Calculation of Attenuation for Ground water, Rainwater and Several locally bottled water using He-Ne Laser

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Abstract:

In this research, a theoretical study and laboratory experiments were conducted to know the relationship of the transmission of helium-neon laser rays with power (2mW) and wavelength of 632nm at different depths through the water medium for several types of water (ground water, rain water and other types of locally bottled water (al-nabaa, Dajala and Al-Waha)) and the amount of transmittance of these rays, which naturally the case is directly related to the so-called attenuation coefficient. The decrease in permeability was observed with increasing the depth of the penetrating path for all water samples under study,This decrease is the product of the scattering of the ray with water molecules [1] As well as the product of absorption by water molecules.but with different values, and this difference is the indicator that indicates the attenuation coefficient and thus the extent of water purity. It was found through this study that the water of Dajla is more pure, it has the lowest attenuation coefficient (0.005cm^{-1}) in the samples under study but the groundwater has Lowest purity in all samples which means highest attenuation coefficient value (0.04cm^{-1}) .

Keywords: A. Absorption B. He Ne Laser C. Beer-Lambert Law D. Attenuation Coefficient E. permeability.

الخلاصة:

تم في هذا البحث دراسة نظرية واجراء تجارب معملية لمعرفة علاقة انتقال اشعة ليزر الهيليوم نيون بقدرة (2mW) وبطول موجي 632 نانومتر بأعماق مختلفة خلال الوسط المائي لعدة انواع من الماء (مياه جوفية, مياه الامطار وانواع اخري من المياه المعبأة محليا (النبع, دجلة والواحة)) ومقدار النفاذية لهذه الاشعة التي بطبيعة الحال علاقة مباشرة بما يسمى بمعامل التوهين. وقد تم ملاحظة نقصان النفاذية بزيادة عمق المسار المخترق لجميع عينات الماء قيد الد راسة وهذا النقصان هو نتاج الاستطارة للشعاع مع جزئيات الماء [1] وكذلك هو نتاج الامتصاص من جزيئات الماء. ولاكن بقيم مختلفة وهذا الاختلاف هو المؤشر الذي يدل على معامل التوهين وبالتالي مدي نقاوة المياه. لقد تبين من خلال هذه الدراسة ان مياه دجلة اكثر نقاوة في العينات قيد الدراسة لديها أدنى معامل توهين (0.005 سم $^{-1}$) في العينات قيد الدراسة ولكن المياه الجوفية لديها أقل نقاوة في جميع العينات مما يعني أعلى قيمة لمعامل التوهين (0.04 سم $^{-1}$)

كلمات دالة: امتصاص, هيليوم نيون ليزر, قانون بيرلامبرت, معامل التوهين, النفاذية.

Introduction:

This research paper has been divided into several parts. In the beginning, the theoretical aspect was addressed to identify the behavior of the laser beam when it penetrates a certain thickness of the water sample and how to know the different parameters (absorption, transmittance and attenuation) of the samples under study, which include (ground water, rain water, spring, Tigris, oasis). The main objective of this study is to know the attenuation coefficient of these samples, which naturally reflects the extent of purity, and the comparison was made between these samples in terms of these characteristics. The equipment used in this research is: a helium-neon laser as a source of electromagnetic energy, as well as a Lux Meter as a reader for the intensity of illumination through the sample.

After the production of the laser and its entry into many applications and uses in all scientific fields, the interest of researchers increased in studying the transmission of electromagnetic waves in general and lasers in particular, and studying the factors affecting its transmission through the material medium.

The beam attenuation coefficient α is sued to characterize the optical transmission properties of water. The beam attenuation coefficient is a measure of the decay of the unscattered light. The beam attenuation coefficient is the sum of the absorption coefficient and the scattering coefficient [2]. As a result of the experiments conducted on the samples, it was found that: The sample S4 has the lowest attenuation coefficient ($0.005cm^{-1}$) than the rest of the samples, which means that it is the best, with less turbidity and more purity, while the sample S1 represents the most in terms of attenuation coefficient ($0.04cm^{-1}$), which means that it is the most turbid (least pure) As shown in Table 7.

Theoretical Part:

The laser transmission experiments through water are carried out with a number of steps:

1- The first or initial intensity (I_0) is taken by sending the laser beam through the tube that has a glass base close to the laser intensity meter, without the presence of the aqueous medium.

2- Other readings of the intensity of illumination I are taken by filling the tube or beaker of various lengths with the required water, which is the path of the laser with water X and through which the transmittance was measured, and the intensity is measured for the various paths recorded by the measuring device (Lux meter).

3- After recording the illumination intensity of the laser beam passing through the different paths of the sample and placing it in a

table, the required curves are drawn and the results are compared for each sample of water.
When a beam of light of a single wavelength enters water sample, the intensity reaching a distance (depth) x is given by the equation1:

$$I=I_0 \exp(-\alpha x) \qquad 1$$

Where: I_0 = the basic intensity of the ray before entering the water
α = Total Attenuation Coefficient of the water sample.

From the previousequation[3].The attenuation coefficient can be expressed as:

$$\alpha = ln\left(\frac{I_0/I}{x}\right) \qquad 2$$

Figure1 shows the path of laser beam through the water sample.

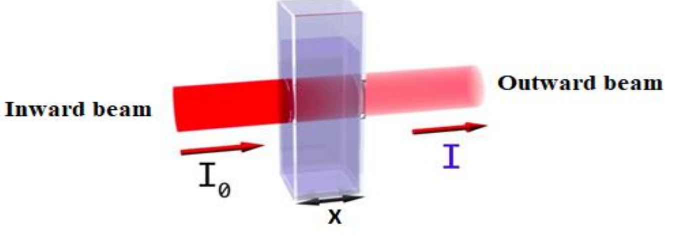

Figure1: The path of electromagnetic radiation through the sample

The attenuation is the product of the sum of the scattering and absorption losses**:**

$$\alpha = a + s \qquad \mathbf{3}$$

a: absorption coefficient, S: scattering coefficient
It is clear from the previous equation that the losses of both scattering and absorption coefficients are variable in the aqueous medium depending on the depth (x). The ttransmittance is the passage of a portion of the incident light ray at a specific wavelength

other than the sample. If the sample is transparent, it will come out undiminished, and usually it loses part of the beam in the sample of the material due to its absorption and gradually weakens and the unabsorbed part comes out.[2]

Equation 4 is known as transmittance, which is the ratio of the intensity of the transmitted light to the intensity of the incident light.

$$T = {}^{I}/_{I_0} \qquad (4)$$

Transmittance is related to absorption as:

$$A = -ln(I/I_0) \qquad (5)$$

Transmittance can be rewrite as:

$$T = e^{-\alpha x} \qquad (6)$$

It is clear from the equation that the transmittance depends on the property of the material (α) and on the thickness of the material x, meaning that the greater the thickness of the material, the lower the percentage of transmitted light.

The Studied Samples:

1. **Groundwater**: It is water found in the pores of sedimentary rocks that were formed through different times, whether they are modern or very old for millions of years. The source of this water is often rain, permanent or seasonal rivers, or melting ice. Water seeps from the surface of the earth into what is known as nutrition. Groundwater is utilized in several ways, including drilling underground wells.
2. **Al-naba water :**Al- naba Water It is water treated in advanced desalination plants and bottledin a factory in the kasser ben kasher in Tripoli and sold in the Libyan market.

Table 1 shows the chemical components of Al-naba water (manufacturer's source).

Table1: The chemical composition of anaba water (mg/l)

Component	Rate
Sodium	16
Potassium	1
Calcium	8
Magnesium	5
Chlorides	28
Sulfates	15
Bicarbonate	25
nitrates	3
fluorides	0.4
dissolved salts	120
pH	6.5-7.5

3. **Alwaha Water :**Alwaha Water It is water treated in advanced desalination plants and bottledin a factory in the Misrata and sold in the Libyan market.

Table 2 shows the chemical components of Alwaha water (manufacturer's source).

Table2:The chemical composition of Alwaha water (mg/l)

Component	Rate
Calcium	4.008
Magnesium	2.4
Sodium	52.9
bicarbonate	24.4
chlorides	12.24
Total endogenous salts	100
pH	7.3

4. **Dajla Water :**Dajla Water It is water treated in advanced desalination plants and bottled in a factory in the Wadi Al

Rabea area in Tripoli and sold in the Libyan market. Table 3 shows the chemical components of Dajla water (manufacturer's source).

Table3: The chemical composition of Dajla water (mg/l)

Component	Rate
Sodium	19
potassium	0.8
Calcium	4.2
Magnesium	2.2
bicarbonate	22.6
Sulfates	10.7
chloride	23
nitrates	2
fluoride	0.02
pH	7-6.5
dissolved salts	120-100
total hardness	22

5. **Rain water :**The sample was collected from rain water in Tarhuna area, and table 4 shows the chemical components of Rain water.

Table4: Chemical composition of rain water (ppm)

Component	Rate
Sodium	1.98
potassium	0.3
Magnesium	0.27
Calcium	0.09
chlorine	3.79
Sulfates	0.58
bicarbonate	0.12
Carbon Dioxide	---
pH	5.7

Samples Codes: Samples were coded in the laboratory as shown in Table 5 for the purpose of reliability in calculating the results

Table57:Codes used for the samples under study

Sample	Groundwater	Anaba	Alwaha	Dajla	Rain
Code	S1	S2	S3	S4	S5

Experimental equipment's and procedures:

1. **Helium-Neon laser**

A helium-neon laser is used as a light source to pass through the water samples under study, the power of laser 2mW and its wavelength 632nm.

2. **Lux-Meter**

A lux measuring device or lux meter is therefore a device for determining illuminance. The illuminance is a value that does not refer to the light source, but to the illuminated area. The lux meter can be used to determine how much of the luminous flux emitted by one or more light sources reaches a specific surface. In this research we used this device to measure the light intensity after passing through the water samples.

The steps for measuring the intensity of illumination by lux meter can be summarized as follows

1- Some part of Light from the light source is transmitted through the sample [4].

2- The sample absorbs light.

3- The optical receiver captures the remaining amount of light after passing through the sample.

4- The photometer converts the amount of light which transmitted through the sample into a number.

5- Draw the result within a chart directly on the device screen.

Figure2 shows the luminous intensity meter (lux meter) used in this research.

Fig2: Lux Meter [5]

Methodology:

The laser transmission experiments through water are carried out with a number of steps:

1- The first or initial intensity (I0) is taken by sending the laser beam through the tube that has a glass base close to the laser intensity meter, without the presence of the aqueous medium.

2- Other readings of the intensity of illumination I are taken by filling the tube or beaker of various lengths with the required water, which is the path of the laser with water X and through which the transmittance was measured, and the intensity is measured for the various paths recorded by the measuring device (Lux meter).

3- After recording the illumination intensity of the laser beam passing through the different paths of the sample and placing it in a table, the required curves are drawn and the results are compared for each sample of water.

The Results and Discussion:

From the following tables (6,7) and figures(3,4.5), the relationship between (luminous intensity, absorption, attenuation) and the depth of the path that the laser penetrates into the water samples under study can be summarized as follows:

1. The decrease in the intensity of illumination with the increase in the depth of the penetrating path of the laser is evident for all samples without exception.
2. The increase in the attenuation coefficient with increasing the depth of the penetrating path of the laser for all samples without exception.
3. The decrease in permeability increases with the depth of the path.
4. After the path depth (12cm), there is a noticeable change in the behavior of the sample S2 that decreases in its loss of luminous intensity with increasing path depth, as well as an increase in transmittance and a decrease in the attenuation coefficient than usual.
5. We note that the percentages of increase and decrease for each of the intensity, transmittance and attenuation mentioned in points 1,2,3 are arranged as follows: s1, s5, s2, s3, s4

Table6: Distance (path depth) and lamination intensity of water samples

X(cm)	Is_1(lux)	Is_2(lux)	Is_3(lux)	Is_4(lux)	Is_5(lux)
0	945	946	945	945	945
2	880	890	934	939	926
4	808	866	929	933	888
6	796	830	910	926	834
8	705	758	905	920	806
10	677	748	896	915	748
12	590	736	856	899	704
14	570	729	846	895	684
16	445	712	839	885	658
18	405	702	827	856	613
20	390	685	819	843	609
22	370	638	791	829	583
24	335	607	759	816	549
26	324	584	725	786	505
28	290	570	713	755	468

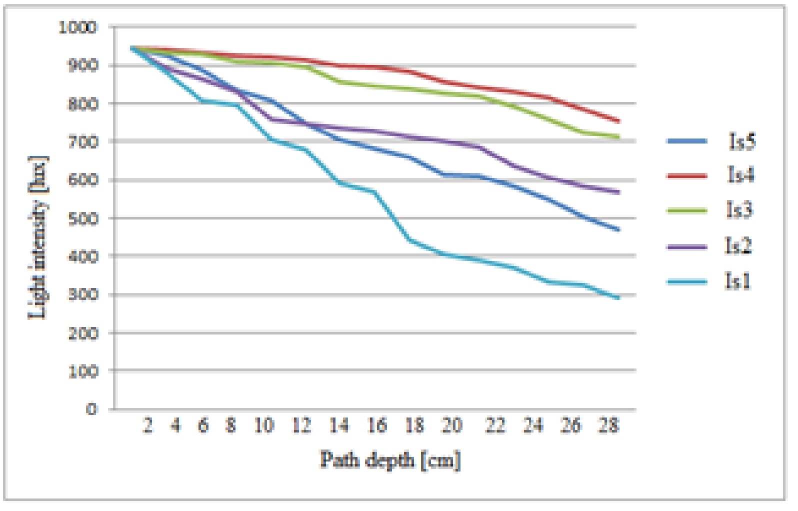

Fig3: Path depth vs Light intensity

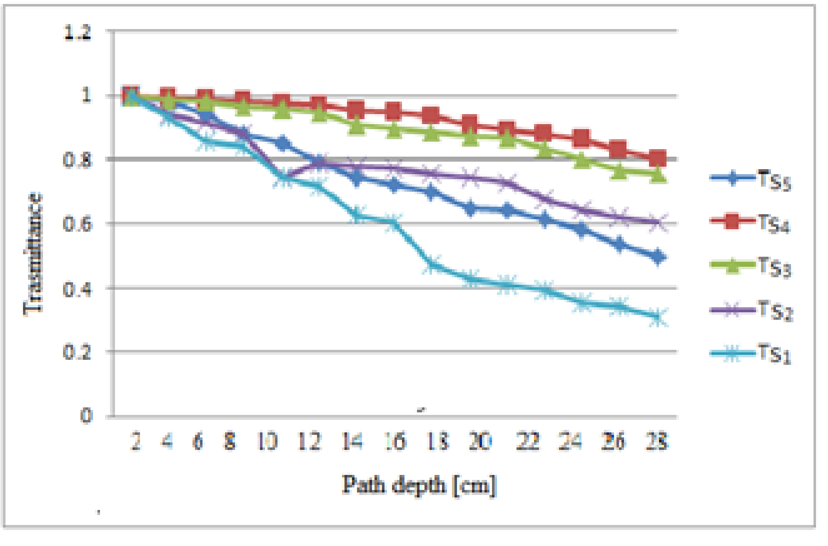

Fig4: Path Depth vs transmittance

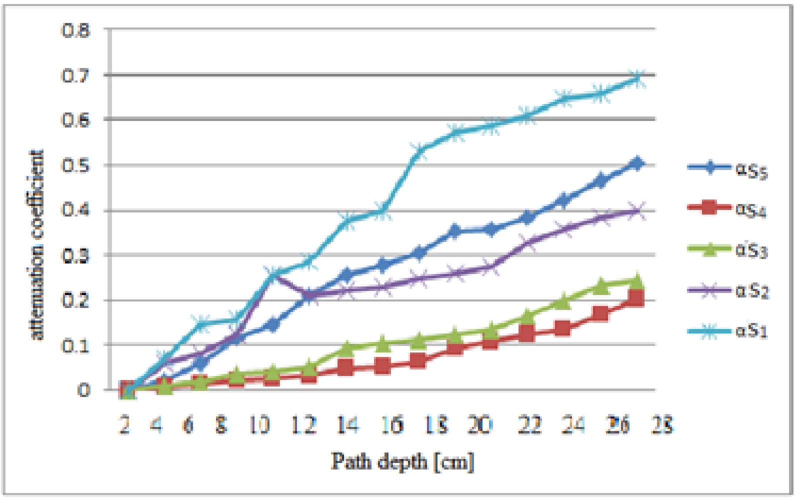

Fig5: Path Depth vs attenuation coefficient

The average attenuation coefficient of the water samples under study, where we note that sample S4 has the lowest attenuation coefficient(0.005cm^{-1}) than the rest of the samples, which means that it is the best, with less turbidity and more purity, while the sample S1 represents the most in terms of attenuation coefficient (0.04cm^{-1}), which means that it is the most turbid (least pure).
Table7 shows the attenuation coefficient of the all samples under study.

Table7: attenuation coefficient of water samples

Sample	S1	S2	S3	S4	S5
Attenuation Coefficient (cm^{-1})	0.040	0.020	0.007	0.005	0.021

Conclusion:

The beam attenuation coefficient is used to characterize the optical transmission properties of water. So, the objective of this study is to know the source purity by reading the attenuation coefficient of water medium for several types of selected water, (groundwater, rainwater and other types of locally bottled water (al-nabaa water, Dajala water and Al-Waha)) which reflects the extent of water purity. The equipment used in this research is a helium-neon laser as a source of electromagnetic energy and a Lux Meter as a reader for the intensity of illumination through the samples. A comparison was made in terms of the attenuation coefficient between the samples, where sample S4 (Dajla water) shows the lowest attenuation coefficient of (0.005cm-1) which means that it is the best purity. In contrast, sample S1 (Groundwater) represents the most turbid (least pure) in terms of the attenuation coefficient of (0.04cm-1). so the attenuation of the laser occurred through the water medium led to knowing the pure source from another.

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