A NEW DIFFRACTION MET
MEASURING ULTRASONIC
CITIES IN LIQUIDS

In this communication we present a
of measuring ultrasonic velocitie
which is based on the diffraction
duced by two identical superposed
ultrasonic waves. The principle of
is as follows: When two identical
ultrasonic waves are set up side
a column of liquid with their
parallel, the diffraction pattern du
beam traversing the gratings par
ultrasonic wavefront, shows variatio
sity as the phase difference betwe
ultrasonic waves is continuously c
the two ultrasonic waves have a pat
which is an integral multiple of
length, the amplitude of corruga
emergent light wavefront is the
amplitudes due to the individual
hence the diffraction pattern attain
intensity. If, on the other hand, th
ference is an odd integral multiple
wavelength, the compressions and
due to one ultrasonic wave lie o
plane as the rarefactions and com
the other so that the amplitude of
of the emerging light wavefront is
ence due to the individual waves

the diffraction pattern acquires minimum intensity. It can now be easily seen that if one of the ultrasonic gratings is moved continuously along the direction of propagation, the intensity of the diffracted light reaches maxima or minima at regular intervals of one wavelength. Knowing the distance through which one of the gratings is moved to cover a fixed number of maxima or minima, the wavelength λ and hence the ultrasonic velocity V can be directly determined by using the relation

$$V = \nu\lambda$$

where ν is the frequency of the ultrasonic waves.

The usual Debye-Sears progressive wave diffraction set up is employed for observing the diffraction patterns. Two identical circular X-cut quartz crystals of 1 in. diameter and 1·265 Mc/sec. fundamental frequency are connected in parallel across the output of a variable frequency Hartley oscillator for the purpose of generating two ultrasonic waves. The crystals were excited at about the third harmonic frequency as it is advantageous to use higher frequencies to set up progressive waves and to get more number of maxima. One of the crystals is mounted in a standard fixed crystal holder with the bottom surface in contact with the surface of the liquid in the ultrasonic cell. The other crystal is mounted in a movable crystal holder, shown in Fig. 1, which consists of two telescoping tubes, the inner tube C sliding freely inside the outer tube A which is rigidly fixed. The central leg of a spherometer which is rigidly fixed on A rests snugly in a small conical groove at the top of cylinder C which is held to it by two springs. An insulator ring T fixed to the bottom of cylinder C carries the crystal in a circular groove pressed to it by metal clips. These clips prevent the crystal from falling and serve as the bottom electrode terminals to the crystal. The groove surrounding the edge of the crystal is filled with paraffin to prevent the liquid in the tank from short-circuiting the crystal. The top surface of the crystal is insulated from the cylinder C by an insulated washer G. An insulated lead from the upper electrode E of the crystal is taken out for feeding power to the crystal. After making careful adjustments to ensure that the surfaces of the two crystals are parallel, the readings of the spherometer for every ten consecutive maxima are noted and the wavelength of the ultrasonic wave is evaluated. To attain very high accuracy in velocity measurements, a sensitive photomultiplier photometer has been used for judging the positions of maxima or minima.

With a view to check the accuracy and reliability of this method, velocity measurements were made for aqueous solutions of sodium chloride at various concentrations. The measured values for 10λ and the calculated values of ultrasonic velocity V at various concentrations upto 1 molal are presented in Table I.

TABLE I

Measurements at 32° C.

Molal concentrations	Frequency ν in Mc/sec.	10λ cm.	Velocity m/sec.
0	3·864	0·3930	1519
0·2	3·810	0·4020	1531
0·4	3·857	0·4000	1543
0·6	3·829	0·4065	1556
0·8	3·828	0·4090	1566
1·0	3·822	0·4125	1576

The frequency of the oscillator which is found to vary from one concentration to the other due to probably the capacitance of the liquid in the ultrasonic tank, is measured by a precision Marconi Wavemeter. The value of ultrasonic velocity for water at 32° C. is in good

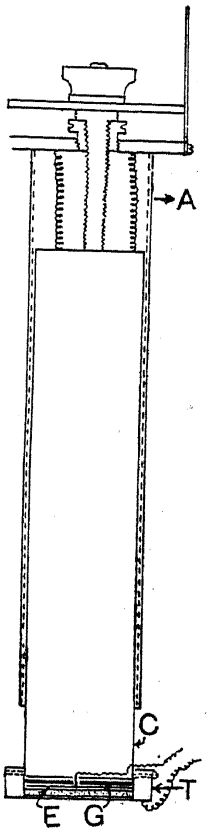

FIG. 1

agreement with the value reported by other workers. The variation of ultrasonic velocity with concentration is nearly linear being

57 m/sec. for 1 molal concentration. This value agrees well with the interpolated value of 57 m/sec. for 1 molal concentration obtained from the results of Barthel.[1]

The method is simple, accurate and reliable, but suffers from the disadvantage that it is applicable only for transparent liquids available in large quantities as the progressive wave tank must have a large capacity.

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Waltair, *October* 28, 1956.

1. Barthel, R., *J. Acous. Soc. Amer.*, 1954, **26**, 227.