MEASUREMENT CAPABILITIES OF PTL300 ECT SYSTEMS

PTL300E ECT systems measure the inter-electrode capacitances of an ECT sensor and from these measurements, produce cross-sectional images of dielectric materials inside the ECT sensor on a PC monitor screen. The ECT systems produce relatively low-resolution, approximate images, but can do this at high speed.

The PTL300E ECT system is intended primarily for use with mixtures of two materials having different dielectric constants (permittivities). These are known as two-phase mixtures and for mixtures of this type, ECT systems can provide information about the relative proportions of the two materials inside the ECT sensor at any given time (voidage) as well as displaying their radial distribution across the sensor plane.

The PTL300E-SP-G ECT system can be used with ECT sensors containing either one plane of between 2 and 12 measuring electrodes and can be used with sensors containing guard electrodes. The PTL300E-TP-G ECT system can be used to view the contents of closed pipes or vessels at two separate axial locations. If the vessel walls are non-metallic external sensor electrodes can be used. If the vessel walls are metallic, the sensor electrodes must be placed inside the vessel walls. The materials to be imaged must be essentially non-conducting dielectric materials such as oils, plastics, powders or other similar materials. In some circumstances, pure water can be imaged, but usually with difficulty.

Measured inter-electrode capacitances can also be stored in a data file on a continuous basis at speeds up to 300 frames per second, depending on the number of electrodes on the sensor. Images are displayed over a circular cross section made up from a selected number of pixels contained in a (typically) 32 X 32 square grid. The colour of each individual pixel represents the approximate average value of the normalised permittivity (in a range from 0 to 1) of the material in the cell.

The ECT system must be calibrated before it can be used. This involves filling the ECT sensor with two different materials having permittivities at the lower and higher ends of the permittivity range to be measured.

The equipment can be used in a number of different modes:

- The ECT system can be used to display on-line images of materials and can also record the inter-electrode capacitance measurements while images are displayed, so that images can be reconstructed and replayed at a later date

- Images can be displayed and captured at data rates selected by the user and can be replayed at the same or different rates, again selected by the user. Facilities are also provided for single-stepping through recorded images.

- The normalised permittivity of individual pixels in the ECT image can be displayed either on-line or when data is replayed and the values of the normalised inter-electrode capacitances can also be displayed in both on-line and replay modes. The instantaneous volume fraction of the materials inside the sensor is displayed continuously.

- Alternative sets of sensitivity maps for different dielectric materials and/or sensors can be used and test software is provided which allows the measurement of absolute values of inter-electrode capacitances for sensor design and testing purposes.

- Twin-plane ECT systems can be used to measure the velocity and flow profiles across the sensor by using suitable additional software (eg the Tomoflow Flowan software).

PRINCIPLE OF OPERATION OF PTL300 ECT SYSTEMS

The properties of the ECT sensor are measured or calculated initially to produce a sensitivity map of the sensor. This is a numerical matrix whose elements correspond to the individual pixels in a rectangular grid which is superimposed on the sensor area. The sensitivity map describes how the measured capacitance between any combination of electrodes changes when a change is made to the dielectric constant of a single pixel inside the sensor.

The change in capacitance measured between any two electrodes electrodes caused by an object with a given permittivity will vary depending on the location of the object. When used with a circular cross section sensor, the ECT system is most sensitive when an object is placed near the walls of the vessel and is least sensitive at the centre of the vessel. Allowance is made for this effect from knowledge of the variation of sensitivity with position for each pixel. This information is stored in the sensitivity map file. When the ECT system constructs images, it reads the sensitivity map and compensates the image pixels accordingly.

The sensor is normally calibrated at each end of the range of permittivities to be measured by filling the sensor with the lower permittivity material initially and measuring all of the individual inter-electrode capacitances. This operation is then repeated using the higher permittivity material. The data obtained during the calibration procedure is used to set up the measurement parameters for each measuring channel and is stored in a calibration data file.

Once the system has been calibrated, the capacitances between all unique pairs of sensor electrodes are measured continuously at high speed, giving E(E-1)/2 unique values per measurement or image frame, where E is the number of sensor electrodes.

An image reconstruction algorithm is used to compute the cross sectional distribution of the permittivity of the material inside the pipe. Images can be constructed from the capacitance measurements either at the time of measurement (on-line) or from stored or captured data (off-line). The algorithm supplied as standard with the PTL300 system is the so-called back-projection algorithm. This is a fast but approximate algorithm which uses the capacitance measurements, together with the sensitivity map to produce the image. Other alternative algorithms can be used with the stored data to produce more accurate images.

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PROCESS TOMOGRAPHY LTD

64, Courthill House, Water Lane, Wilmslow, Cheshire. SK9 5AJ United Kingdom.

Phone/Fax +44 - (0) - 1625-418722

email: enquiries@tomography.com Web site: www.tomography.com

Registered in England No. 2908507. Registered Office 15, Croft Road, Wilmslow, Cheshire. SK9 6JJ United Kingdom.