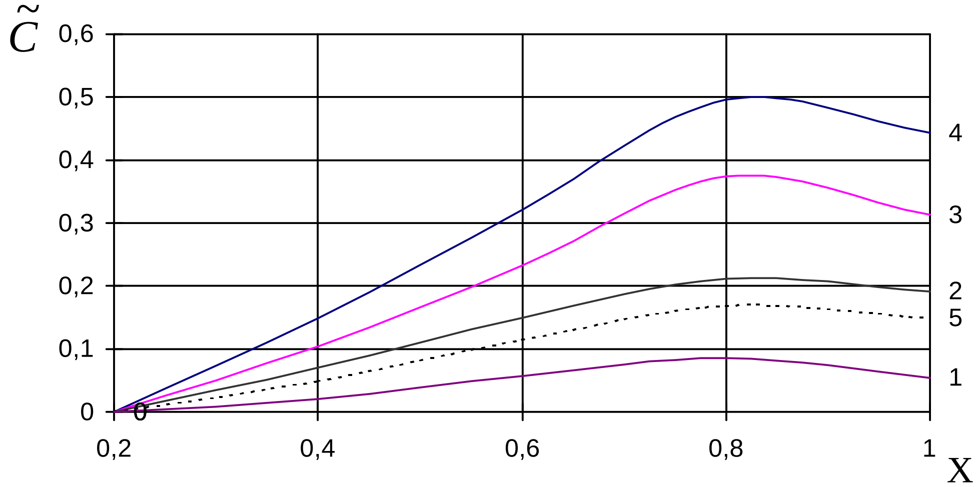

Figure 1. A change of concentration of extracted component along the extractor at $\tilde{t}$ = 0.05(1), 0.13 (2), 0.34 (3), 0.47 (4), 0.55 (5)