Analysis of Kaplan Turbine for electricity generation

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Abstract

For electricity generation, various renewable resources are utilized wherein hydro-power production is one of the most important sources. Hydro-power turbines are in two categories as "impulse and reaction" wherein "Kaplan turbine" is a reaction-type. The efficiency of the turbine is extremely influenced by its sprinter wheel. "Kaplan turbine" is basically a "propeller type turbine" that has adjustable blades. In general, the " blades" inlet/outlet angles demonstrates a significant influence on the turbine's power output [1], [2].

Keywords: hydropower, turbine, Kaplan, blades, electricity

Introduction

In today's world, harmful emissions and greenhouse gases that are causing severe climate alterations and an enormous environmental-pollution all over the world. Hence, different areas are dreadfully researching for possible green alternatives to reinstate the widely used fossil fuels where renewable energy sources would be their key precedence. Although the use of these renewable energies would not solve the problems over night, it would be the best move to solve the prevalent issues in the long-run. Under these circumstances, renewable energy sources such as hydro, solar, wind, geothermal, wave and tidal current have been the current major focus of the global energy sector. Hydropower is the largest in today's scenario and the most reliable source of renewable energy generation. In last one decade, hydro power generation accounts 16.3% from the worldwide electricity-generation and some of the relevant facts. Wind turbines work only when wind is blowing, Solar panels perform well only when the sun is shining but water is quite constantly flowing in the rivers. Hence, hydropower plants can be found all over the world and their turbines can have efficiencies of up to 95% depending on the model type . The design of the runner-blades is the crucial for an efficient-turbine. The blades extract the energy of the flowing water and converts into rotational energy and then to electrical energy. Therefore, the blade design optimized to extract as much energy as possible to achieve the highest possible efficiency but is also endangered for cavitations. Hence, it is timely important for advancement hydropower turbines for improving their power generation capacity/efficiency [3]–[5].

"Kaplan Turbine" works on the principle of "axial flow reaction". In "axial flow turbines", the water flows through the runner along the direction parallel to the axis of rotation of the runner. The water at the inlet of the turbine possesses both kinetic energy as well as pressure energy for effective rotation the blades in a hydro-power station [6].

Result and Conclusion

Progressively improved turbine model wherein the Kaplan turbine model is further proposed which reflects the effects of the wicket-gate opening and the blade opening changes on the turbine mechanical power (i.e., it regards the effect of blade opening on Kaplan turbine as increasing flow amount) and has a high-accuracy through the comparison of the simulation and the measured results. The power disturbance test and the frequency disturbance test confirmed that the established governor model, the dual-regulated vane and blade control system model, and the nonlinear Kaplan turbine model reflected the dynamic response of the Kaplan turbine adequately, which could be applied in the power system analysis.

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