LABORATOIRE DE CONSTRUCTIONS HYDRAULIQUES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Chopin S2C : Caractérisation hydraulique des orifices des chambres d'équilibre d'aménagements à haute chute, paramétrage et influence sur la stabilité du système en charge

PhD candidate: Nicolas Adam
Thesis director: Prof. Dr. Anton J. Schleiss

The research is supported by "The Ark: Promoting innovation in Valais".

Introduction

The electricity market is radically changing. The demand and electricity needs are still growing at the same time as the network complexity. Historically, the production was composed of thermal plants (nuclear, coal, oil, gas, etc.) producing a constant energy. Smaller thermal or hydraulic plants followed cyclic demands (daily, weekly, and seasonal) to follow the peaks. Recently, new individual plants (solar and wind) has appeared, therefore, the producers have to adapt the network (Figure 1).

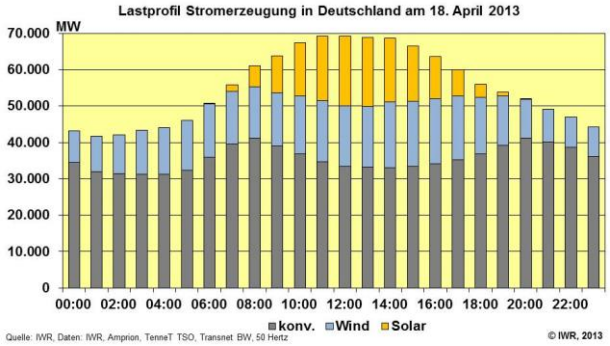

Figure 1: Electricity production in Germany for the 18 April 2013 (Source IWR).

Switzerland imports electricity from neighboring countries in off-peak period (low price) and exports in the peak period (high price). On that basis, Swiss electricity generators consider to increase some high head power plants or pumped-storage plants. Several types of extension are thought such as raising the dam's heights, increasing the power of plants, etc.

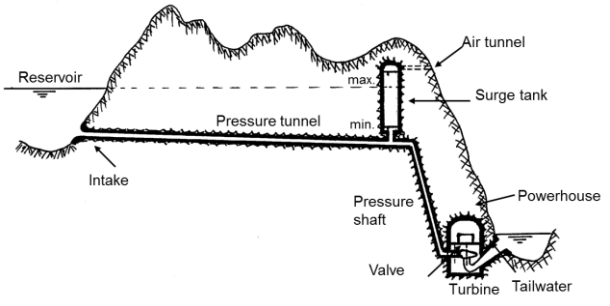

Figure 2: Schematic view of a high-head power plant.

These different transformations require a modification or an adjustment of the existing surge tanks (. This hydraulic device allows to change faster the turbine flow. In other words, this device decreases the impact of the water hammer in the waterway system upstream (pressure tunnel). The modification or the setting up of a diaphragm is an economic way to adjust the surge tank when the characteristic of a high head power plant are modified. However, there is currently no approach for a diaphragm design. Consequently, a physical model and an experimental approach is mostly needed for each project. Several such studies were and are still carried out in the LCH.

Objectives

The objectives of this research thesis are the followings:

- The systematic study of different geometries of diaphragm's orifice (throttle) in order to derive general design criteria.
- Study the stability of all the system (high-head power plant) to complete the existing stability criteria like the Thoma (1910).
- Study the behaviour of head losses at diaphragm throttles in transient flows.
- Facilitate the management of high-head power plant.

The main objective consists in the development of a catalog of diaphragm's orifice. From this catalog, the shape of the diaphragm for a certain wished head loss can be derived in an efficient way. The first type of geometry tested is an asymmetric diaphragm such as the ASME standard (Figure 3).

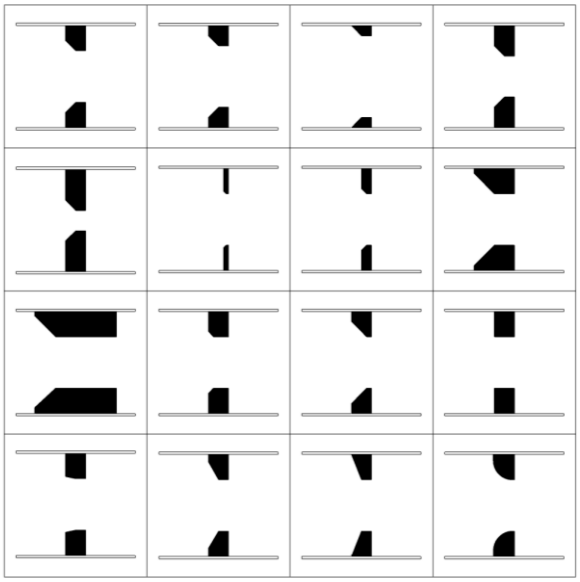

Figure 3: Shapes to be tested.