Optimization of Power System Stabilizer Parameters at the Gabčíkovo Hydroelectric Power Plant

Ing. Adrian ILKA, PhD.

Vodohospodárska Výstavba, š.p. (Water Construction Company, State Enterprise), Karloveská 2, P.O.BOX 45, 841 04 Bratislava, adrian.ilka@vvb.sk,

Institute of Robotics and Cybernetics, Faculty of Electrical Engineering and Informatics, Slovak University of Technology in Bratislava, Ilkovičova 3, 841 04 Bratislava

Ing. Jozef MATLAHA

Vodohospodárska Výstavba, š.p. (Water Construction Company, State Enterprise), Karloveská 2, P.O.BOX 45, 841 04 Bratislava, jozef.matlaha@vvb.sk

Ing. Martin ERNEK, PhD.

Institute of Robotics and Cybernetics, Faculty of Electrical Engineering and Informatics, Slovak University of Technology in Bratislava, Ilkovičova 3, 841 04 Bratislava, martin.ernek@stuba.sk

Ing. Tomáš MURGAŠ

Systémy priemyselnej informatiky, s.r.o., Karpatské námestie 10A, 831 06 Bratislava, tomas.murgas@syprin.sk

ANNOTATION

The stability of the power grid is crucial for the reliable operation of synchronous generators, with active power oscillations posing a significant threat to its integrity. At the Gabčíkovo Hydroelectric Power Plant (HPP), measures are being taken to optimize the damping of active power oscillations through the use of a Power System Stabilizer (PSS), which is an integral part of excitation controller in these generators. Our ongoing project focuses on analyzing and optimizing PSS parameters, reducing the risk of instability, and improving overall operational efficiency. Specific tasks include analyzing the current state of excitation control, measuring transient and frequency characteristics, creating and validating simulation models, as well as proposing and verifying new PSS parameters. This systematic approach to optimization holds potential not only for Gabčíkovo HPP, but also for other facilities facing similar challenges, providing a foundation for improved operational stability and efficiency across a broader range of synchronous generators.

KEYWORDS

Power system stabilizer, Optimization, Excitation control, Hydroelectric Power Plant.

1. INTRODUCTION

Oscillations in power systems are categorized as safe or dangerous. Safe oscillations typically arise from improper settings of excitation controllers and stabilizers, with frequencies above 4.7 Hz. On the other hand, dangerous oscillations can cause instability in the power grid. These include local oscillations between turbo-generators and the power system, inter-area oscillations between different parts of the power system, and torsional oscillations. The role of PSS in damping these oscillations is critical for maintaining system stability.

2. OBJECTIVE

The primary goal of the project is to enhance the stability and performance of Gabčíkovo HPP power sources by:

1. Analyzing the current state of excitation regulation on *Gabčíkovo HPP* power sources.
2. Measuring transient and frequency characteristics of selected *Gabčíkovo HPP* sources to create accurate simulation models.
3. Comparing simulation model outputs with measured data to optimize the performance of the excitation and stabilizer systems.
4. Optimizing PSS parameters based on the technical criteria of SEPS, a.s. and the specific technological constraints of *Gabčíkovo HPP* power sources.

3. METHODOLOGY

The project involves extensive measurements and simulations to model the dynamic behavior of Gabčíkovo HPP power sources. Measurements include transient response and frequency characteristics of synchronous generators under various operating conditions, both with and without PSS activation. The data is then used to create detailed simulation models of excitation systems, including controllers, and stabilizers. The simulation models allow for the analysis and optimization of PSS structures to improve damping and reduce oscillations.

4. RESULTS

The analysis revealed that the damping of power oscillations can be significantly improved by optimizing the PSS parameters. By conducting tests on various Gabčíkovo HPP generators, including measurements at different power levels (45 MW, 60 MW, and 90 MW), the optimal settings for PSS structures were identified. The results indicate that optimized PSS structures can reduce oscillation amplitudes and stabilize the grid more effectively, ensuring safer and more reliable operation of the Gabčíkovo HPP power system.

5. CONCLUSION

The optimization of PSS structures and parameters in Gabčíkovo HPP power sources is critical for enhancing system stability and reliability. The results of this project demonstrate the potential for significant improvements in damping power oscillations, which will help mitigate risks associated with dangerous oscillations and improve overall power grid performance. The methodology and findings from this project can be applied to similar power systems, ensuring better performance and system stability.