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# 論　文　内　容　要　旨

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| 学位論文題目 | Improvements of measurement technique for temperature and concentration fields using CT-TDLAS<br>(CT-TDLASを利用した温度と濃度分布の測定技術の向上) | | |

内容要旨

Recently, exhaustion of energy sources and environmental pollution are major issues. To solve these problems efficiently, we need to use fuel efficiently and reduce emissions. With the advent of the TDLAS (Tunable laser absorption spectroscopy) technique, the temperature and concentration of the gases can be measured simultaneously. To determine the actual behavior of the combustion process in a combustor of the engine, it is necessary to measure the temperature distribution in the state of high-temperature and high-pressure. To improve the TDLAS accuracy measuring of the combustion process of $CH_4$ and $H_2O$ gases from the engine. This was measured temperature fields for the substance of $CH_4$ and $H_2O$ at the same time. The laser wavelength of 1300nm and 1600nm was used at the same time. In this study to know the combustion state in the actual engine and detection of exhaust harmful gases. And practicality was expected to increase. Among them, CT-TDLAS (Computed tomography-tunable diode laser absorption spectroscopy) is the most important technique for measuring the distributions of temperature and concentration across the two-dimensional planes. This method has been developed to measure two-dimensional and three-dimensional temperature and concentration distributions. In CT-TDLAS, the accuracies of the measurement results are strongly dependent upon the reconstruction algorithms. In this study, four different reconstruction algorithms have been tested numerically using experimental data sets measured by thermocouples for combustion fields. Three reconstruction algorithms, MART (multiplicative algebraic reconstruction technique) algorithm, SART (simultaneous algebraic reconstruction technique) algorithm and SMART (simultaneous multiplicative algebraic reconstruction technique) algorithm, are newly proposed for CT-TDLAS in this study. The calculation results obtained by the three algorithms have been compared with previous algorithm, ART (algebraic reconstruction technique) algorithm. Virtual data sets have been generated by the use of thermocouples data obtained in an actual experiment. And we

suggest a three-dimensional measurement to consider the irregular flow of flame or exhaust gases. Use the SMART algorithm among the CT algorithms. Virtual data sets have been generated by the use of thermocouples data obtained in an actual experiment. The HITRAN database in which the thermo-dynamical properties and the light spectrum of the $H_2O$ are listed were used for the numerical test. The reconstructed temperature and concentration fields were compared with the original HITRAN database, through which the constructed methods are validated. The performances of the four reconstruction algorithms were demonstrated. Furthermore, CT-TDLAS has been adopted for the measurements of temperature and concentration distribution at a cross-section of the exhaust gas of a burner. The absorption spectra of $H_2O$ vapor near the wavelength 1388nm were used for signal reconstructions. SMART algorithm has been used for signal reconstructions, with which the temperature and concentration fields were obtained based on the HITRAN database. The temperatures obtained by the use of SMART algorithm were compared with those obtained by thermocouples, and their agreements revealed that the temperature and concentration distribution at a cross-section of the exhaust gas of a burner could be measured by the use of CT-TDLAS with a measurement accuracy of 5.27% relative errors. And we suggest a three-dimensional measurement to consider the irregular flow of flame or exhaust gases. Use the SMART algorithm among the CT algorithms. Virtual data sets have been generated by the use of Gaussian distribution for expected temperature and concentration. The data of the HITRAN database in which the thermo-dynamical properties and the light spectra of the $H_2O$ are listed were used for the numerical test. Further, it is proposed a three-dimensional measurement to consider the irregular flow of fluid such as real flame and exhaust gas. In this study, CT-TDLAS technique was used to measure the three-dimensional temperature and concentration distribution of flame. The absorption spectra of the combustion product $H_2O$ vapor near the wavelength 1388nm were used for signal reconstructions. The temperature and concentration fields were constructed using the SMART algorithm based on the HITRAN database. As a result of comparing the temperature of the high-temperature position using thermocouple and CT-TDLAS technique, it was possible to accurately measure with an average relative error of 0.7%. It can be shown three-dimensional temperature and concentration fields of the flame.