张礼华,程吉林,张仁田,龚 懿.基于试验-整数规划方法的泵站多机组变速优化[J].农业工程学报,2011,27(5):156-159

基于试验-整数规划方法的泵站多机组变速优化

Research on optimal operation for multi-units with variable speed in one pumping station based on the theory of experimental and integer programming method

投稿时间：6/20/2010 最后修改时间：5/9/2011

中文关键词: 线性整数规划 优化 模型 江都四站 变速 峰谷电价 试验选优

英文关键词: linear integer programming optimization models No.4 Jiangdu Pumping Station variable speed peak-valley electricity price experimental optimization method

基金项目: 国家“十一五”科技支撑重大项目（2006BAB04A03）、国家自然科学基金项目（60974099）、教育部博士点基金项目（20093250110002）资助.

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中文摘要:

以国家南水北调东线源头泵站江都四站为例，进行泵站多机组变速优化运行探讨。提出了考虑峰谷电价、长江潮汐变化的站内多机组日变速优化运行非线性模型：在水泵设计叶片安放角不变的情况下，以站内机组耗电费用最少为目标函数，时段为阶段变量，水泵转速、开机机组台数为决策变量，日提水量为约束条件。提出了各阶段水泵转速试验选优、机组开机台数线性整数规划优化的方法对模型进行求解。优化运行结果表明：考虑峰谷电价，日均扬程7.8～3.8m，与额定运行相比，100%负荷运行时，单位提水费用节省介于-3.58%～-2.14%之间，说明在此条件下，变速优化运行效果不足以抵消变频器损耗，80%、60%负荷运行时，单位提水费用节省分别介于11.38～15.71%、24.79～29.17%之间，优化效果明显；不考虑峰谷电价，日均扬程7.8～3.8m，与额定运行相比，只有在日均扬程较低、提水负荷较小（5.8m，60%负荷；4.8m、3.8m，80%、60%负荷）时，变速优化具有一定的效益，在其余日均扬程、提水负荷条件下，变速优化运行效果均不足以抵消变频器损耗。为受潮汐影响的大型泵站多机组变速优化运行提供了新的思路。

英文摘要:

Taking No.4 Jiangdu Pumping Station as a study case, which is one of the source stations in Eastern Route of South-to-North Water Diversion Project in China, the optimal operation of single pumping station for multiple pump units with variable speed was studied. The non-linear model of optimal daily operation for multiple pump units with variable speed was constructed with consideration of peak-valley electricity price and tides variation. Keeping the blade angle of pump unit at designed value, this model took the minimal electricity cost of multiple pump units as objective function, the time period as stage variable, the pump speed and quantity of operation units as decision variables, and the quantity of daily water pumped as constrain condition. The method which took the pump speed for experimental optimization, the quantity of operation units for linear integer programming was proposed to solve the model. The optimization results showed that under the average daily head of 7.8-3.8m, considering peak-valley electricity price and with 100% loads, the cost saving of water pumping per unit was -3.58%~-2.14% compared with operation in rating state, which showed that the optimization effect could not counteract the energy loss carried out by frequency converter. While under 80% and 60% loads, the optimization effect was obvious and the cost saving was 11.38%-15.71% and 24.79%-29.17% respectively. Under the average daily head of 7.8~3.8m, without considering peak-valley electricity price, the optimal operation had some benefits only under the low heads and with small operation loads (such as 5.8 m and 60% loads; 4.8 m and 80% loads; 3.8 m and 60% loads). While under the other heads and loads, the optimization effect could not counteract the energy loss carried out by frequency converter. The results can provide a new way for optimal operation of large-scale pumping station influenced by tides for multiple pump units with variable speed.

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