Investigation of the tailwater flow during hydraulic short circuit operation in the Alqueva II pumped storage power plant

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Abstract. The introduction of hydraulic short circuit operation in existing pumped-storage power plants increases their flexibility but may cause unfavourable flow conditions at pipe junctions, head or tailwater reservoirs. Consequently, this operation is investigated for the Alqueva II power plant by means of CFD simulations prior to on-site tests as the outlets of the draft tubes are positioned very close to each other. The simulations, that are initially carried out using a single-phase approach, show that the tailwater level as well as the configuration, which of the two pump-turbines is operated in pump or turbine mode, influences the flow field in the tailwater reservoir and thus, the inflow conditions for the pumping unit. With the pump-turbine located further away from Alqueva I running as a turbine and the tailwater level at minimum level, the least favourable flow field is present. The initial choice of the single-phase setup is confirmed by the results of two-phase simulations. Moreover, the flow behaviour observed during the on-site tests is similar to the results of the CFD simulations. The on-site tests successfully demonstrate the capability of Alqueva I and II to be operated in hydraulic short circuit for all configurations.

1. Introduction

The Alqueva I and II pumped-storage power plants serve as demonstrators within the European XFLEX HYDRO project, which addresses the flexibilization of hydro power [1, 2, 3]. One of the technologies that is investigated at this demonstrator is the hydraulic short circuit (HSC) operation. Here, the altogether four pump-turbines of both power plants are operated independently of each other, either in pumping or generating mode. While this increases the overall flexibility of the two power plants, it also represents a kind of off-design condition that has yet to be investigated using numerical flow simulations and subsequent on-site testing. The numerical flow simulations, which are the focus of this work, are carried out to identify possible risks prior to the on-site tests and give a better understanding of the flow behaviour. While the initial CFD simulations are performed as single-phase simulations, this study is further extended to investigate the difference between a single-phase and two-phase modelling approach.