Improving Annual Energy Production at Temengor Hydroelectric Reservoir via Probabilistic Annual Reservoir Release Decision with Monthly Reservoir Release Update

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Abstract

One of the important operational decisions to be made by any management of hydroelectric power plant associated with annual storage reservoir is to determine the optimized reservoir release that enables firm energy generated estimation for next operational year. This task is usually a simple and straightforward task provided that the amount of reservoir release is known. The more challenging task is to determine annual release decision that is able to resolve the two conflicting operational objectives; (1) minimizing the drop of turbine gross head, (2) maximizing upper reserve margin of the reservoir taking into consideration future inflow for the system is stochastic in nature. The first requires minimum annual release and the letter requires maximum annual release. It is impossible to comply with (1) and (2) above simultaneously, but it is possible to optimize them.

This paper illustrates the mathematical treatment in determining the rigorous solution for "criterion for optimality" under two conflicting operational objectives. The criterion can be used to determine optimal reservoir release decision that maximizes potential energy by assuming long term annual inflow data are normally distributed around the known average. The mathematical derivation has proven that annual reservoir release shall be made in such a manner that annual return inflow that has return frequency smaller than the reservoir's critical return frequency (f_c) has no merit to be considered. This "criterion for optimality" enables upper reserve margin of the reservoir can be regulated around the known value to ensure the reservoir level shall not fall lower than its optimized value. To further optimize the release decision, monthly time step reservoir release update is incorporated. The premise used is "to keep the inflow that can be kept as long as possible and to release the inflow that cannot be kept as fast as possible". This premise enables only actual inflow that cannot be kept by upper reserve margin of the reservoir will be released in short future. Thus, enables the fore bay elevation (FBE) of the reservoir to be kept as high and as long as possible. Therefore higher potential energy utilization from the prevailing inflow can be expected due to higher turbine gross head. One year application results of the proposed methodologies at Temengor hydroelectric reservoir in Malaysia show that an improvement of potential energy utilization by 2% has been observed.