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Institute of

Thermal Turbomachinery and Machinery Laboratory

Prof. Tekn. Dr. Damian Vogt

**New experimental condensing flow results performed in a Barschdorff nozzle**

Manuel E. Maqueo Martinez\*, Stefan Winkelmann\*, Markus Schatz“,Damian M. Vogt\*

\*ITSM, University of Stuttgart  
Pfaffenwaldring 6  
70569 Stuttgart

“LSM, Helmut-Schmidt-University   
Holstenhofweg 85  
22043 Hamburg

**Abstract:**

Vast progress has been achieved in the last decades on understanding the phenomena related to the onset of condensation in steam flows, both experimentally and especially numerically; yet, as the results of Starzmann et al. [1] demonstrate, there is still a considerable disagreement between the various numerical models used. Unfortunately, the available experimental validation data is not sufficiently accurate and elaborated to allow for a proper validation of CFD-simulations. Thus, further experiments need to be done.

The work performed for this paper presents new experimental results of condensing steam flow in a Barschdorff-nozzle, measured at the Institute of Thermal Turbomachinery Laboratory (ITSM) at the University of Stuttgart. In previous experiments done by Schatz(2016,2017) and Eberle(2015), steam was throttled and cooled down using a controlled water injection. However, the stability of inlet conditions, particularly the inlet temperature, was not satisfactory. Moreover, evidence of larger droplets was detected during the post-processing of data.

Consequently the test-rig was modified by adding a water bath steam cooling vessel system to accomplish steady inlet conditions and control the operating points (OPs) of the nozzle. With this scheme it is possible to maintain stable inlet conditions, having ample time to measure the flow conditions and droplet spectra repeatedly, generating new and reliable experimental data.

Similar to the experiments of Barschdorff, a steady inlet pressure of 784 mbar was set at various inlet temperatures down to 100.2°C, corresponding to an inlet superheat of 7.3°C. Using up to 1 mm space resolution for both pneumatic and droplet size measurements, condensation onset is accurately captured across the nozzle for all operating conditions. Droplet light spectra are measured using the light extinction principle. The data is post-processed using an inversion algorithm developed at the ITSM, whose reliability has been proven in preceding tests performed by Schatz and Eberle [2,3,4]. A minimum of three traverses is performed per each OP, as well as repetition of points on different days.

The validity and accuracy of this work is demonstrated by the extremely high reproducibility of the results. Numerical simulations done with the commercial solver ANSYS CFX are validated with the experimental data based on Sauter diameters, droplet numbers, wetness and its correspondent condensation onset locations. It is assessed that there is a good agreement between experimental and numerical results.

*References*

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[3] Grübel, M., Starzmann, J., Schatz, M., Eberle, T., Vogt, D., Sieverding, F., 2014. *”Two-phase flow modeling and measurements in low-pressure turbines – Part 1: numerical validation of wet steam models and Turbine modelling*”. *Proc. of ASME Turbo Expo 2014*, GT2014-25244

[4] Grübel, M., Starzmann, J., Schatz, and Vogt, D. 2014, *“Two-Phase Flow Modeling and Measurements in Low-Pressure Turbines— Part II: Numerical Validation of Wet Steam Models and Turbine Modeling,”* *Proc. of ASME Turbo Expo 2014*, GT2014-25245