

Session IIIA: Oscillations in turbines and power plants

Paper 41: Casacci, S., Wegner, M., Henry, P., Graeser, J.E., Examen experimental de la stabilité des turbines Francis sur modèle et sur prototype à charge partiële

Discussions

Doerfler, P. (Switzerland)

In section 3 of their paper the authors discuss two cases of what they call resonance at low part load and at full load.

Normally the term resonance is used if there is some (external) forcing function acting on a resonator that gives a high response amplitude at certain frequencies. I am afraid that neither of both cases can be adequately described in such terms. In contrast to the ordinary half load surge (helical vortex type) the other types of surge have no clearly defined exciting function but should be regarded as self-excited oscillations.

This fact (noticed by Campman in 1960) has a considerable bearing on applicability of model tests. There are cases where a condition of surging in the prototype is completely absent in the model test. The reason is just that in one system a limit cycle exists while the other one is stable.

In his presentation Professor Henry stressed the good correlation between pressure fluctuation at tap 7 and torque fluctuation.

I would like to ask whether the authors already have an idea about the physical cause of this relationship.

As long as there is no explanation it is still possible that this is just a coincidence by chance.

Author's reply

I would say to Mr. Doerfler that I am in full agreement concerning the confusion which could be done when using the word "resonance" for a wide range of different phenomena. But in the case presented in our paper for very low load operation, it seems really that the draft tube vortex acts as an excitation for the penstock considered as a resonator.

In full load range, the excitation spectrum is more wide and does not offer isolated peaks. It could be assumed that this bad-organized spectrum becomes a well-organized pulsation when associated to the upstream conduit acoustic frequency. The last mentioned frequency is more or less different from the proper frequency of penstock measured when closing the wicket gates.

As it was presumed by Mr. Doerfler, we do not think that the good correlation between transducer 7 and torque measurement could be a coincidence. In fact we assume that the axis of the main draft tube vorticity remains vertical when passing through the elbow. So it creates an alternate discharge fluctuation at the end of this elbow and this discharge fluctuation becomes therefore a pressure pulsation for the whole turbine. The propagation of the pulsation depends of course of the cavity volume i.e. of the cavitation compliance.