A MULTIPLE LINEAR REGRESSION APPROACH TO NOx EMISSION PREDICTION BASED ON FLAME RADICAL IMAGING AND CONTOURLET TRANSFORM

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Abstract:

NOx emission emitted from fossil fuel combustion in power generation plants is one of main pollutant sources that are responsible for the global climate change. The prediction of NOx emission is therefore an indispensable process in the power plant so as to reduce this harmful gas emission. Earlier studies have shown that flame radicals (e.g., OH*, CN*, CH* and C2*) contain a great deal of information about the NOx formation process and thus can potentially be an indicator of the NOx emission. However, there appears to be lack of methodologies for characterizing flame radicals and using such information to predict the NOx emission from the combustion process.

This paper is concerned with the modelling of the multiple regression relationship between the feature vectors of flame radical images and NOx emission. Firstly, an algorithm based on the contourlet transform is proposed to extract the feature vectors of radical images (OH*, CN*, CH* and C2*). Secondly, multiple linear regression analysis is undertaken, which is a combination of statistical techniques serving as a basis for drawing inferences about relationships between the feature vectors and NOx emission. The proposed methodology has initially been examined on a lab-scale biomass-gas fired test rig. A flame imaging system was used to acquire the radical images of flames for four different biomass fuels. Because the radiative intensities of the radicals are very weak, an EM(Electron Multiplying) CCD camera was employed to acquire images under low light levels. In addition, a gas analyser was employed to obtain NOx emission data in the flue gas during the image acquisition. All radical information obtained was then used to establish the NOx prediction model. The test results demonstrate that the developed multiple linear regression model is effective for the prediction of NOx emission.

Keywords: NOx emission, flame radical image, multiple linear regression, contourlet transform

Acknowledgements: This work is supported by the Chinese Ministry of Science and Technology and the Chinese Ministry of Education as part of ‘973’ Project (2012CB215203) and part of ‘111’ Talent Introduction Project (B12034). The UK Engineering Physical Science Research Council (EPSRC, EP/G002398/1) is also acknowledged for providing financial support for this research.

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