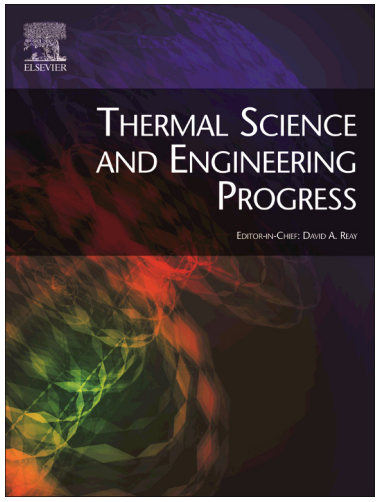

Nonlinear thermal and flow-induced vibration analysis of fluid-conveying carbon nanotube resting on Winkler and Pasternak foundations

M.G. Sobamowo

PII: S2451-9049(17)30034-3
DOI: http://dx.doi.org/10.1016/j.tsep.2017.08.005
Reference: TSEP 54

To appear in: *Thermal Science and Engineering Progress*

Received Date: 19 February 2017
Revised Date: 2 August 2017
Accepted Date: 30 August 2017

Please cite this article as: M.G. Sobamowo, Nonlinear thermal and flow-induced vibration analysis of fluid-conveying carbon nanotube resting on Winkler and Pasternak foundations, *Thermal Science and Engineering Progress* (2017), doi: http://dx.doi.org/10.1016/j.tsep.2017.08.005

Nonlinear thermal and flow-induced vibration analysis of fluid-conveying carbon nanotube resting on Winkler and Pasternak foundations

M. G. Sobamowo

Department of Mechanical Engineering, University of Lagos, Akoka, Lagos, Nigeria.

E-mail: mikegbeminiyiprof@yahoo.com, gsobamowo@unilag.edu.ng, mikegbeminiyi@gmail.com

Abstract

The thermal-mechanical modeling of single-walled carbon nanotube results in nonlinear equations that are difficult to solve exactly and analytically with any existing general method of solution. However, in many cases, recourse is made to approximate analytical methods in which their accuracies largely depend on the number of terms included in the solutions. In this work, approximate analytical solutions are presented using differential transformation method with after-treatment method for the nonlinear equations arising in thermal and flow-induced vibrations of carbon nanotubes. The developed analytical solutions are used to investigate the effects of nonlocal parameter, Knudsen number, temperature, foundation parameters and boundary conditions on the dynamic behaviour of the nanotube. Also, the developed analytical solutions are verified with the numerical solutions and validated with experimental results. Good agreements are established between the analytical solutions and numerical solutions, and also between the analytical solutions and experimental results. The analytical solutions as presented in this work can serve as benchmarks for other methods of solutions of the problem. They can also provide a starting point for a better understanding of the relationship between the physical quantities of the problems.

Keyword: Non-linear Vibration; Differential Transformation method; Aftertreatment techniques; Nanotubes; Thermal effects; Elastic foundations.

1.0 Introduction

Following the discovery of carbon nanotubes (CNT) by Iijima [1], there have been tremendous interests in the analysis and accurate predictions of the dynamic behaviours of the nanotubes. Indisputably, the dynamic analysis of flow and thermal induced vibrations in nanotubes has become a subject of vast interests as it has attracted a large number of studies in literatures [2-26]. This is because, modeling the dynamic behaviours of the structures under the influence of some thermo-fluidic or thermo-mechanical parameters often results in nonlinear equations and such are difficult to solve exactly and analytically with any existing or general analytical method of solution. In some cases where decomposition procedures into spatial and temporal parts are carried out, the resulting nonlinear equations for the temporal part come in form of Duffing equations which have been solved by several analytical and numerical methods in literature. However, application of analytical methods such as Exp-function method, He's Exp-function method, improved F-expansion method, Lindstedt-Poincare techniques, quotient trigonometric function expansion method to the nonlinear equations presents analytical solutions either in implicit or explicit form which often involved complex mathematical analysis leading to analytic expression involving a large number terms. Furthermore, most of the methods are time-