Jokulsa valve chamber

Reverse flow energy dissipater

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Introduction

The Kárahnjúkar Hydroelectric project is developed to harness the river Jökulsá á Dal in East Iceland. In the Jökulsá tunnel a butterfly valve will be installed approximately 100 m upstream of the connection with a 40 km long headrace tunnel. Transient analysis shows that unacceptable high discharges of reverse flow could occur through the valve at total shutdown of the power station. In order to reduce this effect, the construction of a sudden enlargement is foreseen to introduce a damping effect under reverse flow condition. Basically, the energy dissipater consists of a sudden section change passing abruptly from a 2.1 m diameter to a 6 m diameter tunnel, generating high turbulence with massive flow separation.

Goals

The goal of the experimental study is to determine the most appropriate geometrical characteristics of the component parts of the dissipater capable to achieve the requirements of strongly asymmetrical head losses. In general, the purpose is to limit as much as possible the head losses under normal operation conditions (flow out of the Jökulsá tunnel) and to achieve the required level of head losses under reverse flow conditions (reverse flow into Jökulsá tunnel).

Tests were achieved on a 1/20 scaled physical model (Figures 1 and 2) to verify the flow characteristics (head losses, pressures, localized turbulences and eddies, cavitation potential) along the steel-lined dissipater and into the concrete lined sections of the adjoining tunnels. Measurements and verifications cover, of course, the possible range of normal and reverse flow conditions.

Experimental Set-up

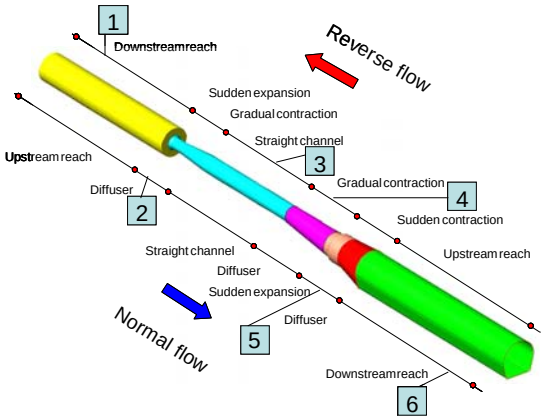
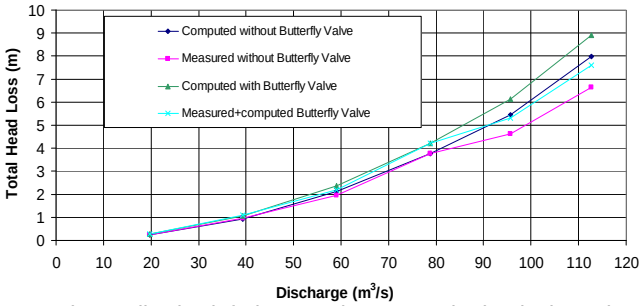


Figure 1 : Model schematic of the main elements of the system

Figure 2 : General view of the 1/20 scaled model

Results and Conclusions

The most important results are surveyed hereafter. Under normal flow conditions the total head loss obtained



experimentally is inferior to the one obtained through theoretical computation. (Figure 3)

Figure 3 : Experimental and computed total head losses with and without butterfly valve head loss, under normal flow condition

Falvey and Quintela indexes values do not suggest risk of cavitation within the discharge and HGL downstream range in the enlarged section after the contraction as well under reverse as normal flow conditions.(Figure 4)

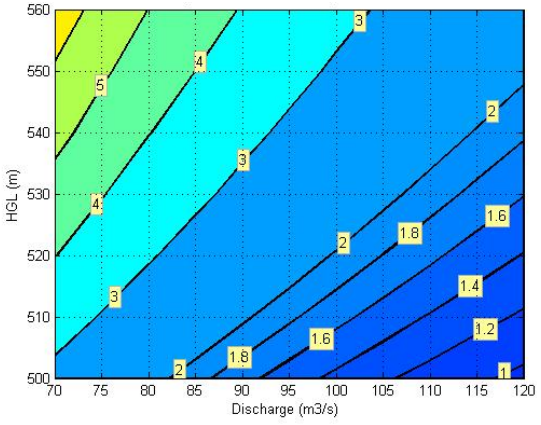


Figure 4 : Falvey index in the enlarged section after the contraction in function of discharge and HGL downstream for reverse flow

Finally, the choice of the throat diameter results of a compromise taking in account HGL, discharge, head loss and risk of cavitation.