Extended Kalman Filter and Markov Chain Monte Carlo Method for Uncertainty Estimation: Application to X-Ray Fluorescence Machine Calibration and Metal Testing

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Abstract : This paper is concerned with a method for uncertainty evaluation of steel sample content using X-Ray Fluorescence method. The considered method of analysis is a comparative technique based on the X-Ray Fluorescence; the calibration step assumes the adequate chemical composition of metallic analyzed sample. It is proposed in this work a new combined approach using the Kalman Filter and Markov Chain Monte Carlo (MCMC) for uncertainty estimation of steel content analysis. The Kalman filter algorithm is extended to the model identification of the chemical analysis process using the main factors affecting the analysis results; in this case, the estimated states are reduced to the model parameters. The MCMC is a stochastic method that computes the statistical properties of the considered states such as the probability distribution function (PDF) according to the initial state and the target distribution using Monte Carlo simulation algorithm. Conventional approach is based on the linear correlation, the uncertainty budget is established for steel Mn(wt%), Cr(wt%), Ni(wt%) and Mo(wt%) content respectively. A comparative study between the conventional procedure and the proposed method is given. This kind of approaches is applied for constructing an accurate computing procedure of uncertainty measurement.

Keywords : Kalman filter, Markov chain Monte Carlo, x-ray fluorescence calibration and testing, steel content measurement, uncertainty measurement

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