

ABSTRACT

This work considers the problem of imaging flow systems using a system of plate capacitors (sensors) surrounding the flow medium to be imaged, a technique known as electrical capacitance tomography (ECT). Methods for the calculation of the sensitivity matrix for the ECT of three-dimensional (3D) flows are considered. Given a sensor geometry, the sensitivity matrix relates the electric permittivity distribution within the flow medium to the values of the mutual capacitances between the various sensor plates. The sensitivity matrix is then used in the reconstruction of the 3-D flow image from the change in the mutual capacitance. The particular ECT measurement apparatus considered in our case is described in detail. Techniques to solve the inverse problem (reconstruction techniques) are also presented, with emphasis on the Neural Network-based Multi-criterion Optimization Image Reconstruction Technique (NN-MOIRT).

Two particular methods for sensitivity matrix calculation are considered. The first is based on the solution of the relevant partial differential equation describing the electric field distribution within the flow medium using the finite element method (FEM). The second is a perturbative approximation suitable for small pixel permittivity sizes (high resolution).