Transient model of a gas turbine driven compressor

- a way to predict the future

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Gas turbines are huge and complex machines, and a designing mistake can have large consequences. Due to this it is important to have the ability to predict its performance, regardless if it produces electricity or, as in this case, drives a large natural gas compressor at a pipeline station.

Gas turbine applications

Gas turbines are widely used all over the world. Industrial gas turbines appear in different applications, which can be divided into two main categories; Power Generation (PG) and Mechanical Drive (MD). In a PG application the gas turbine is connected to a generator with the purpose to produce electricity in a power plant. In an MD application the turbine is instead used to produce rotational work for a driven component, and not a generator. This component can, as in this project, be a compressor that transports natural gas in a pipeline.

Simulate to predict future

In MD applications the driven component may cause varying loads (called *transients*), that have a big impact on the behaviour of the gas turbine. It is therefore important to predict how the gas turbine is affected by different operation sequences, when designing the system. Siemens has solved this by developing simulation models in a software called Dymola. By simulating the behaviour it is possible to predict parameters as temperature, power and efficiency, even before the machines are constructed. The existing models are mainly for PG applications though, why there is a great need for MD simulation models. That was the objective of this project; to design a transient model for a compressor train, containing both the compressor and the gas turbine. This model is then used to study how physical and controller parameters affect the gas turbine behaviour.

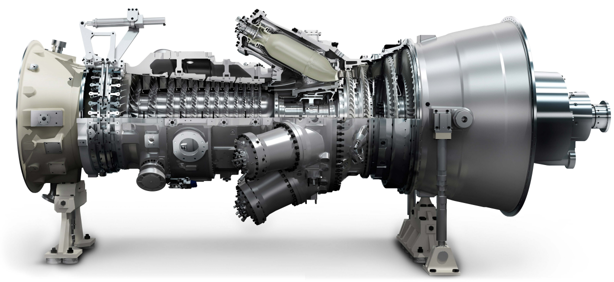

Figure 1: SGT-750

Simulation versus reality

To make sure that the simulation model were reliable and corresponded to reality it had to be verified with data from existing machines. The driven compressor was designed according to specifications from the compressor manufacturer to a project in El Encino, Mexico, where a pipeline compressor station is under construction. With a comparison between simulation results and the given compressor data it was possible to tune in the compressor model. When the modelling of the compressor was finished it was connected to a model of a Siemens Gas Turbine 750 (SGT-750), the one used in El Encino. This compressor train had to be verified as well. This was done with data from an MD site, Eischleben, with a driven compressor. Since the SGT-750 is a new gas turbine model there is yet no data from an MD site with this turbine. Because of that the Dymola model was verified with sites equipped with its forerunner, the SGT-750.

Results

The verification results is shown in Figure 2, where normalized speeds are plotted. It can be seen that the simulation results (dotted red line) corresponds well to the site data (Eischleben, solid red line). The black lines represent the driven compressors and depend thereby on what type of driven compressor the gas turbine is driving. In the figure it can be seen that the driven component on the site not have the same preferences as the one simulated, at El Encino.

The report also shows how some chosen controller parameters affect the gas turbine behaviour. For example it has been seen that a lower fuel ramp during the start-up sequence contributes to a more stable start.

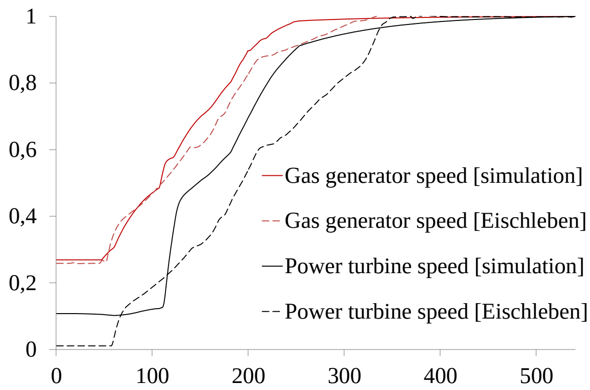

Figure 2: Normalized speeds as a function of time

Conclusion

The verification shows that the developed model corresponds to reality. The gas turbine control system is made as general as possible which makes it applicable to different gas turbines and applications, both for power generation and mechanical drive. With this model it is now possible to study how the gas turbine design can be optimized for a mechanical drive application.