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Hourly Ambient Air Humidity Fluctuation Evaluation and Forecasting Based on the Least-Squares Fourier-Model

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Abstract: Air humidity is one important measurement parameter involved in a wide range of fields of science and engineering. This study addresses Fourier-series-based evaluation and prediction of hourly ambient air humidity fluctuation. It is shown that hourly ambient humidity fluctuation displays a significant 24-hour cyclical variation. Then on the basis of daily periodic extension for hourly ambient air humidity fluctuation, a finite Fourier-series-based evaluation model is introduced for describing its hourly fluctuation. The Fourier-based analysis in its conventional form, however, can not be straightly applicable to prediction. Then in combination with the least-squares method for coefficient-seeking based on finite observations of hourly air humidity, the extended version of the Fourier-series model in the least-squares is proposed for forecasting. The proposed Fourier-series-based method is applied to experiments of evaluating and forecasting hourly air humidity fluctuations at different monitoring stations with satisfying results. The experimental results, further mathematical analysis of the conjugate symmetry property and spectrum characteristic analysis for the Fourier-series involved in the Fourier-based model indicate that daily 24-hour air humidity fluctuation is well described by about 12-term harmonics and the extended Fourier-series forecasting model predicts the hourly humidity fluctuation best fitting with less than 6-term harmonics.

Keywords: Hourly air humidity; Fourier analysis; Least-squares-optimum; Evaluation; Prediction.

1. Introduction

Air humidity refers to the quantity of water vapor in the air. It depends upon the temperature and pressure of the system-of-interest. There usually exist three (absolute, specific and relative) forms of expressions for the air humidity. It is one of important measuring parameters and factors involved in a wide variety of fields of science and engineering [1-7]. Then evaluation and forecasting analysis of the air humidity is increasingly necessary for a wide range of applications. Based on the investigation of influence of meteorological conditions on traffic accidents in Kuwait by employing stochastic models, Al-Harbi et al. [8] found that the air humidity, following the air

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