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Flywheel Energy Storage PCS Topology

Overview

A variable density, stress-constrained topology optimization approach is used, along with the solid isotropic material with penalization (SIMP) power law and a P-norm aggregated global stress measure to optimize the rotor of a flywheel e. A variable density, stress-constrained topology optimization approach is used, along with the solid isotropic material with penalization (SIMP) power law and a P-norm aggregated global stress measure to optimize the rotor of a flywheel energy storage systems (FESS). A new specific energy maximization optimization formulation is proposed which eliminates the need to impose an arbitrary volume fraction constraint to the optimization problem as it is done in traditional kinetic energy maximization approaches. The FESS rotors obtained with the specific energy formulation achieved a 15.8% increase in the specific energy compared to the kinetic energy based approach which improved the specific energy by 12.8%. Factors such as the operating speed, maximum stress, rotational symmetry an.

••Specific energy formulation for FESS topology optimization yields better designs.••Operating speed and rotational symmetry affect the optimal topology.••Rotor topology is material independent if properties (E, ν) scale proportionally.••Acceleration stresses are significant only for very quick charge-discharge cycles.

Flywheel energy storageStress-constrained topology optimizationRotor designSpecific energy.

α□Maximum volume fractionβ□Projection filter slopeρˆ□Vector of projected design densitiesρ□Vector of topology design densitiesρ̃□Vector of filtered design densitiesω̇□.

Flywheel energy storage systems (FESS) are known to be a viable short duration energy storage solution in grid-scale applications [1]. FESS can store mechanical energy in the form of the inertia of a rotating disk, where the stored energy is dependent on the angular speed and geometry of the disk. Excess energy from the grid can be stored in the disk by accelerating it to higher speeds using an electric motor, and the reverse can be achieved by operating the electric machine as a generator driven by the decelerating flywheel rotor. The moment of inertia of the flywheel depends on the choice of material and the geometry of the rotor. The choice of rotor material can influence various FESS characteristics, such as cost, speed of operation and thermal conductivity. Since low speed metal rotors are easier to fabri.

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A comprehensive review of control strategies of flywheel energy storage system is presented.

To increase the energy storage density, one of the critical evaluations of flywheel performance, topology optimization is used to obtain the optimized topology layout of the flywheel rotor ...

The concept of flywheel energy storage is to store the electrical energy in the form of kinetic energy by rotating a flywheel which is connected mechanically between motor and ...

First, a new topology of FESS in MGs is introduced, where the FESS is connected at the same DC-bus of the fuel cells and the Photovoltaic (PV) inverter instead of connecting it with a ...

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This paper presents a Flywheel Energy Storage System (FESS) concept based on the use of Reluctance Magnetic Gear (RMG) and Superconducting Magnetic Bearing (SMB

In this article, a density-based stress-constrained topology optimization approach for energy storage flywheel design is proposed. The specific energy of the rotor is maximized, ...

Ever wondered how futuristic energy storage systems keep Formula E cars zipping or data centers humming during blackouts? Let's peel back the layers of the flywheel energy storage ...

First-generation flywheel energy-storage systems use a large steel flywheel rotating on mechanical bearings. Newer systems use carbon-fiber composite rotors that have a higher ...

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