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Radiation Physics Lab

Third stage- Radiology Techniques Department

Experiment 7

By

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Drawing the path of sound waves when they transmitted through the media which different in acoustic impedance

The objective of the experiment:

1- Drawing the path of sound waves through air, then water, then air.
2- Measuring the angle of refraction of sound in water.
3- Finding the velocity of sound in water.

The equipment needed:

1- a parallelepiped shaped container with suitable dimensions so that the dimensions of its rectangular base can be determined on a regular sheet of paper.
2- Protractor for measuring angles.
3- Ruler.
4- Source generating sound waves.
5- Decibel meter.

The theory:

When the sound is transmitted from the air whose acoustic impedance is (Z_1) and where the velocity of sound is (V_1) at a

certain temperature such as (T) to the water whose acoustic impedance is (Z_2) and where the velocity of sound is (V_2), the sound will be refracted away from the vertical line on the acoustic boundary between air and water because ($V_2 > V_1$) , And when the sound comes out of the water into the air, the boundary between air and water , and since the relationship between the velocity of sound in the air and the temperature is expressed by the following equation

$V_1 = V_\circ + (0.6)T$ .....(1)

Where

$V_\circ$: the velocity of sound in air at (0C°) , and it is equal to (331 m/sec).

And that the relationship between the velocity of sound in water and the velocity of sound in air is expressed through Snell's law of refraction

$\text{Sin } \Theta_i / \text{Sin } \Theta_r = V_1 / V_2$ .....(2)

Where

Θ_i: represents the angle of incidence in the air.

Θ_r: represents the angle of refraction in water.

The experimental procedure:

1- We take piece of paper (A_4) or graphical paper and put it on the table .
2- We put the container in which we will add the water on the paper, and then determining its rectangular base with a pencil.
3- We lift the container from the paper and put it away from it, then draw a vertical line at a certain point on the long side of the rectangle drawn on the paper, which represents the base of the container.
4- We use the protractor to draw a ray that makes an angle of (10°) with the vertical line mentioned in step (3).
5- We put the container again on the paper between the borders of its base drawn in step (2), then add water in the container until it reaches half the height of the container .
6- We place the sound source towards the ray that makes an angle of (10°) with the vertical line on the boundary between water and air, so the angle of incidence is (Θ_i=10°).
7- We put the intensity level meter on the other side of the container, then we move it to get the highest intensity level, which is in the direction from which sound waves pass from water to air.
8- When obtaining the highest intensity level, we fix a point with a pencil on the paper to represent the location of the decibel meter (the point of receiving waves in the device).
9- We put a ruler on the decibel meter and parallel to the passing axis of the wave reception point in the device to reach the face of the container opposite the decibel meter, then we fix a point with a pencil on the paper at the end of the ruler close to the

face of the container, so it is close to the boundary between air and water.

10-We lift the container again and place it away from the paper, then draw from the point that we obtained in step (9) a line perpendicular to the line separating between air and water.

11-We draw a straight line between the point that we obtained in step (8) and the point of intersection of the vertical line with the boundary between air and water that we obtained in step (10), and that the resulting line represents the path of sound waves which transmitted from water to air.

12- We draw a straight line between the point of intersection of the vertical line on the boundary between air and water from the side of the waves which incident from the air into the water and the point of intersection of the vertical line on the boundary between water and air from the side of the waves exiting from the water into the air, and that the drawn line represents the path of the waves inside the water.

13- We measure by the protractor the angle of refraction of the sound waves (Θ_r) when the waves transmitted from air to water, which is the angle made by the line drawn in the step (12) with the vertical line on the boundary between air and water .

14- We measure the air temperature (T) in the laboratory.

The calculations and results:

1- We apply equation (1) to get the magnitude of the velocity of sound in air at temperature (T) which is (V_1).

2- We find ($\sin\Theta_i$) and ($\sin\Theta_r$), since (Θ_i) and (Θ_r) were measured with the protractor during the experimental procedure.

3- We apply equation (2) to get the magnitude of the velocity of sound in water which is (V_2).