Simulation of Electrode For Dual-Modality Electrical Resistance Tomography and Ultrasonic Transmission Tomography for Imaging Two-Phase Liquid and Gas

Fazlul Rahman Mohd Yunus[a], Ruzairi Abdul Rahim[a], Leow Pei Ling[a], Nor Muzakkir Nor Ayob[a], Yasmin Abdul Wahab[ab], Suzzana Ridzuan Aw[ac], Anita Ahmad[a], Nasarudin Ahmad[a], Mohd Hafiz Fazalul Rahiman[d]

[a]Process Tomography & Instrumentation Research Group (PROTOM-i), Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Malaysia

[b]Department of Instrumentation & Control Engineering (ICE), Faculty of Electrical & Electronics Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

[c]Faculty of Electrical & Automation Engineering Technology, Terengganu Advance Technical Institute University College (TATiUC), Jalan Panchor, Telok Kalong, 24000, Kemaman, Terengganu, Malaysia

[d]School Of Mechatronic Engineering Universiti Malaysia Perlis, Malaysia

ABSTRACT

Accurate multiphase flow measurement of gas/liquid, liquid/solid and liquid/liquid flow is still challenging for researchers in process tomography. The reconstructed images are poor particularly in the center area because of ill-posed inverse problems and limited of measurements data. Dual-modality tomography has been introduced to overcome the problem by means each modality is sensitive to specific properties of materials to be imaged. This paper proposed combination of ultrasonic transmission tomography (UTT) and electrical resistance tomography (ERT) for imaging two phase gas/liquid. In the proposed combination, detection ability in the medium of interest improved because two different images in the same space can be obtained simultaneously. This paper presents 3D numerical modeling approach using COMSOL software for ERT excitation strategy and electrode pre-designed geometry. Electrical resistance tomography (ERT) can be implemented for gas/liquid flow if the liquid is conductive. The objectives of this work is to analyze the optimum electrode dimension and shape in order to improve the situation of: (1) gas bubble detection located in the centre of the medium, (2) potential distribution and current density in a conductive medium, the developed numerical model simulated the changes in resistivity of the conductive material, with variations of electrode sizes, with opposite current excitation implemented into the region of interest. Simulation results show that the electrode size of 12 mm (w) × 40 mm (h) is suitable, which gives a good detection of center gas bubble with diameter 10mm in 100-mm-diameter acrylic vessel. Finally the findings are verified with Image reconstruction using Linear Back Projection (LBP) which gives good indication of the 10mm gas bubble.

KEYWORDS: Dual-modality tomography, Electrical resistance tomography, ultrasonic tomography, opposite excitation, time-of-flight (toF)

DOI: org/10.11113/jt.v77.6436