Magnetic Effects on Fluid-Density Measurements in a Magnetic-Levitation Densimeter

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It is possible to accurately measure fluid density in a wide range of vapor and liquid phases by using a magnetic levitation densimeter. The uncertainty of the commercial type densimeter is about 0.03 %; some factors still exist which must be solved in order to obtain the fluid density with higher reliability.

One of the factors is a force transmission error between a permanent magnet surrounded with the sample fluid and an electromagnet suspended from an electronic balance. The error due to the magnetism of the measuring cell and the sample fluid causes an uncertainty of around 0.01 % in the density measurement. The effect of the error has been analyzed by a finite element method (FEM) and examined experimentally using the commercial type densimeter. As a result, the experimental data for n-tridecane qualitatively agreed well with the FEM analytical results. It was found from the results that the error changes sensitively to the vertical position of the permanent magnet in the densimeter. Furthermore, it was revealed from the FEM analysis that when the permanent magnet position is fixed at an appropriate position, the magnitude of the error becomes a tenth smaller than that in the existing magnetic-levitation densimeter, and linearly changes in response to the magnetic force of the electromagnet.

By considering the above results, part of a new magnetic-levitation densimeter is now being developed, which can keep the vertical position of the permanent magnet constant before and after exchanging two sinkers (Si, Ge), to be coupled alternately. This new densimeter can compensate not only for the force transmission error in measurements of the liquid density, but also an adsorption effect in measurements of the vapor density. The goal for the standard uncertainty of the new densimeter is about 0.001 % for liquid density.