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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 samplecontent using X-Ray Fluorescence method. The considered method of analysis is acomparative technique based on the X-Ray Fluorescence; the calibration step assumes theadequate chemical composition of metallic analyzed sample.It is proposed in this work a new combined approach using the Kalman Filter and MarkovChain Monte Carlo (MCMC) for uncertainty estimation of steel content analysis. The Kalmanfilter algorithm is extended to the model identification of the chemical analysis process usingthe main factors affecting the analysis results; in this case the estimated states are reducedto the model parameters. The MCMC is a stochastic method that computes the statisticalproperties of the considered states such as the probability distribution function (PDF)according to the initial state and the target distribution using Monte Carlo simulationalgorithm. Conventional approach is based on the linear correlation, the uncertainty budgetis established for steel Mn(wt%), Cr(wt%), Ni(wt%) and Mo(wt%) content respectively. Acomparative study between the conventional procedure and the proposed method is given.This kind of approaches is applied for constructing an accurate computing procedure ofuncertainty measurement.

Keywords : Kalman filter, Markov Chain Monte Carlo, X-Ray fluorescence calibration and testing, steel content measurement, uncertainty measurement