due to thermal expansion, while the pore pressure increase causes tensile stress. The results provide a theoretical basis for the rational design of steam injection program, and the prevention and reduction of casing damage.

**Key Words:** Steam injection, Borehole stability, Porous media, Thermo-hydro-mechanical, Numerical method

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**TS157**

**A METHOD FOR MODIFYING THE THERMAL STRESS OF A COMPOSITE STRUCTURE**

Ying Wang¹, Ding Chen², Fengjing Shen², Yan Zhang², Hongqiang Ma²

¹FengTai district, Yangang West Street No.17, Beijing 100074, China, Email: wyzy926@sina.com, Phone: 15001079405
²China Academy of Aerospace Aerodynamics, 100074, Beijing, China

The characteristic of a thermal protection structure is very important to an aero-craft. It is necessary to examine the thermal stress of thermal protection structure especially the instantaneous changing of temperature. Thermal protection structure usually has several layers. This paper focused on the thermal stress of inner structure. Unfortunately, instantaneous heating is a very difficult problem especially for the measuring of the thermal stress. This is mainly due to the trouble of modification of these thermal stress data. In this paper, a method of modification for measuring the thermal stress under wind tunnel testing was proposed, and the finite analysis was also used to verify this technique. In order to reduce the modification error, we testing many ways. Firstly, usual calibration was conducted in a usual heating way which means that the temperature grown slowly. We record the data curve of strain gauge and the inner structure during the calibration. Testing was accomplished after calibration. Actual strain data was recorded during the testing; the temperature was also recorded by some thermocouples which located nearby. We modified the actual strain by the calibration data above. After that, we calibrated the affection of velocity of temperature changing to the strain gauge. We used the same material to fabricate the inner structure of thermal protection structure, the same strain gauge, the same scope of temperature, and the same of velocity of temperature changing. Many useful results derived from above work. These results were utilized to modify the actual strain. We used finite analysis method to verify the testing results.

**Key Words:** Thermal stress, Modification, Finite analysis

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**TS158**

**THERMOELASTIC BENDING AND BUCKLING BEHAVIORS OF NANOBEEAMS**

Zhi-Qiao Wang¹, a, Jian-Guo Lv¹, b, Ya-Pu Zhao², Si Li¹

¹School of Engineering and Technology, China University of Geosciences, Beijing, 100083, China
²State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China, Email: zqwang@cugb.edu.cn

Low-dimensional nanostructured materials, such as nanobeams, have found plenty of applications as nano
components of electronic devices, sensors, actuators and nanoelectromechanical systems. Studies show that free surfaces will affect the mechanical behaviors of low-dimensional nanostructures significantly.

This manuscript investigates the thermoelastic bending and buckling behaviors of nanobeams by incorporating surface thermoelasticity. In the absence of external loading, the residual surface stress will induce an initial stress field in the bulk of nanostructures. A continuum model, which involves the residual surface stress and the residual stress field in the bulk, is proposed to analyze the thermo-elastic behaviors of nanobeams. Results show that the surface stress and the residual surface stress have significant effects on the thermoelastic bending and buckling behaviors of nanobeams.

**Key Words:** Nanobeams; Thermoeelastic; Bending; Buckling

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**HYGROTHERMAL STRESSES IN MAGNETOELECTROELASTIC CYLINDERS**

A.H. Akbarzadeh\(^1\), Z.T. Chen\(^2\)

\(^1\)Mechanical Engineering Department, University of New Brunswick, Fredericton, NB, E3B 5A3, Canada, Email: h.akbarzadeh@unb.ca

\(^2\)Mechanical Engineering Department, University of New Brunswick, Fredericton, NB, E3B 5A3, Canada, Email: ztchen@unb.ca, Tel: +1(506) 458-7784, Fax: +1(506) 453-5025.

Multiphysical materials with energy harvesting capability and the lowest level of external energy consumption are being developed to replace the conventional fossil fuels. Multiphysical materials are frequently called smart or adaptive materials due to their ability to accurately monitor and respond to external disturbances. The magnetoelectroelastic (MEE) materials are one of the advanced multiphysical materials with coupling among elastic, electric, and magnetic fields. Such multifield interactions could be observed directly in multiferroics or indirectly in piezoelectric/piezomagnetic composites. Regarding the application of smart materials in various industries such as aerospace, transportation, green energy, wood structure, and biomechanics, they are subjected to different hygrothermal conditions. As a result, the magnetoelectroelastic behaviour of a radially polarized and magnetized hollow cylinder under steady-state temperature and moisture concentration changes is investigated in present article. An infinitely long, axisymmetric cylinder is considered for the investigation to simplify the analytical solution procedure for obtaining closed-form solutions. The cylinder is assumed to be homogeneous and transversely isotropic. The elastic foundation boundary conditions are also considered for the investigation. The governing equations including constitutive, potential field, and conservation equations are given for the steady-state hygrothermomagnetoelectroelastic analysis. Due to the uncoupled analysis, the temperature and moisture concentration distributions are gained separately by solving the Fourier heat conduction and Fickian moisture diffusion equations. The three coupled governing differential equations in terms of displacement, electric potential, and magnetic potentials with effects of temperature and moisture concentration are solved analytically. The closed-form solutions for displacement, electromagnetic potential, stress components, electric displacement, and magnetic induction are obtained. The results are verified with those available in the literature in the absence of the temperature, moisture, and elastic foundation. Finally, the numerical results are given to depict the effects of hygrothermal loading, elastic foundation, and electromagnetic boundary conditions on the multiphysical responses.