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Abstract

In this work we address the Lane-Emden boundary value problems which appear in chemical applications, biochemical applications, and scientific disciplines. We apply the variational iteration method to solve two specific models. The first problem models reaction–diffusion equation in a spherical catalyst, while the second problem models the reaction–diffusion process in a spherical biocatalyst. We obtain reliable analytical expressions of the concentrations and the effectiveness factors. Proper graphs will be used to illustrate the obtained results. The proposed analysis demonstrates reliability and efficiency applicability of the employed method.

Keywords: Lane–Emden equation; spherical catalyst; spherical biocatalyst; variational iteration method

1 Introduction

The Lane–Emden equation of shape factor k [1–14] is

$$u''(x) + \frac{k}{x}u'(x) + f(u(x)) = 0,\ k > 0. \tag{1}$$

The Lane–Emden equation is a basic equation in the theory of stellar structure for a shape factor of $k = 2$ [1–6], i.e. signifying spherical bodies. This equation also describes the temperature or concentration variation in many fields of physics, chemistry, biology, biochemistry, and many others [7–18].

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