ABSTRACT

Adaptive Forecasting System of Hourly Municipal Water Consumption with Optimum Pump Scheduling for Water Distribution Systems. (December 1995)

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The cost of pumping water in municipal water distribution systems is a major concern in almost every city and town in the United States. Significant cost savings can be achieved by using hourly water demand forecasts for input to an optimization program which selects efficient pump combination and optimally utilizing elevated storage tanks in the system.

This dissertation presents an adaptive approach to on-line forecasting of hourly municipal water use time series. The proposed seasonal time series model and adaptive forecasting algorithm can capture both weekday and weekend demand characteristics to produce very accurate forecasts from one to twenty-four hours ahead. The methodology is based on using the recursive least squares (RLS) and the Kalman filter algorithms in tandem. The RLS is used for estimating and updating coefficients of the hourly seasonal time series model. The deseasonalized residuals are passed on to the filter to correct for residuals' biases and autocorrelations which may be caused by external dynamical effects such as changes in the weather condition. The validation tests conducted in this study successfully show that the forecasting system can maintain surprisingly small prediction errors and produce robust forecasts for long forecast lead times despite various unmodeled time-varying climatic disturbances.

An optimum pump scheduling program based on the dynamic programming algorithm is presented. The pump scheduling program uses hourly water consumption forecasts as on-line input. It is found that optimality of the pump schedule is sometimes affected by the forecast error which can cause an increase in both the total and peak energy consumptions. Forecast errors may also cause the water in an elevated water storage tank to drop below the minimum reserved level. The effects of forecast error on electric energy costs are studied in this research through a macroscopic distribution network simulation model. The results of this study provide some guidelines for water utility personnel to follow in the presence of forecast error.