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A symmetric angle-ply composite flywheel study for high-speed energy storage

Emmanuel C Nsofor and **Michael A Conteh**
Southern Illinois University, USA

This study on the symmetric angle-ply composite flywheel rotor was conducted to investigate the stress, strain and strength ratio distributions for high-energy density storage applications. The rotor used in the study consists of multiple anisotropic unidirectional plies. Because of the different ply orientations, the continuity conditions of the radial stresses and displacements between plies were used to obtain a local stiffness matrix for each ply. Consequently, the global stiffness matrix for the rotor was developed. The Tsai-Wu 3-D quadratic failure criterion in stress space was used to evaluate the strength ratio of the rings. The study found that the circumferential stress increases as the ply angle increased in the circumferential direction, while the axial stress decreased. The maximum circumferential stress obtained for the rotor for [±85°]S ply lay-up was 650 MPa. The highest safe rotational speed was 33,000 rpm. Results from this study will contribute to further development of the flywheel that has recently re-emerged as a promising application for energy storage due to significant improvements in composite materials and technology.

Biography

Emmanuel C Nsofor is an Associate Professor of Mechanical Engineering at Southern Illinois University, Carbondale where he primarily teaches courses and conducts research primarily in the area of heat transfer, energy storage and advanced energy systems. He has over twenty years' experience in advanced energy systems (analysis, storage, utilization and recovery). He has authored several related peer-reviewed papers. He is a reviewer for many highly-rated journals including *International Journal of Heat and Mass Transfer, Applied Thermal Engineering*, and *International Journal of Experimental Thermal and Fluid Science*. He has professional engineering experience with York Division of Borg-Warner Corporation, London, England. He is a Senior Member of AIAA and a member ASME, ASHRAE and ASEE.

nsofor@siu.edu