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SIMULATION OF AN ADVANCED ADIABATIC COMPRESSED AIR ENERGY STORAGE (AA-CAES) OF 100 MW POWER PLANT

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Abstract

So far, power consumption was variable and power production was driven to respond to demand. Nowadays, electricity production ways from renewables, as wind or solar energies, are variable sources. In order to conciliate offer and demand, the energy storage clearly appears as one of the most relevant solutions. For this reason, Advanced Adiabatic Compressed Air Energy Storage (AACAES) has recently caught the attention due to its efficiency, capacity and lifetime expectance.

The AACAES technology is based on the compression and decompression of atmospheric air to store and release energy by means of compressors, turbines and generators. Thermal energy generated by the air compression is stored using thermal energy storage devices (TES). Thermal storage can severely impact the AACAES global yield, so many different thermal storage technologies (heat exchanger with water or heat transfer fluid, pressurized packed beds and IFPEn TES) were studied by process simulation to be compared in terms of cost, convenience and reliability. Our study highlights that IFPEn TES technology was the most competitive. This technology is an innovation based on pressurized packed beds. IFPEn TES allows AACAES to be more profitable than batteries for energy-power ratio greater than4.

This paper focuses on the evaluation by simulation of an industrial application of an AACAES for a 100MW power plant to evaluate its ability to improve the flexibility in electricity production. The AACAES process was simulated using a commercial process simulation software (ProII). The air is compressed up from atmospheric pressure to 117 bar and stored in a cavern. The main parameters of the train of compressors and turbines (polytropic and adiabatic efficiencies) correspond to current commercial values (varying from 84% to 88% for compressors and 90% to 92% for turbines). The design parameters for the TES devices are obtained from in-house pilot plant experiments and calculation tool developed by IFPEn. The air storage is not simulated but it is considered at constant pressure. Temperature variation in the cavity was neglected as well. The simulation results indicate an AACAES process global efficiency better than 70% for an installation of 100 MW and 600 MWh.

This results highlights the suitability of AACAES process to improve flexibility in electricity production due to its high global yield and the high storage capacity.

Key words: Caverns for Air Storage, Computer process simulating, AACAES, Thermal Energy storage