SIEMENS energy

Substantial improvement in power generation

Small Hydro Sipocon-H Optimizer

Renewable Energy Production

The hydro power plant system is composed of specifically designed and harmonized components. As a tailor-made solution it aims to fulfill customers' requirements. To achieve the targeted performance of the plant, the overall process control system optimally manages the interaction of the components. It offers numerous ways to select modes, to switch between states and to prioritize operational aspects also dynamically.

The Challenge

The hydropower plant, through its complexity and interaction of components, is designed based on available basic raw data. Even if this original data is of high quality, the actual physical situation after installation will always be different.

When operating a plant over time it becomes apparent that conditions and parameters change throughout the plant's lifetime.

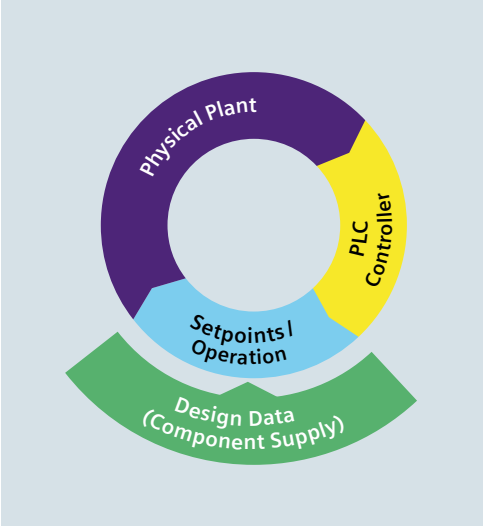

Figure 1: Real physical plant conditions deviate from the ideal design

Consequently, key performance targets, such as maximum efficiency based on water availability or maximum lifetime of components or maximum productivity including maintenance and service aspects, etc., will not always be achieved.

The standard array of setpoints for the operating range is based on the plant design data. The plant design and therefore the setpoints are based on scaled model tests under laboratory conditions and rounded out by the design of specific components.

These setpoints are fed into the process control system. This means that the standard control loop is for ideal conditions of the plant which will not exist under actual circumstances.

The Task

The precondition for operation and performance of the hydropower plant is completely determined by both the plant's individual components and the dynamic boundary conditions at the installation location. To take this into account for operation and for improving the controlling quality, these insights must be considered and implemented in the controller structure.

Your Benefits:

- Improved turbine efficiency
- More power generation with the same water flow
- Continuous adaptation to changing conditions
- Identification of weak points of plant operation
- Independent from turbine OEMs
- Adaptability to your Siemens PLC hardware

Plant performance optimization with Sipocon-H

Applying specific engineering expertise, a virtual plant model is created, forming a so-called digital twin. Knowledge of the essential physical influencing parameters and their correlation is the key to generating the corresponding digital twin.

The optimization tool Sipocon-H optimizer uses the digital twin and creates operational setpoints for the specific given conditions. By calculating the complete characteristic field of the virtual plant model, the best setpoints for actual power plant unit operation are evaluated. The algorithm of the Sipocon-H optimizer operates independently as a stand-alone solution and can be entered into the turbine governor system offline.

The setpoint array can be improved by calibrating with flow measurement. As an example, the graph in Figure 3 shows the overall improvement of plant efficiency (purple line) by optimizing the runner-guide-vane relationship. The originally measured efficiency is shown (blue line) as a comparison. Potential improvement of up to 7% is obtained, in particular in the part-load range. This total efficiency difference across the whole operational flow range is shown in detail in Figure 4.

Adaptive Turbine Governor

Much can occur over the lifetime and operating period of the plant unit. This can include misalignment of the adjusting mechanism for moving parts, varying reactive power during operation. That may affect the production performance as well as aging effects such as erosion, abrasion and sedimentation.

Consequently, consideration of these effects in the model leads to an updated recalculation of the optimum setpoints and an actual "new current state" of the plant.

This issue is solved by the adaptive turbine governor Sipocon-H, which offers dynamic evaluation of the operational setpoints.

Continuous adaptation is conducted for the updated situation to provide maximum performance in line with the plant operation strategy goals. This solution can either be used for a green field plant or for a modernization project.

Capture the potential of your Hydroelectric Power Plant

Do you plan to run a newly built Hydroelectric Power Plant or aim to retrofit your existing units? Siemens Energy Plant Optimization will drive optimal operation setpoints for your Power Plant using Siemens Energy Turbine Governor PLC.

This model may be applied as a setup for a perfect startup point or can also be integrated as an adaptive approach for continuous or periodic optimization routines.

Get in touch with our experts!

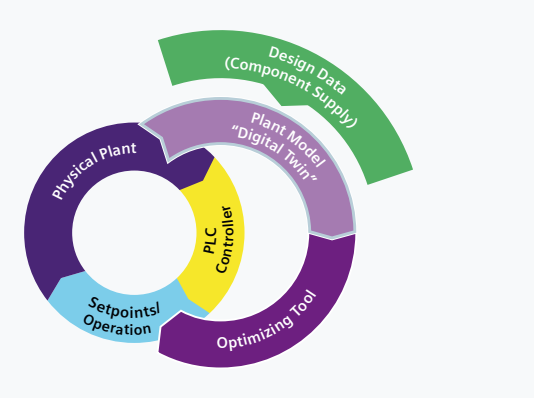

Figure 2: The optimizing solution integrates the actual states of the plant and its components

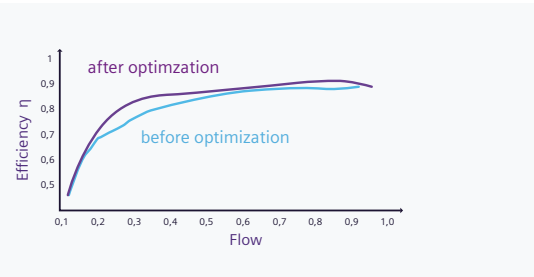

Figure 3: The diagram shows the original measured turbine efficiency (blue) and the results after optimizing the operational setpoints (purple)

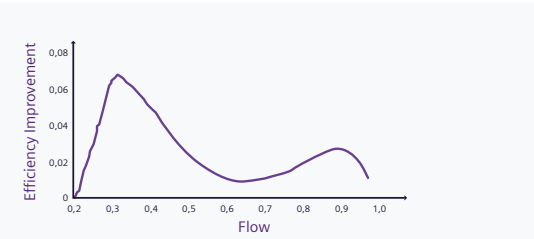

Figure 4: The diagram shows the turbine efficiency improvement at different flow rates after the optimization

Published by

Siemens Energy © 2021

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