THE NEOTIA UNIVERSITY

WORK INSTRUCTION

1.0 EXPERIMENT NO: BNS/103a/05

2.0 NAME OF EXPERIMENT: ULTRASONIC INTERFEROMETER

3.0 0BJECTIVE: DETERMINATION OF VELOCITY OF ULTRASONIC WAVE IN WATER

4.0 PRINCIPLE:

The ultrasonic interferometer consist of transducer crystal at the bottom of the cell, which is driven by a crystal controlled oscillator fixed frequency.

Ultrasonic wave is transmitted to the liquid in contact with the transducer and reflected back from the metal plate, placed at a distance from the transducer in the liquid. The reflective wave is received by the same transducer and a meter indicates the position of the metal reflector is at node or anti node. Stationary wave is formed in the liquid.

An Ultrasonic Interferometer is a simple and direct device to determine the ultrasonic velocity in liquids with a high degree of accuracy. The principle used in the measurement of velocity (V) is based on the accurate determination of the wavelength (λ) in the medium. If the separation between these two plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz plate and the anode current of the generator becomes a maximum. If the reflector is set now on two successive maxima or minima, the difference between the micrometer readings will be $\lambda/2$. If the reflector is set at m^{th} and $(n+m)^{th}$ maxima, then the difference between the micrometer reading,

$$d = n\frac{\lambda}{2} \qquad \text{So, } \lambda = \frac{2d}{n}$$

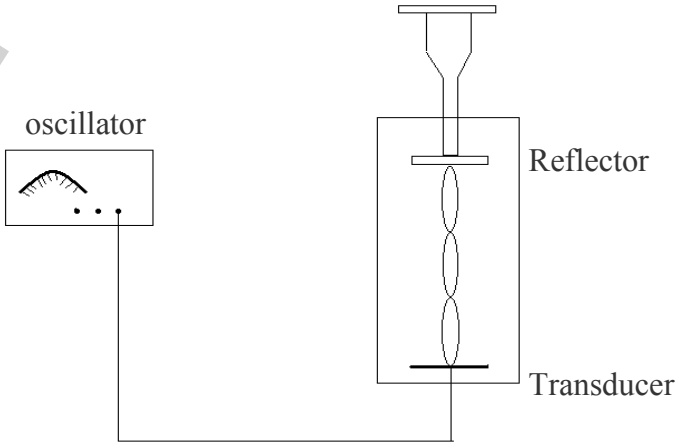
From the knowledge of wavelength (λ), the velocity (V) can be obtained by the relation

$$V = \lambda \times f$$

5.0Procedure: (don't write the procedure in your Lab. Copy)

1. Adjustments of ultrasonic interferometer:

Insert the cell in the square base socket and clamp to it with the help of a screw provide on one of its side. Unscrew the knurled cap of cell and lift it away from double walled construction of the cell. In the middle portion of it pour experimental liquid and screw the knurled cap. Two chutes in double wall construction are provided for water circulation to maintain desired temperature. Connect the High frequency Generator with cell by co-axial cable provided with the instrument. For initial adjustment two knobs are provided on high frequency generator, one is marked 'Adj' and the other with 'Gain'. With knob marked 'Adj' the position of the needle on the Ammeter is adjusted and the knob marked 'Gain' is used to increase the sensitivity of the instrument for greater deflection if desired. The meter is used to notice the number of maximum deflections while micrometer is moved up and down in liquid. The micrometer is slowly moved till the anode current on the meter on the High Frequency Generator shows a maximum. Note the anode current and the micrometer reading.



6.0 TOOLS/APPARATUS REQUIRED:

1) ULTRASONIC INTERFEROMETER
2) Signal generator

7.0 Tabulation:

TABLE-1
Determination of the least count of the micrometer screw

No. of div. in circular scale n	pitch x (mm)	Least count L.C.=x/n (cm)

TABLE-2
Determination of Velocity of Ultrasonic Wave:
Frequency of Ultrasonic Wave = 2×10^6 Hz

Liquid used	Reflector set on maxima (n)	Linear scale reading (cm)	Circular scale reading	Total reading (cm)	Linear shift d (cm)	Wave length $\lambda = \frac{2d}{n}$ (cm)	Mean λ (Meter)	Velocity Of Ultrasonic Wave $V = \lambda \times f$ (Meter/sec.)
Water	0			d_0=	0.0			
	4			d_1=	$d_0 - d_1$=			
	8			d_2=	$d_0 - d_2$=			
	12			d_3=	$d_0 - d_3$=			
	16			d_4=	$d_0 - d_4$=			
	20			d_5=	$d_0 - d_5$=			

Graph and Result

From the data of the Table – 2 plot a graph with Reflector set on maxima (n) along abscissa (x - axis) and Linear shift (d) along vertices (y – axis). Determine the values of *n* and *d* from the graph. There from calculate the value of the velocity of ultrasonic wave in water in Table -3.

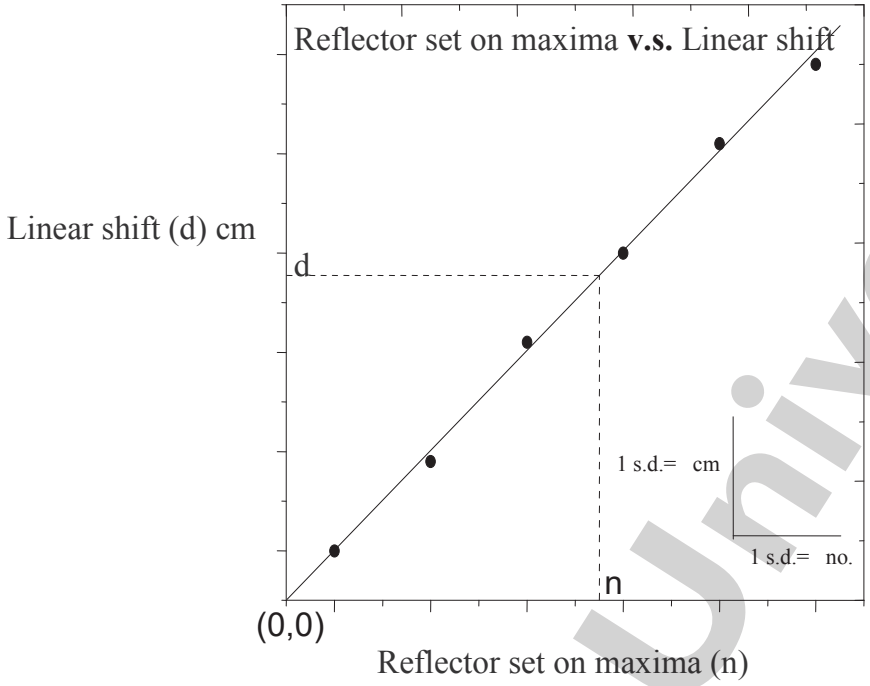


TABLE-3

Determination of Velocity of Ultrasonic Wave:
Frequency of Ultrasonic Wave = 2×10^6 Hz

Reflector number (n) (From graph)	Linear shift (d) cm ((From graph)	Wave length $\lambda = \frac{2d}{n}$ (cm)	Velocity Of Ultrasonic Wave $V = \lambda \times f$ (Meter/sec.)

8.0 Error calculation

9.0 COMPUTATION OF PERCENTAGE ERROR:

We have the formula for

$$\lambda = \frac{2d}{n}$$

Taking ln in both sides we get,

$\ln \lambda = 2\ln d - \ln n$

Differential both sides we get for maximum

proportional error, $\frac{\partial\lambda}{\lambda} = \frac{2\partial d}{d} + \frac{\partial n}{n}$

(For maximum proportional error the negative signs will be Converted into positive signs)

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Now,

δd= error in measuring d

= Least count (*l.c.*) of the screw gauge (because probability of making error is in one side)

δn= error in measuring *n*

Putting suitable values calculate the value of proportional error.

Hence, the percentage error is $(\frac{\partial \lambda}{\lambda} \times 100)$ % (Put the values and calculate the percentage error).

9.0 Discussion :

You have to write all the difficulties you faced during the experiment and their remedies. Also you have to mention some way out that one should adopt during the practical to have a better result.