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Energy Efficiency Analysis of Discharge Modes of an Adiabatic Compressed Air Energy Storage System

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Abstract : Efficient energy storage is a crucial factor in facilitating the uptake of renewable energy resources. Among the many options available for energy storage systems required to balance imbalanced supply and demand cycles, compressed air energy storage (CAES) is a proven technology in grid-scale applications. This paper reviews the current state of micro scale CAES technology and describes a micro-scale advanced adiabatic CAES (A-CAES) system, where heat generated during compression is stored for use in the discharge phase. It will also describe a thermodynamic model, developed in EES (Engineering Equation Solver) to evaluate the performance and critical parameters of the discharge phase of the proposed system. Three configurations are explained including: single turbine without preheater, two turbines with preheaters, and three turbines with preheaters. It is shown that the micro-scale A-CAES is highly dependent upon key parameters including; regulator pressure, air pressure and volume, thermal energy storage temperature and flow rate and the number of turbines. It was found that a micro-scale AA-CAES, when optimized with an appropriate configuration, could deliver energy input to output efficiency of up to 70%.

Keywords : CAES, adiabatic compressed air energy storage, expansion phase, micro generation, thermodynamic
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