

ABSTRACT

The problem of calculating shock temperature indirectly from experimental data without assuming thermodynamic properties is formulated and solved theoretically. In principle, the (e-p-v) and (T-p-v) equations of state can be constructed in an overlapping domain of the (p-v) plane from a family of Hugoniot curves centered at points of known energy and temperature.

Experiments were performed in an attempt to construct these equations of state for silicone fluid 210. Shock and free surface velocities were measured to determine Hugoniot curves in the 300-kbar regime, and energies and densities were measured from -30° to $+260^{\circ}\text{C}$ along the atmospheric isobar to determine the initial states of the shock wave experiments. In practice, it was necessary to assume a form for the (e-p-v) equation of state, since the differences in volumes between states on Hugoniot curves at the same pressure above 40 kbar were found to be comparable with the experimental error in measuring the volumes of each of these states. The data were fitted to a Mie-Grüneisen type (e-p-v) equation of state with variable C_v and $(\partial p/\partial T)_v$, since Hugoniot points indicated a linear dependence of energy on pressure along an isochore, and C_v varied along the atmospheric isobar. Shock temperatures on the 25°C Hugoniot were calculated at points of intersection with isentropes and by integrating with constant atmospheric pressure values of C_v . The position of the 296°C isentrope limits the temperature calculation with isentropes to values below 522°C and 58 kbar, and the values around 50 kbar are 8% lower than those calculated with the 25°C value of C_v , since C_v increases along the Hugoniot curve. Temperature calculations above 58 kbar assumed the 296°C value of C_v . Considerably more experimental work would be required over the entire pressure range to permit determining equations of state of silicone 210 without making assumptions.