A model and simulations for liquid films in steam turbines

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Wetness in steam turbines induces losses and erosion. Droplets are created due to the fast expansion of the steam. The droplets grow and some among them settle on the blade leading to a liquid film. This film may then atomize into coarse water drops. The aim of the study is to propose a continuous model and then a numerical model able to describe this liquid film on stator and rotor blades.

This liquid film can legitimately be assumed to be thin, laminar and continuous on steam turbine blades. The proposed model is based on modified Shallow-Water equations. The development of this integral formulation of simplified Navier-Stokes equations needs closure laws. Once chosen, the model takes into account convection, mass transfer, gas and wall frictions, gravity, surface tension, steam pressure, droplet impact and possible rotational effects. The properties of this model, i.e. hyperbolicity, entropy, Galilean invariance and rotational invariance, are examined.

A two-dimensional code for unstructured meshes has been developed using finite volumes to numerically simulate this liquid film model. The code is verified with analytical solutions such as Riemann problems and inclined lake at rest. The model is then validated with the experiment of a highly sheared film under steam turbines conditions (*Hammitt et al.,FiI 1981)*, the experiment of a film under inverted gravity (*Brun et al., PoF, 2015; Scheid et al., PoF, 2016*) and the experiment of a falling liquid film on inclined plane (*Liu & Gollub, PoF, 1994*). For this last case, a linear stability analysis is carried out on the model .