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NUTECH CONTROLLER CASE STUDY

Introduction

Kaplan turbines by means of their dual regulation have the capability to provide high efficiency output over a wide range of flow and head. NuSTREEM's patented NuTECH Controller (NTC) provides the intelligence to tap the unused potential of any Kaplan turbine by maximizing efficiency regardless of the hydraulic or machine conditions.

Paradigm Shift in Optimization

The common method to optimize the output of a Kaplan is to use combination or cam curve. Cam curves as delivered by manufacturers are typically based on either scaled model tests, simulations such as those based on computation fluid dynamics or results from both types of modeling. These methods can produce non-optimal results due to scaling effects or modeling uncertainty among other reasons. Index testing aims to improve manufacturer cam curves by characterizing the turbine in operation. Such testing typically requires expensive consultants, downtime for the unit under test, and optimizes only for one value of head.

One aspect of the innovative design concept of the NTC is to make cam curves and index testing a thing of the past by optimizing for each operating point. This approach ensures that any inefficiencies by operating at a different condition in which the cam curve was generated are eliminated. The monetary benefit is twofold by improving efficiency over what is typically achievable via cam curves and index testing as well as eliminating the cost associated with the index testing. The other innovation of the NTC is to perform the optimization without requiring a measurement of the flow through the turbine. There are several advantages to optimization without a flow meter:

1. Significant reduction in cost
2. Significant reduction in installation effort and time
3. Faster optimization convergence
4. Less wear and tear on actuation hardware

Note that the last two advantages depend on the oscillatory nature of the flow feedback and are, therefore, expected to be site specific.

NTC Performance Evaluation

Initial performance testing of the NTC has been performed at a nearby hydropower site. Nustreem temporarily installed the NTC such that one of the Kaplan turbines at the site could be controlled by the NTC. The NTC cabinet is shown in Figure 1.

Figure 1 – Picture of NTC Installed during Performance Evaluation

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The site has an ultrasonic flow meter that measures the total flow in the penstock feeding the site. Testing was performed with only the one turbine generator unit controlled by the NTC in operation. With the unit in power control mode the performance was evaluated with the NTC. In order to have a baseline for comparison the performance of the unit was also evaluated with the original cam curve. Figure 2 shows that there is an efficiency gain throughout the operating range but that it is most prominent at low flow and power.

The NTC is available as a complete control system when delivered with NuSTREEM's NuTURBINE. As a standalone product the NTC is intended to be fielded as a controls systems add-on that interfaces via a standard communications protocol to a pre-existing plant controls. This approach minimizes installation effort and time as well as risk to the safety of the equipment.

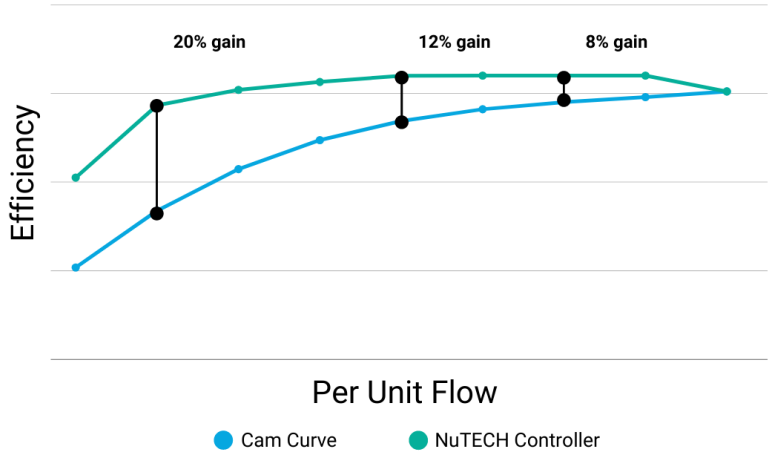

Figure 2 – Comparison of TG Efficiency with NTC's Optimization vs. Original Cam Curve at Maximum Site Head

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