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THE MODELLING AND OPTIMAL SCHEDULING FOR PRESSURE AND FLOW VARYING PARALLEL-CONNECTED PUMP SYSTEMS

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Abstract. The paper first analyzes the general used modelling methods of optimal scheduling problem for the pressure- and flow-varying parallel-connected reciprocating plunger pump systems. One commonly adopted approach is to take the shaft horsepower of pumps as objective function with the water-supply index and the high-efficiency operation ranges of pumps as its constraints, but the formulated optimization problem has too many constraints and is difficult to be solved. The other popular strategy is to use the square of the difference between the actual and expected water flow as the objective function. While the constraints are only the high-efficiency ranges of pumps, the obtained model does not match the actual operation properly. Based on the analyzes, a new modeling method is then proposed, which is not only compatible with the actual operation, but also has the advantages of with fewer constraints as well as lower pump switching frequency. An example is given to show the validity and feasibility of the proposed method.

Keywords. Optimal scheduling, Constrained nonlinear programming, Reciprocating plunger pump, Speed regulation of pumps.

1 Introduction

Energy problem has been attracted increasing attention over the world. In water engineering, the electric energy cost consumed by pumps accounts for over 60 percent of the total water supplying cost, while the consumption of electric energy by pumps is over 21 percent of the total electric energy consumption annually in China [1]. There is no doubt that the research on energy saving problem for pump system is of great economic significance.

Most of the current pumps installed in China are based on maximizing their flow and head even in the worst operational conditions, while the actual flow and head are less than the maximum in the general case. To save energy, it is necessary to make pumps operate adaptively to the variable load. Although it is still very common to regulate water flow via valves in many enterprises, such a scheme results in additional energy consumption on the valves and further reduces the efficiency of pumps. To overcome this problem, some enterprises make use of water-supply control system to