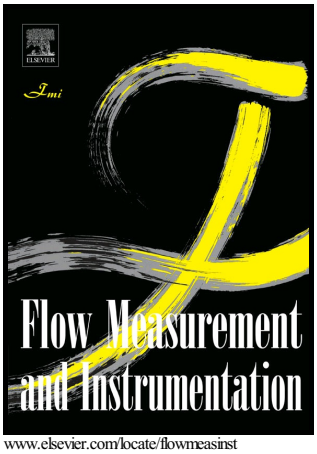
Simulation and Experimental Study of the Sensor Emitting Frequency for Ultrasonic Tomography System in a Conducting Pipe

Goh Chiew Loon, Ruzairi Abdul Rahim, Hafiz Fazalul Rahiman, Tee Zhen Cong, Yasmin Abdul Wahad



www.elsevier.com/locate/flowmeasinst

PII: S0955-5986(17)30003-1
DOI: http://dx.doi.org/10.1016/j.flowmeasinst.2017.01.003
Reference: JFMI1307

To appear in: *Flow Measurement and Instrumentation*

Received date: 2 July 2015
Revised date: 7 December 2016
Accepted date: 3 January 2017

Cite this article as: Goh Chiew Loon, Ruzairi Abdul Rahim, Hafiz Fazalu Rahiman, Tee Zhen Cong and Yasmin Abdul Wahad, Simulation and Experimental Study of the Sensor Emitting Frequency for Ultrasoni Tomography System in a Conducting Pipe, *Flow Measurement an Instrumentation,* http://dx.doi.org/10.1016/j.flowmeasinst.2017.01.003

Simulation and Experimental Study of the Sensor Emitting Frequency for Ultrasonic Tomography System in a Conducting Pipe

Goh Chiew Loon[1], Ruzairi Abdul Rahim[1,2*], Hafiz Fazalul Rahiman[3], Tee Zhen Cong[4], Yasmin Abdul Wahad[5]

[1]Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Skudai, Johor, 81310, Malaysia.
[2]Faculty of Electrical and Electronic, Universiti Tun Hussein Onn, Batu Pahat, Johor, 86400, Malaysia.
[3]School of Mechatronic Engineering, Universiti Malaysia Perlis, Arau, Perlis, 02600, Malaysia.
[4]LOGO Solution, Sdn. Bhd, Taman Sierra Perdana, Masai, Johor, 81750, Malaysia.
[5]Universiti Malaysia Pahang, Pekan, Pahang, 26600, Malaysia.
*ruzairi@fke.utm.my,

Abstract

Ultrasonic tomography techniques provide flow visualization capability, non-invasively and non-intrusively, to enhance the understanding of complex flow processes. There is limited ultrasonic research in tomography imaging systems in the tomogram analysis of fluid flow in a conducting pipe because of a high acoustic impedance mismatch, which means that very little ultrasonic energy can be transmitted through the interface. The majority of industrial pipelines are constructed from metallic composites. Therefore, the development and improvement of ultrasonic measurement methods to accommodate a stainless steel pipe are proposed in this paper. Experimental and simulation distribution studies of the ultrasonic emitting frequency in acrylic versus stainless steel pipes were studied, measured and analyzed. During the simulation, ultrasonic transducers were placed on the surface of the investigated pipe to inspect the ultrasonic sensing field. The distribution of the sound wave acoustic pressure was simulated based on the physical dimensions and parameters of the actual experimental hardware set-up. We developed ultrasonic acoustic models using the finite element method with COMSOL software, and experiments were carried out to validate the simulation results. Finally, by performing the static phantoms tests, a feasibility study of ultrasonic tomography system was presented to investigate the void fraction of liquid column inside a stainless steel pipe.

Graphical Abstract

In this paper, experimental and simulation distribution studies of ultrasonic tomography systems in acrylic versus stainless steel pipes were studied and analysed. During the simulation, ultrasonic transducers were placed at the surface of the investigated pipelines to inspect the ultrasonic sensing field. The distribution acoustic pressure of the sound wave was scattered based on the physical dimensions and parameters of the actual experimental hardware set-up. Experiments were carried out to test the sensor performance and validated the simulation results. From the experimental and simulation results, the development of high-frequency epoxy front end ultrasonic sensors in 3 MHz of ultrasonic imaging tomography, as shown in Figure 1, were introduced and developed to measure the void fraction in liquid-gas column.