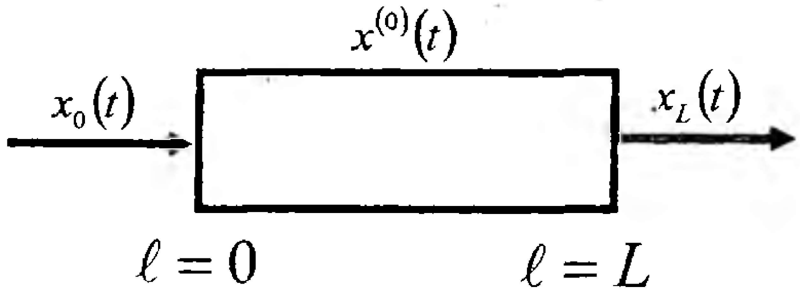
$T_T(0)*$
$f_{1'} = T_T(L)\{T_T(0)\} - T_T^{(0)} = 0$

5.1.5.2. Nostatsionar rejimdagi quvurli reaktorlar



$A \xrightarrow{k} P$

Asosiy qo‘yimlar:
Izotermik rejim;
Bir parametrli diffuziyali model.

Matematik tavsifning tenglamasi:

$$\frac{V^R}{L}\frac{\partial x}{\partial t} = \frac{DV^R}{L}\frac{\partial^2 x}{\partial \ell^2} - v\frac{\partial x}{\partial \ell} + G^R_{A(\ell)}$$

$$x = [A]; \; S = \frac{V^R}{L}; \; G^R_{A(\ell)} = \frac{V^R}{L} g_A = -kx, \; V = S \cdot W$$

$$1) \quad \frac{\partial x}{\partial t} = D\frac{\partial^2 x}{\partial \ell^2} - W\frac{\partial x}{\partial \ell} - kx$$

1) tenglama ikki mustaqil o‘zgaruvchi t va ℓ ga ega parabolik tipdagi ikkinchi tartibli xususiy hosilali differensial tenglama hisoblanadi va agar oqim uchun bir parametrli diffuziyali model qabul qilingan bo‘lsa, yagona oddiy reaksiya oqib o‘tuvchi reaktorning nostatsionar rejimini tavsiflaydi.

Topish lozim:
$x = x(t, \ell)$
$t^{(0)} \le t \le t^{(k)}$
$0 \le \ell \le L$
Boshlang‘ich shart:
1') $x(t^{(0)}, \ell) = x^{(0)}(\ell), \quad 0 \le \ell \le L$
Chegaraviy shart:

$$1'')\ \begin{cases} x(t,0)=x_0(t) \\ x(t,L)=x_L(t) \end{cases} \quad t^{(0)} \le t \le t^{(k)}$$

Xususiy hosilalarda differensial tenglamalar tizimi (XHDTT) ni yechish uchun hosilasi ma'lum $\left[t^{(0)},t^{(k)}\right]$ va/yoki $[0,\ L]$ intervaldagi chekli – farqli shaklda namoyon bo'luvchi diskretlashtirish usulidan foydalanish mumkin, natijada 1') va 1'') chegara shartli 1) tenglama chekli tenglamalar tizimi (CHTT) dagi va/yoki oddiy differensial tenglamalar tizimi (ODTT) ga aylanib qoladi.

Bu tenglamalar uchun diskretlashtirishning uchta variantdan foydalanish mumkin:

1) ℓ mustaqil o'zgaruvchi bo'yicha:

$$\frac{\partial x}{\partial \ell} \cong \frac{x_{i+1}-x_i}{\Delta \ell}$$

$$i=1,..n-1$$

Natijada t mustaqil o'zgaruvchili 1 – tartibli oddiy differensial tenglamalar tizimi olinadi.

2) Mustaqil t o'zgaruvchi bo'yicha:

$$\frac{\partial x}{\partial t} \cong \frac{x_{j+1}-x_j}{\Delta \ell}$$

$$j=1,...m-1$$

Natijada ℓ mustaqil o'zgaruvchili 2 – tartibli oddiy differensial tenglamalar tizimi olinadi.

3) ℓ va t mustaqil o'zgaruvchilar bo'yicha:

$$\frac{\partial x}{\partial \ell} \cong \frac{x_{i+1}-x_i}{\Delta \ell}$$

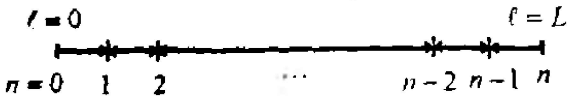
$$i=1,..n-1$$

$$\frac{\partial x}{\partial t} \cong \frac{x_{j+1}-x_j}{\Delta \ell}$$

$$j=1,...m-1$$

Natijada chekli tenglamalar tizimi olinadi.

Mustaqil o'zgaruvchi bo'yicha diskretlashtirishning 1 - variantini batafsil ko'rib chiqamiz:



$0 \le \ell \le L$ da hosilalarning chekli - ayirmali keltirilishi quyidagi ko'rinishga ega:

– «Kamchiliklar bo‘yicha» hosila:

$$\left.\frac{\partial x_i}{\partial t}\right|_{\ell-\Delta\ell} \cong \frac{x_i - x_{i-1}}{\Delta\ell}$$

– «Ortiqchalik bo‘yicha» hosila:

$$\left.\frac{\partial x_i}{\partial t}\right|_{\ell+\Delta\ell} \cong \frac{x_{i+1} - x_i}{\Delta\ell}$$

– Ikkinchi hosila:

$$\frac{\partial^2 x_i}{\partial\ell^2} \cong \frac{\left.\frac{\partial x_i}{\partial\ell}\right|_{\ell+\Delta\ell} - \left.\frac{\partial x_i}{\partial\ell}\right|_{\ell-\Delta\ell}}{\Delta\ell} = \frac{x_{i+1} - 2x_i + x_{i-1}}{\Delta\ell}$$

Ushbu holda 1’’) chegaraviy shart quyidagiga teng:

$$x(t,0) = x_0(t) = x_0$$

$$x(t,L) = x_L(t) = x_n$$

Natijada xususiy hosilalarda tenglamalardan birini diskretlashtirish oqibatida t mustaqil o‘zgaruvchili va 1’) boshlang‘ich shartli, quyidagi diskret ko‘rinishga keltirilgan oddiy differensial tenglamalarning (n–1) tizimi olinadi:

$$x_i\left(t^{(0)}\right) = x_i^{(0)}$$

$$i = 1,...n-1$$

Agar chekli - ayirmali keltirishlarda «ortiqchalik bo‘yicha hosila» hosilasidan foydalanilsa, unda boshlang‘ich shartli oddiy differensial tenglamalar tizimi quyidagi ko‘rinishga ega bo‘ladi:

$$\bar{1}) \quad \frac{\partial x_i}{\partial t} = D\frac{x_{i+1} - 2x_i + x_{i-1}}{(\Delta\ell)^2} - W\frac{x_{i+1} - x_i}{\Delta\ell} - kx_i$$

$$i = 1,..n-1$$

$$\bar{1}') \quad x_i\left(t^{(0)}\right) = x_i^{(0)}$$

$$i = 1,...n-1$$

$\bar{1})$ tenglamani o‘zgartirib va uning parametrlari (D, W va k) ni o‘zgarmas hisoblanishini ko‘rsatib, quyidagi oddiy differensial tenglamalar tizimini olish mumkin:

$$\frac{dx_i}{dt} = \frac{D}{(\Delta\ell)^2}x_{i-1} + \left[\frac{W}{\Delta\ell} - k - \frac{2D}{(\Delta\ell)^2}\right]x_i + \left[\frac{D}{(\Delta\ell)^2} - \frac{W}{\Delta\ell}\right]x_{i+1}$$

$$i = 1,..n-1$$

yoki

$$\begin{bmatrix} \dfrac{dx_1}{dt} \\ \dfrac{dx_2}{dt} \\ \vdots \\ \dfrac{dx_{n-2}}{dt} \\ \dfrac{dx_{n-1}}{dt} \end{bmatrix} = \begin{bmatrix} b & c & 0 & \cdots & 0 & 0 & 0 \\ a & b & c & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \ddots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & a & b & c \\ 0 & 0 & 0 & \cdots & 0 & a & b \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{n-2} \\ x_{n-1} \end{bmatrix} + \begin{bmatrix} ax_0 \\ 0 \\ \vdots \\ \\ cx_n \end{bmatrix},$$

bu yerda,

$$a = \frac{D}{(\Delta\ell)^2};\ b = \frac{W}{\Delta\ell} - k - \frac{2D}{(\Delta\ell)^2};\ c = \frac{D}{(\Delta\ell)^2} - \frac{W}{\Delta\ell}$$

Ifodalanganligidan kelib chiqib $\overline{\mathrm{I}})$ tenglama $\overline{\mathrm{I}}')$ chegaraviy shartni o‘z ichiga oladi va matritsa ko‘rinishida quyidagicha ko‘rsatilishi mumkin:

$$\overline{\mathrm{I}})\quad \frac{d\overline{x}}{dt} = \overline{\overline{A}}\,\overline{x} + \overline{S}$$

$$\overline{\mathrm{I}}')\quad \overline{x}\left(t^{(0)}\right) = \overline{x}^{(0)},$$

bu yerda, $\overline{S}$ – chegaraviy shartli vektor, $\overline{\mathrm{I}}')$ boshlang‘ich shart esa quyidagi boshlang‘ich shart bilan diskret holga keltirilgan hisoblanadi:

$$\overline{\mathrm{I}}')\ -\ x^{(0)}(\ell)\ -\ 0 \le \ell \le L$$

Olingan bir jinsli bo‘lmagan oddiy differensial tenglamalar tizimi ixtiyoriy ma’lum usullar (masalan, Eyler usuli yoki Runge–Kutt usuli) bilan oson yechilishi mumkin, chunki uning $\overline{\overline{A}}$ koeffitsiyentlari matritsasi uch diagonallidir.

O‘z - o‘zini tekshirish uchun topshiriq

To‘g‘ri oqim rejimida (issiqlik tashuvchining asosiy oqimi va oqimi ideal o‘rin almashish modeli bilan ifodalanuvchi) harakatlanuvchi statsionar rejimdagi issiqlik tashuvchilarning murakkab ko‘p bosqichli kinetik reaksiyalari sxemalariga ega gomogen uzluksiz suyuq fazali izotermik quvurli reaktorlar uchun to‘g‘ridan-to‘g‘ri masalalarni yechishning matematik tavsifi va algoritmining blok - sxemasini tuzish.

Teskari oqim rejimida (issiqlik tashuvchining asosiy oqimi va oqimi ideal o‘rin almashish modeli bilan ifodalanuvchi) harakatlanuvchi statsionar rejimdagi issiqlik tashuvchilarning murakkab ko‘p bosqichli kinetik reaksiyalari sxemalariga ega gomogen uzluksiz suyuq fazali izotermik quvurli reaktorlar uchun to‘g‘ridan-to‘g‘ri masalalarni yechishning matematik tavsifi va algoritmining blok - sxemasini tuzish.

Asosiy oqimning harakati bir parametrli diffuziyali model bilan ifodalanuvchi nostatsionar rejimdagi oddiy kinetik A→V reaksiyalar sxemasiga ega gomogen uzluksiz suyuq fazali izotermik quvurli reaktorlar uchun to‘g‘ridan-to‘g‘ri masalalarni yechishning matematik tavsifi va algoritmining blok - sxemasini tuzish.

5.1.6. Tarelkali kolonnalardagi ko‘p komponentli uzluksiz rektifikatsiya jarayonini kompyuterli modellashtirish, hisoblash va algoritmlashtirish

Rektifikatsiya – o‘zaro to‘la yoki qisman erigan suyuqlik aralashmalarini teskari oqim bo‘yicha harakatlanuvchi suyuqlik bug‘lari o‘rtasida issiqlik massasining almashish yo‘li bilan ajratish jarayoni bo‘lib, natijada yengil uchuvchi komponentlar yuqoriga (deflegmatorga) ko‘tariladi, og‘ir uchuvchi komponentlar esa pastga (kollonna kubiga) tushadi.

Rektifikatsiya qurilmasi kub, N tarelkadan iborat kolonna va deflegmatordan tashkil topadi.

Rektifikatsiya kolonnasining matematik modeli balans munosabatlari, bug‘ - suyuqlik muvozanati, massa uzatish kinetikasi va oqimlarning gidrodinamikasini hisobga olishi kerak.

Modellarning asosini kolonnaning material va issiqlik balanslari tashkil etadi. Bug‘ - suyuqlik muvozanati, massa uzatish kinematikasi va oqimlar gidrodinamikasi o‘zida mustaqil murakkab masalalarni namoyon qiladi. Fazaviy muvozanat, kinetika va gidrodinamikani hisoblashning turli usullaridan foydalanish balans munosabatlaridagi alohida koeffitsiyentlar yoki bog‘liqliklarni