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Influence on the electrical efficiency of a hybrid MGT-SOFC-System by μ-fogging in a two stage compressor system

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Abstract. Hybrid combinations of solid oxide fuel cell and recuperated micro gas turbines can convert chemical energy of hydrocarbon-based fuels in electrical energy with a high electrical efficiency. With an integrated and improved cycle management, more than 70% of the energy content of the fuel could be converted into electrical energy. Therefore, the systems are highly suitable for PowerToGas conversion. In particular, a pressure charging of the SOFC fuel cell leads to an increase in stack performance. By a downstream turbo set, after residual fuels are intentionally oxidized with an afterburner, additional electrical energy can be gained from the expansion of the hot exhaust gas stream and the overall efficiency can be increased. In order to increase the electrical efficiency of the system, it is proposed, to ensure the required compression of the process air in particular by a two-stage turbo compressor with an intermediate cooling system. By thus achievable reduction of the dissipation of the compressor and by targeted condensation of finest drops in front of the second compressor stage affected by intermediate cooling, an increase in efficiency of the system is possible. It is achieved by targeted cooling down the process air rear of a low-pressure compression, so that there saturation above 100% relative humidity is given. As a result, a slightly supersaturated airflow is available for the second compressor stage, which enters the compressor after heat removal via an intermediate cooling having a small amount of microdroplets. Therefore, the condensed water evaporates again by the heat of compression in the second stage and the compressed flow ultimately enters the recuperation at a lower temperature than during normal compression. Thus, more heat can be recovered within the recuperation system. Therefore, the electrical energy of the system can be produced having a higher efficiency, because the heat dissipation of the overall system decreases. In this article it is presented, how such a process is thermodynamically modelled and how a technical realization can be built after optimization by simulations. Finally, in a study, the process-influencing factors are analyzed to show the highest possible electrical yield of such a system.

Keywords: MGT-SOFC, Hybrid System, Fogging, Fuel Cell, micro gas turbine.