Abstract
The understanding of condensation process at the low pressure (LP) turbine is important because condensation introduces extra losses, and erosion caused by the droplets wear turbine blades. The investigation of turbulence effect on the non-equilibrium homogeneous condensing steam flow in stationary turbine cascade is presented employing 2D compressible Navier-Stokes equations coupled with turbulence models. The SST k-ω model was modified and implemented into CFD code. The numerical results are validated against the experimental data available in the literature and good agreements were observed.

Introduction
There is a worldwide importance on low-pressure (LP) turbine stages research because their relatively low efficiency. The presence of liquid phase within the turbine generates thermodynamic and aerodynamic losses, as well as erosion in the turbine components. Therefore, an accurate prediction of the loss mechanism due to condensation in steam turbines is very important. The turbulence plays an important role on the processes of mass, momentum, and heat transfer in boundary layers on the surface walls, especially on the possible deposition of condensed liquid droplets. The turbulence may have some direct/indirect influence on the condensation shock formulation and the generation of shock waves under conditions of supercooled steam flow.

This work presents effect of the turbulence on the process of non-equilibrium homogeneous condensing steam flow in turbine blade cascade. The predicted numerical results are compared with the available experimental data.

Physical model
The two-phase flow is modeled using compressible NS equations by means of ANSYS Fluent 14.0 CFD code. Additionally two transport equations for the liquid-phase mass-fraction and the number of liquid droplets per unit volume are solved. The rate of formation of liquid droplet embryos due to the homogeneous condensation per unit mass of the vapour-liquid mixture is obtained from the classical theory of non-isothermal homogeneous condensation. The SST k-ω model is modified including turbulent viscosity and source terms, where source terms determines the modulation of turbulence energy due to additional dissipation by liquid droplets.

Results
To investigate the effect of turbulence in the steam turbine cascade, the experiments proposed by White et al. [1] are selected. These experiments were organized with the turbine blade profile which was the fifth stage stator blade from the six-stage LP cylinder of a 660 MW steam turbine. The corresponding boundary conditions of the selected case are at the inlet: $P_0 = 40300 \text{ Pa}, T_0 = 354 \text{ K}$ and mean static pressure at downstream $P_0 = 16300 \text{ Pa}$.

Future plans
Future research work will be continued to investigate turbulence effect and loss mechanism in stator-rotor cascade flow.

Publications


References