Some Physical Properties of Compressed Gases

V. The Joule-Thomson Coefficient for Nitrogen

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Corrected values of the Joule-Thomson coefficient μ for nitrogen are tabulated between -70 and 600°C, and to 1200 atmospheres. $\mu=$const. contours are exhibited on a p–t diagram. The inversion temperature for zero pressure is found to be about 326°C.

IN previous papers[1] values of certain physical properties of nitrogen, carbon monoxide, and hydrogen have been presented, the calculations having been made by mechanical methods from compressibility data. The purpose of the present paper is to correct an error in the published values of the Joule-Thomson coefficient for nitrogen,[1a] also to exhibit the family of $\mu=$const. contours (Fig. 28 ahead)—a form of presentation that in the case of other gases has proved to be useful in thermodynamic calculations.

In computing the Joule-Thomson coefficient μ for nitrogen from the equation[2]

$$\mu\rho C_p=(T/v)(dv/dT)_p-1, \qquad (14)$$

the factor for converting cc atmos./g into cal./mole was inadvertently omitted from the calculation. The published values of μ are on this account too high numerically by the factor 1.474. We are indebted to Dr. J. R. Roebuck for advising us that he had discovered a serious discrepancy between these published values of μ and the results of his own work on nitrogen.[3]

The corrected values of μ appear in Table V. They were obtained by dividing the source of the entries in column 9 of Table I by 1.474. The agreement over that portion of the pressure and temperature range covered by Roebuck and Osterberg's work is now entirely satisfactory. This substantiation gives support to the hope previously expressed that the calculations of physical properties of gases from compressibility

TABLE V. *The Joule-Thomson coefficient μ for nitrogen.*

p in atmospheres, t in degrees centigrade, μ in degrees per atmosphere.

p	$t=-70$	-50	-25	0	20	50	100	200	300	400	500*	600*
0*	0.443	0.408	0.346	0.285	0.242	0.181	0.118	0.058	0.012	−0.025	−0.043	−0.054
20	.425	.379	.319	.262	.220	.168	.110	.051	.007	−.029	−.046	−.056
40	.402	.347	.288	.233	.197	.155	.101	.043	.001	−.032	−.049	−.059
60	.366	.314	.260	.209	.178	.141	.093	.036	−.004	−.035	−.052	−.061
80	.319	.275	.230	.188	.160	.128	.085	.030	−.008	−.037	−.054	−.063
100	.276	.241	.202	.168	.143	.115	.078	.024	−.012	−.039	−.056	−.064
200	.087	.092	.091	.085	.077	.064	.040	.001	−.028	−.050	−.063	−.068
300	.019	.024	.027	.029	.029	.026	.014	−.015	−.039	−.055	−.066	−.072
400	−.009	−.008	−.005	−.003	−.001	−.001	−.007	−.028	−.048	−.060	−.068	−.075
500	−.022	−.024	−.024	−.022	−.021	−.020	−.024	−.038	−.052	−.064	−.071	−.077
600	−.030	−.034	−.035	−.035	−.035	−.034	−.035	−.046	−.057	−.066	−.073	−.079
800	−.039	−.043	−.047	−.048	−.048	−.048	−.049	−.056	−.065	−.071	−.076	−.079
1000	−.044	−.049	−.053	−.054	−.054	−.054	−.055	−.062	−.070	−.075	−.078	−.081
1100*	−.047	−.052	−.055	−.056	−.056	−.055	−.056	−.064	−.071	−.076	−.079	−.081
1200*	−.051	−.055	−.058	−.057	−.057	−.056	−.058	−.067	−.073	−.077	−.079	−.081

* Extrapolated

[1] W. Edwards Deming and Lola E. Shupe, (*a*) Phys. Rev. **37**, 638–654 (1931); (*b*) **38**, 2245–2264 (1931); (*c*) **40**, 848–859 (1932); (*d*) **45**, 109–113 (1934).

[2] The equations and tables have been numbered consecutively throughout the series; those that reappear from previous papers will be given their original numbers.

[3] J. R. Roebuck and H. Osterberg. Phys. Rev. **48**, 450–457 (1935).

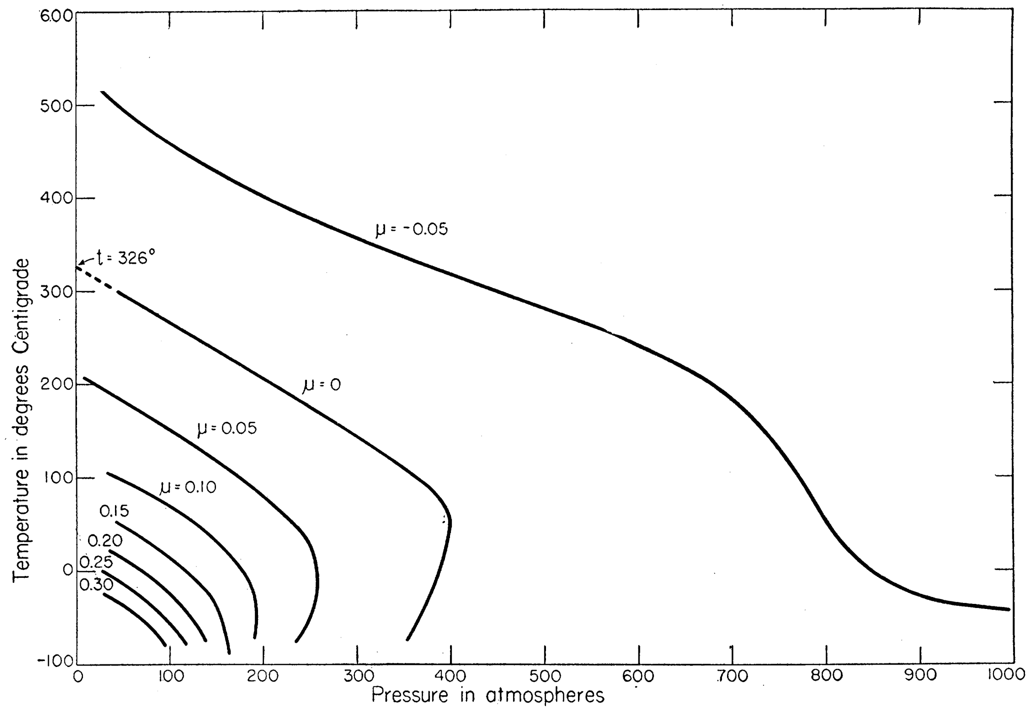

FIG. 28. The μ contours on the pressure-temperature diagram for nitrogen.

data may be of practical and theoretical importance until more direct experimental work is carried out.

Fig. 28 shows the family of μ contours on the p–t diagram. These were obtained by plotting the data of Table V in the form of μ against p in isotherms, and reading off values of μ at $p=20$, 40, 60, $\cdots$, 1000, with an extrapolation to $p=0$. The starred values in Table V for $p=1100$ and 1200 atmos., and for $t=500$ and 600°C are based on extrapolations of the Δ curves, as described on page 647 of reference 1a.

It is evident from the spacing between contours that the variation of μ with both pressure and temperature increases as μ increases. The contour $\mu=0$ in Fig. 28 is the inversion curve. It crosses the axis $p=0$ at about 326°, which is therefore the inversion temperature for zero pressure.