



US007966882B2

(12) **United States Patent  
Greenwood**

(10) **Patent No.: US 7,966,882 B2**  
(45) **Date of Patent: Jun. 28, 2011**

(54) **SELF-CALIBRATING METHOD FOR  
MEASURING THE DENSITY AND VELOCITY  
OF SOUND FROM TWO REFLECTIONS OF  
ULTRASOUND AT A SOLID-LIQUID  
INTERFACE**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 613 days.

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Shear Wave Velocity of a Liquid or Slurry for On-Line Process  
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(21) Appl. No.: **12/108,161**

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(22) Filed: **Apr. 23, 2008**

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(65) **Prior Publication Data**  
US 2009/0266165 A1 Oct. 29, 2009

(57) **ABSTRACT**

(51) **Int. Cl.**  
**G01N 9/24** (2006.01)  
(52) **U.S. Cl.** ..... **73/597**; 73/30.01; 73/32 A; 73/602;  
73/61.79  
(58) **Field of Classification Search** ..... 73/30.01,  
73/30.04, 32 A, 597, 598, 599, 600, 602,  
73/54.01, 54.41, 61.49, 61.79  
See application file for complete search history.

A method for determining a velocity and density of a fluid without requiring the transmission of ultrasound through the fluid, and a system for performing such a method. The method involves the steps of delivering, receiving and analyzing ultrasound pulses sent from a longitudinal and a shear wave transducers to a member that is in contact with a fluid. The ultrasound pulses reflecting between surfaces provide a first ultrasound pulse echo series, that is transmitted, received and processed. The shear wave ultrasound pulses are also delivered through a shear wave transducer at a predesignated angle relative to the interface of the member and the fluid and the results of this are received to obtain a second ultrasound pulse echo series. Reflection coefficients for the first and second ultrasound pulse echo series are then calculated and the density of the fluid and the velocity of sound in the fluids are extracted.

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**12 Claims, 6 Drawing Sheets**

