# Reliable Thermodynamic Property Information for Acceptable Hydrocarbon Refrigerants and Their Mixtures in the Entire Fluid Phase Region

H. Miyamoto[C, S] and M. Uematsu
*Center for Mechanical Engineering and Applied Mechanics, Keio University, Yokohama, Japan*

Hydrocarbons (HCs) including propane, n-butane, and isobutane are environmentally acceptable refrigerants and are currently expected to be promising components of long-term alternatives by blending either with other HCs or with nonflammable hydrofluorocarbon (HFC) refrigerants. In view of its importance and possibility, Helmholtz-type equations of state for the entire fluid phase of the aforementioned hydrocarbons and their binary and ternary mixtures have already been developed. For their modeling, more than 6700 points of data for pure hydrocarbons and 2300 points of data for mixtures of thermodynamic properties such as PVT, caloric and acoustic properties, and saturation properties have been compiled. Through detailed examination of such available measurements, 65 % of data for pure HCs and 44 % of data for their mixtures have been selected as input data. These sets of data are far fewer than those for HFCs, and exist in a limited range of temperatures and pressures. For example, the pressure range of available measurements for isobutane is up to 35 MPa, which is lower than for propane (up to 103 MPa) and n-butane (up to 69 MPa). Measurements for mixtures are also limited and only qualitative tests could be performed in the entire fluid phase throughout the modeling. Additional experimental data are therefore encouraged especially for the liquid phase, since the contributions of mixing become larger at higher pressures.

The goals of the present study are to elucidate the binary and/or ternary interactions of such typical hydrocarbons with quantitative accuracy for further improvement of thermodynamic property models. In this presentation, we will describe the updated information about thermodynamic property measurements and detailed comparisons using the available equations of state for hydrocarbons and their mixtures. The priorities of the required measurements will also be reported. Moreover, we will make a brief introduction of an upcoming apparatus to measure PVTx properties for such hydrocarbons with sufficient accuracy in the range of temperatures from 250 to 473 K and pressures up to 200 MPa. We also aim to report new measurements for pure fluids of current interest.