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电池与储能

基于EWT-FC方法的氢-超级电容混合储能功率分配

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Hydrogen-supercapacitor Hybrid Energy Storage Power Distribution Based on EWT-FC Method

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History +

摘要

为平抑风电功率波动,弥补单一储能的不足,引入氢和超级电容构成的混合储能装置平滑风电功率波动。针对传统功率分配方法难以建模,容易出现模态混叠现象等问题,以及为了提高储能系统可靠性,提出了一种经验小波变换EWT (empirical wavelet transform) -模糊控制FC (fuzzy control) 策略方法。首先,为了验证EWT算法能实现储能设备间功率精确分配,将EWT算法与经验模态分解EMD (empirical mode decomposition) 和小波变换WT (wavelet transform) 算法进行对比;其次,采用EWT算法分解重构风电原始功率得到并网功率和混合储能平抑功率;最后,考虑超级电容荷电状态SOC (state-of-charge) 和储氢罐压力对系统安全稳定运行的影响,采用模糊控制修正储能元件的充放电功率。仿真结果表明, EWT算法避免了模态混叠,实现了储能设备间功率精确分配。该控制策略能有效平抑风电波动,保证了SOC和储氢罐压力在合理范围内,延长了设备寿命,实现系统稳定运行。

Abstract

To smooth the wind power fluctuations and make up for the shortage of single energy storage, a hybrid energy storage device composed of hydrogen and supercapacitor is introduced in this paper to smooth the wind power fluctuations. Aimed at problems such as the difficulty in modeling the traditional power distribution method and the modal mixing phenomenon which is likely to occur, an empirical wavelet transform (EWT) -fuzzy control (FC) strategy is proposed to improve the reliability of the energy storage system. First, to verify that the EWT algorithm can achieve an accurate power distribution among energy storage devices, the EWT algorithm is compared with the empirical mode decomposition (EMD) and wavelet transform (WT) algorithms. Second, the EWT algorithm is used to decompose and reconstruct the original wind power to obtain the grid-connected power and hybrid energy storage smoothing power. Finally, the effects of state-of-charge (SOC) of the supercapacitor and the hydrogen storage tank pressure on the safe and stable operation of the system are considered, and the charging and discharging power of the energy storage element is modified by FC. Simulation results show that the EWT algorithm avoids the modal mixing and achieves the accurate power distribution among energy storage devices. The proposed strategy effectively smooths the wind power fluctuations, ensures a reasonable range for the SOC and hydrogen storage tank pressure, and extends the lifetime of devices, thus realizing the stable operation of the system.

关键词

功率分配 / 氢储能 / 混合储能 / 经验小波变换 / 模糊控制

Key words

power distribution / hydrogen energy storage / hybrid energy storage / empirical wavelet transform (EWT) / fuzzy control (FC)

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