’Control Strategies of Solar-powered Micro Gas Turbine’

Shahrbanoo Shamekhi Amiri | School of Mathematic, computer science and Engineering

Introduction

Micro Gas Turbine (**MGT**) combined with solar energy is a highly promising technology for small-scale electric power generations in remote areas. The combination of MGT with concentrated solar power (**CSP**) dish aims to replace photovoltaic systems in the future.

Microturbines are regarded as systems with a nervous dynamic behaviour due to the low mechanical inertia of the shaft. Therefore, the analysis of transient behaviour of this system by a suitable dynamic model is considered an important procedure.

Dynamic modelling is provided for two main reasons: to investigate the system response to disturbance, and to improve **control systems**.

Problem / Question

- In fueled MGTs, fuel flow rate is the controlling variable, but in solar-powered systems, there is no control on the energy input. **What to do to overcome this issue?**
- The development of control strategies and predicting any damage as a result of sudden changes in DNI and load cannot be done only by steady state analysis. **So what is needed?**

Solutions

- Controlling the **input voltage** into the rectifier and consequently changing the **speed.**
- **Changing the air mass flow rate with** an auxiliary compressor and a bleed valve discharge, or two three-way valves.
- A reliable **dynamic model** to evaluate the transient performance of the system with devised controllers, and modify or develop them to reach a **sustainable system.**

Materials and Method

- 0-D thermo-mechanic dynamic models that are suitable for real-time simulations are mainly **iterative** and **inter-component volume** models.
- The former is only suitable for a normal operation mode and does not include mass imbalance. The latter consists of mass imbalance that helps the model describe its dynamic behavior more precisely.
- A dynamic model of the generation system of MGT is also required to model speed controller.
- So far, the **iterative model** has been made in **Matlab/Simulink**.

References

- 1.Amelio, M., et al., *Dynamic simulation of the temperature inlet turbine control system for an unfired micro gas turbine in a concentrating solar tower.* Energy Procedia, 2018. **148**: p. 712-719.
- 2.Ghavami, M., *Cycle Analysis And Optimisation Of Micro Gas Turbines For Concentrated Solar Power.* 2017.
- 3.OMSoP, *OMSoP project.* 2013: p. Website: https://cordis.europa.eu/project/id/308952.
- 4.Lin, P., et al., *Modeling and controller design of a micro gas turbine for power generation.* ISA Transactions, 2020.

Discussion

- The transient response of the provided model has shown that all system variables reach their values of the **design point** after a while.
- In order to analyze the stability of the system by using the mentioned controllers during DNI and load changes, the iterative model can provide a reasonable accuracy for **small changes**.
- **Controlling the speed** with the help of altering voltage into rectifier can result in different operation strategies.
- By **changing air mass flow rate**, overheating of the receiver will be prevented and the output power will be controlled to be suitable for **load-oriented conditions**.
- **Changing air mass flow rate** causes decrease in overall efficiency of the system.

Conclusion

- The iterative dynamic model that has been made provides an acceptable result.
- In order to evaluate the transient behavior of the devised controllers, a more accurate model is required.
- Control strategies in fueled MGTs and solar-powered MGTs are different with each other. In solar-powered MGTs, changing air mass flow rate and speed are suitable choice for controlling the system.
- In or der to evaluate transient performance of speed controller, a model of **generation system** is required.