DAILY OPTIMAL OPERATING POLICY OF HYDROPOWER SYSTEMS

Ahmed BENSALEM[1], **Ali EL-MAOUHAB**[2], **Salah-Eddine ZOUZOU**[3]
[1] Department of Electrical Engineering. Faculty of Engineering
University of hadj Lakhdar, 05000 Batna. ALGERIA.
Tel: +213–33–927287, Fax: +213–33–815123, Email: a_bensalem_dz@yahoo.com

[2] Department of Electrical Engineering. Faculty of Engineering
University of houari Boumèdienne, 16000 Algiers. ALGERIA.

[1, 3] LEG Laboratory, Faculty of Engineering Science and Engineering
University of Mohamed Kheider, B.P 145 - 07000 Biskra. ALGERIA.

.

Abstract: - *In this paper, we have presented a new model for daily operating policy of hydroelectric power systems, which consists to maximize the potential energy of the whole system. The method used for the solution is based on the discrete maximum principle for determining the optimal daily operating policy of hydroelectric power systems consisting of multi-reservoirs, where the objective is to maximize the potential energy while satisfying all operating constraints over a short-term planning horizon. The major focus of this paper will be also the treatment of the two-sided inequality constraints using the augmented Lagrangian method. The proposed algorithm takes into account spilling and time delays between reservoirs. The proposed algorithm is tested on a large hydroelectric power system consisting of ten reservoirs. The developed algorithm gives a satisfactory solution for the problem and turns out to be very efficient.*

Key-words: *Daily operating policy, potential energy, discrete maximum principle, augmented Lagrangian method.*

1. Introduction

The daily optimal operating policy of hydropower systems is a deterministic problem [1][2], which consists in determining the amount of water to be discharged from each reservoir of the system over the day so that to meet the hourly load demand assigned previously. The prime objective here is to perform the operating policy with the lowest use of water; which is achieved by avoiding spilling and by maximizing the hydroelectric generation, besides satisfying all operating constraints. The maximization of electrical power production is achieved by maximizing the heads. Consequently, this allows maximizing the reservoirs content.

When modeling the problem, and for more accuracy, the following factors which make the problem more complex are taken into consideration; significant water travel time between reservoirs, the multiplicity of the input-output curve of hydroelectric reservoirs that have variable heads, the maximum generation of the hydroelectric plant varies with the hydraulic head i.e. the quantity of water required for a given power output decreases as the hydraulic head increases, the water stored in the upstream reservoir is more valuable than that stored in the downstream reservoir, whether the reservoirs have very different storage capacity and whether the system has quite complex topology with many cascaded reservoirs.

To solve the daily operating policy problem, we use the discrete maximum principle [3-4]. While solving the equations relating to the discrete maximum principle, we use the gradient method [3]. However, to treat equality constraints we use Lagrange's multiplier method. To treat the inequalities constraints we use the augmented Lagrangian method [5]. The present paper is concerned particularly with the treatment of the constraints on the state variables, which are of two-sided inequalities. The augmented Lagrangian method is proposed to deal with this type of inequalities.

The hydroelectric power system considered in this paper consists of ten reservoirs hydraulically coupled, i.e., the release of an upstream reservoir