

Combining linear and non-linear ultrasonic techniques for the characterisation of HTT products

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Abstract

Ultrasonic systems are integral in a diverse range of applications including non-destructive testing (NDE), sonar, biomedicine, process control and industrial cleaning. Ultrasound is a well established technology in most of these application areas and has recently started to find application in many industrial process control systems.

In this paper, active acoustic techniques for the on-line characterisation of high throughput technology (HTT) products are presented. An experimental procedure using ultrasound technology to analyse shampoo and conditioner samples in a process analytical environment has been developed. The ultrasonic monitoring system was configured to detect ultrasonic backscatter from the HTT product [1]. In this arrangement, ultrasound with a specified frequency was fired into the sample, signals were scattered by sample and received by a second transducer orientated at a 90 degree angle to the axis of the excitation transducer. The excitation transducer was water coupled to the sample container and the detection device placed directly in contact with the sample. Both linear and non-linear approaches have been evaluated. The non-linear ultrasound technique focussed on the generation of harmonics from the HTT sample and hence, the transducer should operate at twice the excitation frequency. To enhance reproducibility in this experimental arrangement, a double mode transducer was designed using the finite element analysis package PZFlex. This transducer was fabricated in two sections: one is a disk with a centre frequency of 2.25 MHz; and the other is a ring configuration with a centre frequency of 4.5 MHz. By using this design, it is possible to acquire both fundamental and second harmonic signals simultaneously from the sample. Backscatter signals have been measured from diluted conditioner samples with complementary material information acquired at the linear and harmonic frequency bands. This new approach provides valuable information for the characterisation of HTT products and offers potential for use as an on-line process analytical tool.

References

1. G. Benny, A. Gachagan, G. Hayward, A. Nordon, D. Littlejohn, 'A wideband ultrasonic test system for characterisation of particulate systems in the linear and non-linear regimes', International Congress on Ultrasonics, ICUltrasonics Vienna 2007, April 9-12 2007, http://papers.icultrasonics.org/1468_benny.pdf

