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| RESEARCH ARTICLE

Comparing three recently developed techniques and using them to address the non-Newtonian fluid flow and heat transfer issue on a turbine disk

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| ABSTRACT

This study is investigating three distinct semi-analytical methods (SAGPM, q-HALPM, and PYRDTM) to solve nonlinear equations in the context of turbine cooling during heat transfer and fluid flow. These methods include Shehu, Laplace, and Young transformations and are improved by Padé approximation. The analysis not only explores how these methods deal with the complicated problems of cooling turbine systems but also remove to test efficiency, accuracy, and convergence of each of them. A comprehensive comparison of approximate solution methods to identify the most effective approach for modeling nonlinear thermal systems is conducted. The findings provide critical insights in to efficient analytical estimations for applications of the above recent methods. Ultimately, the results contribute to the advancement of accurate and computationally efficient solutions for complicated fluid dynamics problems, with broad applicability to various flow-thermal challenges. Moreover, the results showed that the methods are effective and powerful and give an indication that q-HALPM has superior convergence and high accuracy compared to PYRDTM and SAGPM.

| KEYWORDS

Fluid dynamics, SAGPM, q-HALPM, PYRDTM, Nonlinear thermal systems, Padé approximations, Computational efficiency, convergence, accuracy.

| ARTICLE INFORMATION

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1. Introduction

This study considers three advanced ways to solve complex equations to find the best method for getting accurate and reliable results while also being efficient with computing. The goal of the research is to make reliable estimates for complex thermodynamics and nonlinear mechanics problems by solving accuracy issues and improving solutions. The comparison study shows that the SAGPM, q-HALPM, and PYRDTM methods can create useful solutions, which helps us understand heat transfer and fluid flow better [1-2]. Their results matched numerical answers very well [3-5]. The Akbari–Ganji method [6] was further developed by Mirgolbabaee and others [8] in order to solve the nonlinear differential equations that control non-Newtonian fluid flow on a turbine disk in a symmetrical channel. This method was very close to the fourth-order Runge–Kutta method. At this time, Singh and Yadav [9] used the perturbation technique to examine the influence of different factors on the heat transfer and momentum equations of non-Newtonian fluid flow by employing the perturbation method. Their investigation brought out a strong correlation of temperature with Prandtl number and velocity with Reynolds number. In another study, Sheikhzadeh et al. [10] have solved the governing equations of the smooth non-Newtonian fluid flow in a porous-walled channel using the Galerkin and least squares methods. Comparing their results with the fourth-order Runge–Kutta method, they obtained good agreement and concluded that the Galerkin method was easier to implement and required less computation than the least squares method. Akinshilo et al. [11] studied the effect of heat on turbine disks and checked the validity of the analytical solutions by comparing them with numerical methods. They studied, by using two techniques—variational iteration and homotopy perturbation—the flow of a special fluid in a symmetric channel. To obtain an approximate solution for the non-Newtonian viscoelastic fluid flow through a circular channel, Al-Griffi and Al-Saif [12] applied the Yang transform combined with the homotopy perturbation method. Their study showed how the key factors influenced the main equations, and they found their results to be very close to