General Turbine Flow Conditions at a HYDROMATRIX®-Module

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ABSTRACT

This paper contains the results of series of experimental investigations of turbine influx, efflux and draft tube pressure conditions at a " HYDROMATRIX®-module". Such a module can be placed in the bay of a run-of-river station to generate electrical energy. In case of flow separation (air-entrainment) in individual draft tubes the efficiency of the turbines decreases significantly and the performance of the turbine can not be guaranteed. In addition, turbine damages can occur easily. In order to investigate stable turbine flow conditions three different hydraulic models were built. The first model comprises one full and two adjoining half bays in a scale of 1: 40. This model should allow to appraise different approaching flow conditions to the turbines and turbine outflow conditions as well. The second one presents a sectional model with three bulb turbine-axes in span and two turbine-rows in height (six pack). The third one was a copy of a set of a border bulb turbine row (pier unit) including a half weir pier to test asymmetric flow conditions up- and downstream of the module. Both models were built with a complete mechanical turbine system to a scale of 1:12,5 in plexiglass. Measurements show the energy losses, the net-head and the dynamic draft- head as a function over all operational gross-heads of the plant. Operational measures taken to prevent flow separation (air-entrainment) in the upper draft tube row during lowest tailwater conditions will also be described and evaluated.

Introduction

HYDROMATRIX®-technology /1/, advanced by VA TECH HYDRO, is a new concept in hydraulic energy production combining the advantages of proven technology and low cost installation in existing hydraulic structures. A usage of this technology at new hydroplants is generally possible and could offer a new way to reduce construction costs significantly.

A HYDROMATRIX®-module realize the generation of electric energy by means of a factory assembled module block (“grid”) of several small assembled turbine-generator units (*Figure 1*) /2/. The module block consists of a stiff steel fabricated structure which supports the TG-units including trash racks, draft tubes with control gates, rooms for HPU, electric switchgear and control systems (*Figure 2*).

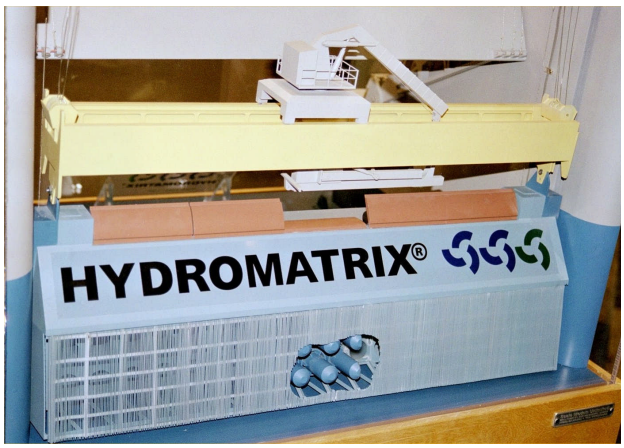

Figure 1: Upstream view on a HYDROMATRIX® -Module /1/

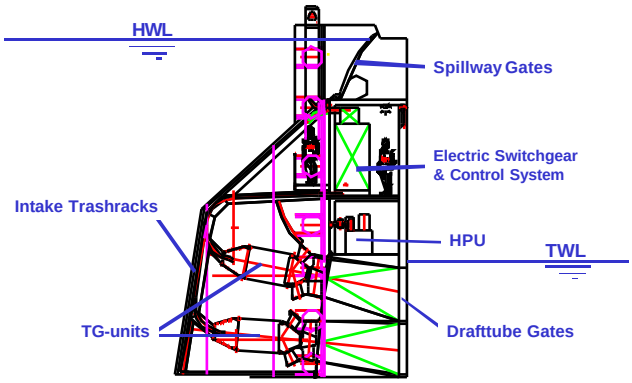

Figure 2: HYDROMATRIX® -Module Typical Cross Section /2/

HYDROMATRIX®-modules can be installed in dams, usually in weirs, ship lock sluices, intake towers for drinking water as well as in intake structures of irrigation systems. In the usage of existing hydraulic structures these should be suitable or adaptable for a HYDROMATRIX®-Module installation and a utility grid connection should also be in close proximity.

In general the plant should have an available discharge of ~100 m3/s (3,500 cfs) and the gross head should amount from 3 m up to 30 m (10-100 feet) with a minimum submergence of 1.5 m (5 feet) below tailwater to achieve technically and economically feasible applications.

However, HYDROMATRIX®-technology is a clean and environmentally friendly energy production form (KYOTO-protocol). It is an opportunity to utilize unexploited water resources at competitive costs. It represents a standardized modular concept with a project schedule from 1.5 to 2 years. The HYDROMATRIX®-module is easily removable for flood conditions and also for repair and maintenance work.

The investigation presented here deals with the installation of several HYDROMATRIX®-modules in the tainter gate bays of an existing dam which currently serves only navigation and flood control. In addition to the generation of electric energy the modules have to fulfill the function of emergency stoplogs. Hydraulic experiments /3/ to this project were recently carried out to determine the drag forces occurring during underflow conditions. Submergence conditions of the draft tubes on a simple pre-version of the HYDROMATRIX®-module were investigated as well /4/.

The modules are shifted into the stoplog slots of the existing bays *(Figure 3)*. The turbine-generator units (TG-unit) are arranged in double rows in a module. Depending on the available module discharge conditions, single turbines can be opened or closed by a draft tube gate at the two overlapping draft tube outlets. Each gate is operated by a hydraulic hoist mechanism.

A TG-unit consists of a stay ring with fixed stay vanes, a fixed blade propeller type runner and an induction type generator directly connected to the turbine runner *(Figure 4)*.

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