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Water injection in a micro gas turbine for combined heat and power applications

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Micro Gas Turbines (mGTs) offer several advantages for small-scale (up to 500 kW) Combined Heat and Power (CHP) production compared to internal combustion engines: cleaner exhaust, lower maintenance cost, higher power-to-weight ratio and concentration of the residual heat in a single source. The major drawback of mGTs for CHP is their rather low electric efficiency. Hence, when the heat demand decreases, both overall efficiency of the cycle and return on investment substantially drop down.

To address this issue, the Thermodynamics Research Group at VUB is investigating hot liquid water injection in mGTs through a cycle known as micro Humid Air Turbine (mHAT). In an mHAT, the residual heat in the flue gas residual heat is used to warm up water, which is then re-injected in the cycle instead of being used for external heating purposes. In this way, in moments of low heat demand, the process' 'waste' heat is re-utilised to increase the electric efficiency of the facility. A model of an mHAT cycle, based on the Turbec T100 mGT, has been developed in Aspen Plus and simulations prove that a 15% relative electric efficiency increase is possible with water injection. In addition, the Turbec T100 mGT present at the research group's lab has been transformed into an mHAT by adding a saturation tower and the required sensors and piping system. Preliminary tests have shown that operation with water injection is stable. Finally, an economic analysis has been carried out to assess the potential application of mHAT technology for domestic purposes. As a result, the cases in which investing in mHAT technology is profitable have been outlined.

Future work within this project includes the full experimental characterization of the mHAT and the development of an optimisation tool to determine the optimal operation mode of the facility