Experimental data substituted in the latter equation show that, over the range 50–225 kg/cm², $\Delta\beta$ has a constant value of $\sim 2.5 \times 10^{-5}$ cm²/kg, which is at most 2.5 percent of β_f. At 3555 kg/cm² $\Delta\beta$ is calculated to be 2.8×10^{-6} cm²/kg or 5 percent of β_f. The compressibility coefficient of solid He^3 is therefore very similar to that of the fluid along the full range of the melting curve investigated. For Na and K, the data of Bridgman (*34*) lead to values of 38 and 29 percent, respectively, for $\Delta\beta/\beta_f$ at $P_m = 1$ kg/cm².

C. Thermal Properties of Melting

At the lower end of the P_m range for He^3, the ΔS_m results were combined with the entropy of saturated liquid S_{sat}, measured by Roberts and Sydoriak (*35*), and the entropy of compression ΔS_{comp} to give the entropy of solid. The values of ΔS_{comp} can be obtained through the formula

$$\Delta S_{\mathrm{comp}} = -\int_{P_{\mathrm{sat}}}^{P_m} \left(\frac{\partial V}{\partial T}\right)_P dP.$$

For the computation, the present measurements were used from 5 kg/cm² to P_m, and those of Sherman and Edeskuty (*29*), from P_{sat} to 5 kg/cm². The results over 1.2° to 2.0°K showed the entropy of solid at the melting curve (or S_α) to rise only from 1.34 to 1.43 cal/deg/mol. Subtraction of the entropy change of compression and of transition in solid gave approximate S_β values of 1.32 to 1.34. The entropy associated with a nuclear spin system in completely random orientation is $S = R \ln 2 = 1.38$. It would appear that for solid He^3 this is the major source of entropy.

The values of ΔS_m listed in Tables I and II were derived from the Clapeyron equation using experimental ΔV_m data and slopes computed from analytical expressions for the melting curves. For both He isotopes ΔS_m increases with P_m over the experimental range covered, although the increase becomes progressively smaller at higher melting pressures. This behavior is contrary to that of N_2 (*15*), which showed a decrease of ΔS_m with increasing P_m. Ebert (*36*), using melting properties for almost all materials studied to 1947 by Bridgman, found that ΔS_m and ΔV_m always decrease with rising P_m and, indeed, extrapolate to zero at some finite high pressure, a criterion of a critical point. The behavior of He then appears to be anomalous, at least up to 3555 kg/cm². The continued rise with pressure of ΔS_m is incompatible with the possibility of a critical point between solid and fluid. Since the question of a critical point in melting curves has yet to be resolved, it is interesting to extrapolate the He melting data to higher pressures than were measured.

An expression for ΔS_m at high pressures can be derived in terms of P_m by combining Eqs. (1) and (3). When $d\Delta S_m/dP_m$ is set equal to zero, one finds the solutions $P_m = 4219$ kg/cm² and $P_m = 3628$ kg/cm² for He^3 and He^4, respectively.