Isochoric Heat Capacity Measurements of Multicomponent Mixtures for Natural Gas at Temperatures from (77 to 340) K

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Natural gas has become one of the most important resources in the world. It is a multi-component mixture of hydrogen, carbon monoxide, methane, ethane, and other alkanes, which has a relatively low impact on the environment compared to petroleum. Natural gas has a very wide range of applications in many fields, such as industry, life, etc., and it accounts for almost a quarter of the world's primary energy consumption [1]. An accurate understanding of the thermophysical properties of natural gas is important for its further applications.

Specific heat capacity is one of the most important properties of natural gas. When dealing with natural gas flows with heat transfer, it is often necessary to calculate the enthalpy change, and then the heat capacity is needed to calculate the thermal energy transferred by the temperature changes of natural gas. This is because the vapor-liquid equilibrium of a substance is sensitive to temperature, which in turn is determined by an energy balance that includes heat capacity and enthalpy calculations [2]. On the other hand, due to the lack of data on the heat capacity, the equation of state models used to predict thermodynamic properties of natural gas are usually fitted to density and vapor-liquid-equilibrium data, making it difficult to validate the ability of the equation of state to predict heat capacity of natural gas.

In the present work, based on the adiabatic calorimetry method, a new low-temperature isochoric heat capacity apparatus was developed and tested with nitrogen over the temperature range of 77 K~200 K, and good agreement between the experimental data and literature was found. With the new apparatus, the isochoric heat capacity of multi-component mixtures for natural gas were carried out over the temperature range from (77 to 340) K and at pressures up to 10 MPa. The combined expanded uncertainties of temperature, pressure, molar fraction, and isochoric heat capacity with a confidence level of 0.95 ($k = 2$) are estimated to be 0.036 K, 0.03 MPa, 0.005, and less than 2.5 % over the entire temperature and pressure range, respectively.

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References

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