LARGE SCALE PUMPING SYSTEM SCHEDULING USING SCATTER SEARCH, TABU SEARCH AND NEURAL NETWORKS THE CASE OF BOUREGREG WATER SYSTEM IN MOROCCO

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1 Introduction

Water pumping is an energy intensive activity, as electricity cost rises and water needs increases water service related use and associated cost became a heavy load for water utilities. Recently the electricity utilities introduced different tariff structure to manage the cost load. This represents an incentive to the electricity users to take advantages of off peak prices while shifting the load for the electricity utilities resulting in peak saving for them.

This win-win strategy affords a cost effective option for water pumping peak load management. Pumps can be scheduled to take profit of the off-peak rates, minimizing the electricity cost.

In the case of pumping with storage like municipal water pumping, pumps can be operated at its best efficiency point, matching with system characteristics subject to storage, treatment limits and consumption requirement. The control is only “on” or “off” the pumps at an optimal schedule to minimize the peak demand and therefore the electricity cost.

Also Flexibility in selecting the pumps as per the load and efficiency characteristics in a multi-pumping system will also reduce the energy consumption.

As optimal pump schedule directly relates to storage and treatment capacity limits, these variables should be integrated in the early phase of system design of the water facilities to provide optimal storage and optimal treatment capacity for a given system considering the cost parameters.

The problem of finding the optimal operation strategy is not straightforward. Both users demand and the electricity tariff can fluctuate greatly through a typical operating cycle – electricity tariffs are varied in an attempt by power suppliers to shift or distribute the load more evenly in order to operate at as high a load factor - that is, the ratio of the actual energy consumption (kW.hr) to the maximum power recorded (demand) over a period of time as possible and minimize electricity costs. As an outcome, the user of energy is encouraged to use off-peak energy with preferential tariff system.

The number of possible operation strategies becomes also vast for a system with more than a few pumps and reservoirs. Added to the above is the fact that the hydraulic behavior of water production and distribution systems is highly non-linear, making computer modelling complex and a time consuming process. A logical solution is to develop a set of rules that would manoeuvre system operation, maximize efficiency and minimize costs for a particular system configuration and demand pattern. This is a complex problem to solve as indicated above and has been attempted by several researchers using various mathematical tools.

We propose a nonlinear programming approach that yields practically satisfactory pumping schedules in acceptable computing time even for large system with several pumps. Based on a carefully designed software using Scatter Search, Tabu and Neural Networks in hybrid optimization algorithms, this approach employs a special initialization strategy for convergence acceleration, special minimum up and down time constraints together with pump aggregation to handle switching decisions, techniques for further speed-up. Results for selected application scenarios at Morocco largest water production system “Bouregreg” demonstrate the success of the approach.

The applied methodology has allowed the slash of the energy cost per day of about 23% wish represent substantial savings for the company. The applied methodology has also come out the optimal reconfiguration of the system by reviewing the sizing of the different components of the plant.

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