XXI ASRDA INNOVATSION TEXNOLOGIYALAR, FAN VA TA'LIM TARAQQIYOTIDAGI DOLZARB MUAMMOLAR
Volume 03, Issue 06, 2025

O‘ZGARUVCHAN KO‘RSATKICHLI KUCHLI NOLINEAR DIFFUZIYA-REAKTSIYA TENGLAMALARINING AVTOMODEL VA SONLI YECHIMLARI

J. M. Toshtemirov[1] , S. Toxirov[2]
Qarshi state university, Qarshi, Uzbekistan[1]
University of science and technologies, Tashkent, Uzbekistan[1,2]
jaloliddintoshtemirov0@gmail.com[1]

Annotatsiya: Maqolada kuchli nolinear diffuziya va reaktsiya jarayonlarini ifodalovchi quyidagi tenglama:

$$\frac{\partial u}{\partial t}=\left(u^{m-1}\left|\nabla u^{k}\right|^{p-2}\nabla u\right)+u^{a}-u^{b}$$

uchun nazariy tahlil, avtomodel (o‘z-o‘ziga o‘xshash) yechimlar va sonli hisoblash algoritmlari ishlab chiqiladi. Sonli yechimlar grafiklar orqali tasdiqlanadi. Olingan natijalar ushbu turdagi tenglamalarning fizik, biologik va kimyoviy modellashtirishdagi qo‘llanilishi uchun asos yaratadi.

Nolinear parabolik tenglamalar ko‘plab fizik, biologik va kimyoviy jarayonlarning matematik modelini ifodalaydi. Masalan, kimyoviy moddaning tarqalishi va reaktsiyasi, biologik populyatsiyalar evolyutsiyasi, issiqlik tarqalishi kabi. Ushbu maqolada o‘rganilayotgan tenglama quyidagicha:

$$\frac{\partial u}{\partial t}=\left(u^{m-1}\left|\nabla u^{k}\right|^{p-2}\nabla u\right)+u^{a}-u^{b}$$

Tenglama kuchli nolinear diffuziya va nolinear reaktsiya komponentlarini o‘z ichiga oladi, bu esa analitik yechim topishni murakkablashtiradi. Shu sababdan avtomodel yondashuvi va sonli metodlar qo‘llaniladi.

$$\frac{\partial u}{\partial t}=\left(u^{m-1}\left|\nabla u^{k}\right|^{p-2}\nabla u\right)+u^{a}-u^{b},\quad x\in\Omega,\quad t>0, \tag{1}$$

$$u(t,x)=0,\quad x\in\partial\Omega,\quad t>0, \tag{2}$$

$$u(0,x)=u_{0}(x),\quad x\in\Omega, \tag{3}$$

bu yerda n, $m,k>1$, $p>2$, $a>1$, $b\geq 1$, $a\neq b$ va $\Omega\subset R^{N}$ esa silliq chegara $\partial\Omega$ bilan chegaralangan sohadir.

Mazkur tezisda nochiziqli manba va yutilishga ega nochiziqli diffuziya jarayonlarini matematik modellashtirish, tahlil qilish va sonli yechish bilan bog‘liq

asosiy vazifalar ko‘rib chiqilgan. Ushbu vazifalar, nazariy tahlil, sonli usullar va dasturiy ta’minotni ishlab chiqish orqali hal qilingan:

Taqqoslash printsipi, nochiziqli ajratish usuli va avtomodel tahlil kabi metodlar yordamida tenglama va tenglamalar sistemasi uchun yechimning global mavjudlik va chegaralanmaganlik shartlari olingan. Ushbu natijalardan o‘zgarmas va o‘zgaruvchan zichlikli diffuziya modellari sifat xossalarini aniqlashda foydalanilgan.

Foydalanilgan adabiyotlar

1. A. A. Samarskii, V. A. Galaktionov, S. P. Kurdyumov, A. P. Mikhailov, Blow-Up in Quasilinear Parabolic Equations, Walter de Gruyter, 1995.
2. J. M. Toshtemirov, "Effects of a multicomponent heat source on ambient density in multidimensional fields," ILM SARCHASHMALARI, 33-350, 2-son (fevral 2025).
3. J. M. Toshtemirov, " A mathematical model for convective and nonlinear heat transfer in multi-variable, multi-component media" ILM SARCHASHMALARI, 48-250, 5/2-son (may 2025).
4. Adrien Drouillet et al., "Multidimensional simulation of phase change by a D-2D model coupling via Stefan condition," Communications on Applied Mathematics and Computation, 2021.
5. M. M. Aripov, O. R. Djabbarov, Sh. Sadullaeva, "Mathematic modeling of processes describing by double nonlinear parabolic equation with convective transfer and damping," AIP Conference Proceedings, 2021.
6. A. T. Khaidarov, J. M. Toshtemirov, "Modeling of heat propagation processes in multidimensional domains," Modern Problems of Applied Mathematics and Information Technology, 2024.
7. A. T. Khaidarov, J. M. Toshtemirov, "Heat source density in non-linear heat dissipation processes," Proceedings of Scientific Conference on Multidisciplinary Studies, 2023.
8. A. Mamatov, J. Toshtemirov, "Visualization of the problem of multidimensional heat transfer through digital technologies," Pedagogical reforms and their solutions, 2024.
9. A. A. Samarskii, Teoriya raznostnyx sxem, Nauka, 1989.
10. U. U. Begulov, Kh. Abdugappor, J. M. Toshtemirov, "Cauchy problem for a parabolic equation describing the heat propagation process in a non-divergent form under the influence of an exponentially varying density," Matematik fizikaning zamonaviy usullari, 2025