Accepted Manuscript

Forces on a marine current turbine during runaway

Anders Goude, Staffan Lundin

PII: S2214-1669(17)30079-6
DOI: https://doi.org/10.1016/j.ijome.2017.09.007
Reference: IJOME 181

To appear in: *International Journal of Marine Energy*

Forces on a marine current turbine during runaway

Anders Goude[a,*], Staffan Lundin[a]

[a]*Division of Electricity, Department of Engineering Sciences, Uppsala University, Sweden*

Abstract

A runaway marine current turbine will typically overshoot the runaway speed significantly before it settles at that speed. Numerical simulations of an experimental turbine indicate that the peak forces experienced by the turbine during runaway are up to 2.7 times those seen during nominal operation, and 2.1 times those at asymptotic runaway speed, making peak runaway force an important consideration in turbine design. The main contribution to the force increase is found to originate from the increased rotational speed, but a significant part is also due to the temporal lag in turbine wake development. A parameter study further shows that turbines with low inertia, turbines that have low losses, and turbines designed for low tip speed ratios will experience larger increases in forces.

Keywords: Marine current turbine, Hydrokinetic turbine, Hydrodynamic Forces, Runaway, Vortex methods

1. Introduction

The rotational speed of a turbine is governed by the water flow speed and the applied electrical load. During normal operation, the driving torque of the water is balanced by the electrical torque of the load. If the load is lost or disconnected, the energy captured by the turbine no longer passes on to the load but is accumulated in the rotating system leading to increased rotational speed. The turbine is said to be in a runaway situation, and the rotational speed will increase until a new torque equilibrium is reached at what is known as the runaway or no-load speed.

A marine current turbine, also known as a hydro-kinetic turbine, under runaway conditions will typically accelerate to a temporarily higher rotational speed than the (asymptotic) runaway speed, after which it will slow down and settle at the runaway speed. This phenomenon has been observed in scale model experiments and numerical simulations [1]. It is caused by the inertial properties of the rotating system and of the water around it, which allow the turbine to

*Corresponding author
Email address: anders.goude@angstrom.uu.se (Anders Goude)