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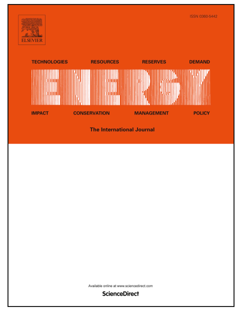

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Abstract

In traditional thermodynamic analysis methods, the strong physical relationship between energy charge and discharge processes is usually underestimated, as well as being weak in exploring the energy transfer mechanism of physical energy storage (PES) systems. Aiming at this problem, a new method, corresponding-point methodology (CPM), for analyzing and optimizing PES systems is proposed on the basis of the correspondence of the system flow, and its application to compressed air energy storage (CAES) system is conducted in this paper. Meanwhile, a diagram of thermal exergy and mechanical exergy (E_{th}-E_{mech} diagram), which reflects not only energy loss but also the quantity of stored energy, is proposed in a complex plane. This method, along with E_{th}-E_{mech} diagram, focuses on analyzing the corresponding processes rather than the single process of the CAES. Some indicators, such as corresponding-point separation, corresponding quotient, intersection angle, and optimum object, are proposed, thereby making the analysis and optimization of the CAES system more efficient and explicit. For two typical corresponding processes, the relationship of thermal and mechanical exergy variations is revealed. Finally, CPM is used to analyze a supercritical compressed air energy storage system, and the system efficiency is improved by 9.2 percentage points after CPM analysis and optimization.