Main requirements to modern materials are low cost and, at the same time, unique physical and chemical properties. Effective materials for energy storage and conversion are compounds which allow providing necessary electrochemical and thermophysical properties. Obtaining such characteristics usually carried out by choosing various composite components and certain technological processes of producing materials.

The aim of this work is the development of universal discrete models of composite materials, which can take into account its complex structure, and allows one to solve heat transfer problem and calculate effective thermal conductivity coefficient of those materials.

In the current work we propose a software tool for thermal analysis and design of various composite material structures, represented by a unit volume a form of cuboid. The software operates with three most popular composite structures:

- Stratified composite (laminate, sandwich)
- Particle-reinforced composite (droplets, inclusions)
- Fiber-reinforced composite (various length and orientation)

Calculations are based on a combination of analytical and numerical methods: 1D/2D non-stationary analytical solution for stratified composites, and 1D/2D/3D stationary numerical solution based on finite element method (FEM) for stratified, particle and fiber reinforced composites. Modelling mode allows materials engineer to analyse temperature distribution in composite materials in various heating regimes, while analysis mode estimate average values of heat parameters for newly designed composite structures. For the estimation of the effective thermal conductivity coefficient the discrete model is proposed.

Effective thermal conductivity, $\lambda_{\text{eff}}$, reflects the ability of a material to conduct heat, it can be defined as

$$\lambda_{\text{eff}} = \frac{d_m}{R_T}$$

where, $d_m$ – thickness of material, $R_T$ – thermal resistance, $\Delta T$ – constant temperature difference between sides.

By applying the thermal-electrical analogy and theory of thermal circuits, FEM discretization of composite structure can be described as the system of conductors. In 2D/3D case, mesh element can be described as system of three resistors, where their values can be described according to element shape function as:

$$\frac{1}{R_k} = \frac{1}{2} b_i h_i + c_i c_j$$

Thus one can simulate anisotropic materials by using a single simplex element. So, any kind of complex composite structure where the conduction problem is considered, can be described as the grid of resistors. For effective proportional coefficients finding, we are considering the conduction stationary state and the model of parallel connection of conductors.

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