6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

NUMERICAL MODELING OF HEAT TRANSFER IN BIOLOGICAL TISSUE DOMAIN USING THE FUZZY FINITE DIFFERENCE METHOD

Alicja Piasecka-Belkhahayt[1]* and Paweł Kowalski[2]

[1*] Silesian University of Technology, Konarskiego 18A, 44-100 Gliwice, Poland
alicja.piasecka@polsl.pl
[2] Embed Paweł Kowalski, Gdańska 48C/8, 41-819 Zabrze, Poland
pawel.kowalski@pl.sii.eu

Key Words: *Bio-heat Transfer, Fuzzy Finite Difference Method, Fuzzy Numbers, Directed Interval Arithmetic.*

In this paper, the numerical analysis of a heat transfer process proceeding in the biological tissue domain is presented. A one-dimensional problem is considered. Additionally, in the mathematical model, the thermophysical parameters such as volumetric specific heat and thermal conductivity are given as fuzzy numbers. The problem discussed has been solved using the fuzzy finite difference method with α-cuts.
The tissue parameters appearing in the mathematical model of the problem discussed can change in a wide range because they depend on numerous individual traits such as the age, sex, occupation etc. Here, this uncertainty has been included in the mathematical description by means of fuzzy thermophysical parameters for successive tissue sub-domains [1].
The base of the mathematical model is given by a fuzzy Pennes set of equations supplemented by the boundary-initial conditions. At the beginning in the paper, the fuzzy governing equations describing thermal processes proceeding in the heterogeneous skin tissue domain are presented. Next, the fuzzy version of the finite difference method algorithm using α-cuts and the rules of directed interval arithmetic is shown [2]. The application of α-cuts allows one to avoid complicated arithmetical operations in the fuzzy numbers set because α-cuts are closed intervals.
In the final part of the paper, examples of numerical computations are shown, in particular the solutions presenting the thermal processes proceeding in the skin tissue domain subjected to external heat source.

REFERENCES

[1] B. Mochnacki and A. Piasecka-Belkhayat, Numerical modeling of skin tissue heating using the interval finite difference method, *MCB: Molecular and Cellular Biomechanics*, 10, 3, pp. 233-244, 2013.
[2] A. Piasecka-Belkhayat and A. Korczak, Numerical modelling of the transient heat transport in a thin gold film using the fuzzy lattice Boltzmann method with α-cuts, *J. of Applied Mathematics and Computational Mechanics*, 15 (1), pp. 123-135, 2016.

[1] The research is funded from the projects Silesian University of Technology, Faculty of Mechanical Engineering BK-220/RMT-4/2017 (10/040/BK 17/0045).