Application of Fourier and Wavelet Methods to Analysis of Positron Emission Particle Tracking Data

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Abstract

Fourier and wavelet methods are applied to data derived from Positron Emission Particle Tracking (PEPT) experiments conducted at the iThemba LABS outside Cape Town in South Africa. This is the only facility of its kind in South Africa fully dedicated to research involving Positron Emission Tomography (PET) as applied to industrial applications – that is, the only application outside medical use. The UCT PEPT Cape Town facility is housed within South Africa's main accelerator research lab called the iThemba LABS that runs a specialized cyclotron which produces positrons for use in medical PET and industrial-related PEPT research. Discrete time series data are obtained from the PEPT experiments and the 3D particle motion images are reconstructed within matlab that shows the particle circulation within the opaque grinding environment of the experimental tumbling mill. The Fourier and wavelet methods are applied as an aid in developing a computational procedure for determining the value of the circulation rates of the charge found in typical industrial tumbling mills (granulation mills). The circulation rate values are obtained as fundamental harmonics from power spectral plots from Fourier analysis. These plots indicate noise in the data obtained from typical PEPT experiments. The wavelet method is applied to identify and remove the noise from the data in order to improve on the computationally determined value of the circulation rate. For the analysis presented herein, parameters are obtained directly from the flow dynamics of the PEPT tracer particle.

Key words: Fourier and Wavelet methods, Circulation rates, Power draw