EXPERIMENTAL DETECTION OF SOUND DISPERSION NEAR CRITICAL POINT

S. G. Komarov and E. P. Sheludyakov

The existence of sound dispersion near the critical point was pointed out in [1]; however this dispersion has not been detected experimentally to date. We have made measurements of the speed of sound in the vicinity of the critical point of freon-12 using an ultrasonic interferometer [2], somewhat modified, with the objective of detecting this dispersion. The test freon-12 was analyzed on a mass spectrometer to determine the presence of other freons, uncondensed gases, and moisture. Such impurities were not present to within the sensitivity of the mass spectrometer.

The possibility of measuring the sound speed at different frequencies was provided by the arrangement of three radiators on a table driven by a single micrometer screw. The pressure was measured by a highly sensitive membrane sensor (sensitivity 1 mm Hg for atmospheric pressure of tens of atmospheres), the temperature was measured by a reference 10-Ω platinum resistance thermometer. The temperature was held to within 0.01° C in the thermostat. Measurements were made along the isotherms at three frequencies: 150.00 kHz, 978.50 kHz, and 2.096 MHz. The error in the sound speed determination did not exceed 0.5%. However, we note that the absorption in the region of the speed-of-sound minimum on the isotherms at the frequency 2.096 MHz was so strong that it was practically impossible to analyze the interferometer reactions. Therefore data are presented only for the frequencies 150.00 kHz and 978.50 kHz. It was noted in [2] that near the critical point there is an intersection of the temperature dependence of the sound speed in the liquid and vapor phases along the saturation line. This complicates markedly the sound propagation pattern in the subcritical region. Therefore we investigated only the supercritical region. Measurements were made on the isotherms: 112.27, 112.31, 112.47, 112.66° C (according to [3] the critical temperature of freon-12 is 112.04° C). The greatest dispersion (2.1%) was detected on the 112.27° C isotherm, which is closest to the critical isotherm in the region of the minimum. No dispersion was observed at the temperature 112.66° C. The results of the measurements of the sound speed a_1 (at the 150.00 kHz frequency) and a_r (at the 978.50 kHz frequency) on the three isotherms as a function of the pressure p, kgf/cm³, are shown in Table 1.

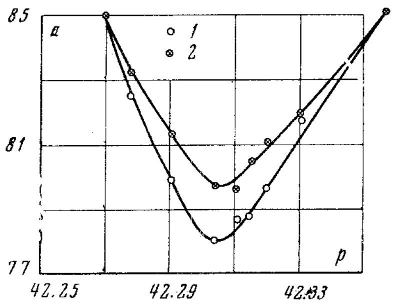

Fig. 1

TABLE 1

p	a_1	a_2	p	a_1	a_2	p	a_1	a_2
Isotherm $t = 112.27°$ C			Isotherm 112.31° C					
42.270	85.0	85.0	42.302	85.0	85.0	42.359	80.8	81.5
42.278	82.5	83.2	42.305	83.5	84.1	42.363	82.1	82.3
42.291	79.9	81.3	42.311	81.8	82.3	42.386	84.5	84.5
42.304	78.1	79.7	42.316	80.7	81.5	Isotherm 112.47° C		
42.311	78.7	79.6	42.320	79.8		42.426	86.0	86.0
42.315	78.8	80.5	42.322	79.5	80.4	42.454	81.7	82.0
42.320	79.7	81.1	42.333	78.8	80.2	42.463	80.8	81.5
42.331	81.7	81.9	42.334	78.8	80.2	42.477	81.7	81.7
42.357	85.1	85.1	42.345	79.2	80.7	42.535	85.7	85.7

Novosibirsk. Translated from Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki, Vol. 10, No. 5, pp. 124-125, September-October, 1969. Original article submitted May 28, 1969.

The nature of the dependence of the dispersion on the pressure p, kgf/cm^2 at constant temperature is seen in the figure, which shows the results of measurements of the sound speed (a, m/sec) at the frequencies 150.00 KHz (points 1) and 978.50 kHz (points 2) on the 112.27° C isotherm. We see from the figure that marked dispersion is observed in the region of the sound speed minimum in a very narrow pressure range on the order of 0.05 kgf/cm^2. The same is true of the temperature interval: marked dispersion is observed at a distance of 0.2-0.3° C from the critical temperature.

In conclusion we note that long-term maintenance of each experimental point in a given regime required the conduct of continuous measurements extending over a period of several days.

LITERATURE CITED

1. M. Sh. Giterman and V. M. Kontorovich, "On the effect of spatial dispersion on the propagation and scattering of waves near the critical point," ZhETF, Vol. 47, No. 6 (1964).
2. S. G. Komarov, A. N. Solov'ev, and E. P. Sheludyakov, "Intersection of temperature dependences of the sound speed in liquid and vapor phases of freon-12 on the saturation line near the critical point," PMTF [Journal of Applied Mechanics and Technical Physics], Vol. 9, No. 4 (1968).
3. N. B. Vargaftik, Handbook on Thermophysical Propeties of Gases and Liquids [in Russian], Fizmatgiz, Moscow (1963).