INVESTIGATING THE TEMPERATURE – CAPACITANCE RELATIONSHIP OF A POLYCARBONATE MATERIAL USING FUNCTIONAL WEIGHTED INVERSE MATRIX METHOD IN A ELECTRICAL COMPUTER TOMOGRAPHY PROCESS

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Abstract: Temperature – Capacitance relationship was investigated using polycarbonate Compact Disc (CD). Ideally, a capacitance of a capacitor would be the same at all temperatures. But in reality, capacitance changes as the capacitance gets warmer or cooler. In many cases, these changes are ignorable but since research is always engage in a very precise experimental value results, determining the capacitance value or dealing with very large temperature swings are must take into considerations. In this study, in the absence of capacitor, the capacitance has been measured. The CD resins and CD strip (both are polycarbonate) were placed in the different containers and was undergo different testing conditions. Different electrical devices were used. The thermocouple was placed in the middle of the container connected to the tester to measure the temperature in terms of voltages output while the electrodes were connected to the ECT to measure the capacitance value. Both conditions were done simultaneously after subjecting the load (CD) into a high temperature set with a given time. This experiment aim to discuss how the capacitance change with temperature and what is the factor has caused of these changes. Using the Electrical Computer Tomography (ECT), the gathered numerical data was used in calculations for image reconstructions using non-iterative Functional Weighted Inverse Matrix method.

1. Introduction

One of the conventional way in measuring the temperature of any material while it’s on the process especially polymer (plastic) products is by using a thermocouple, but it has a disadvantage and limitation particularly in precision and accuracy. Thermocouples are usually less suitable for applications where smaller temperature differences need to be measured with high accuracy, for example the range 0–100 °C with 0.1 °C accuracy. For high temperature irradiations, traditional thermocouples drift either due to degradation at high temperatures (above 1100 °C) or due to transmutation of thermocouple components. Most thermocouples consist of a shorter (typically 0.1 m to 2 m long) high temperature region followed by a considerably longer (2 m to 30 m long) lower temperature region [1]. This study discusses about the temperature distribution and its relation to capacitance using polycarbonate materials under Electrical Capacitance Tomography process. Electrical capacitance computer tomography has been investigated as a visualization technique for the solid behavior in multiphase phase flow [2,3]. The purpose of these is to measure and reconstruct an image during particle distributions inside the vessel in order to investigate, analyze and visualize the physical and chemical properties and the behavior of the mixing fluids.

2. Experiment set up and Conditions

The following illustrations show the different set-up conducted. Varying the electrodes and thermocouple positions and using different physical compositions (CD strips and resins) of polycarbonate materials were made to figure out different possible considerations in performing these experiments. There were two conditions for these set ups, first, using ceramic and CD strip. The CD strip together with electrodes and thermocouple were inserted between the two ceramic walls to hold them while heating process was occurs. The thermocouple and electrodes were placed about 0.4 cm close to the heater plate, while the CD strip touched the heater plate. While the heat was continuously applied, the data was recorded until the strip melted. The second condition is by using polycarbonate resins and beaker with different
sizes as a container. Electrodes and thermocouple were placed elevated above from the heater plate (about 2cm). In this condition, the process of gathering the data was different in the first, because resins were melted first before recording all the necessary data. Take note that the heat input coming from the electric heater is constant and evenly distributed (for both conditions) to the surface area of the heater plate, and because of heat transfer process, the heat was become concentrated to the enclosed area reason for the polycarbonate strip and resins to melt.

3. Experiment results

The graphs show the results of the set ups fig. 1 and 2. The first graph, result from fig. 1, shows as the capacitance decreases the temperature increases. They are inversely proportion to one another. Changing the materials and procedures in gathering the data, give a different graphical results. As show in 2nd graph result from fig. 2, as the Temperature decreases the capacitance also decreases, and the two are said to be directly proportional to one another. Also in this process, varying the positions of electrodes and thermocouple inside the beaker didn’t have any significant effect, whether they were elevated away from the heater plate nor placed near the heater plate it doesn’t matter the result still the same. Using ECT in gathering the capacitance data, Functional Weighted Inverse matrix method has been applied to display its 3D images. The result has been compared to the Linear Back Projection method. The result of using FWIM display that the temperature has been distributed properly to the entire area unlike LBP which is not, and this can be seen in figures 5 and 6.

4. Conclusions

Comparing the LBP and FWIM methods, the FWIM 3D image results shows more accurate, because it display that the temperature has been distributed equally to a polycarbonate material in a entire area, considering that the heat supplied was also evenly distributed during the process. In contrast, the LBP 3D image result only show that the temperature distributions has been only occurs to some polycarbonate materials in a particular area and it is not evenly distributed.

5. References


1 : Mechanical Engineering Dept. Nihon University