Laser beam intensity modifications via fluids viscosity

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Abstract :
In this search we study the effect of laser radiation by use laser diod 630 nm on viscosity of ethanol liquid .the viscosity was very important parameter in physics .we are using a viscometer in different temperature from 20 to 60 c°. since the relation ship between Viscosity and temperature are nonlinear. our work present the same relation in the presence of laser radiation and the intensity of laser raise (23.5-18.5) Watt/^{cm2}with creasing of temperature .the out put radiation change with the value of viscosity (14.97-34.802) poise.

Theory:
Viscosity is the resistance that displayed by a fluid when its layers slide each on another. In general liquids show high resistance than gases.
Some materials have high viscosity like lubricants while other materials exhibit low viscosity like water.
Viscosity in gases is the result of the transition of their molecules from a layer to another layer. In more precise words it is due to the transfer of the momentum from some molecules in a certain layer to other molecules which is in turn this process is responsible for viscosity
It is clear from the following relation that gases viscosity dose not depend on its density [1]

$$\eta = \frac{2}{3\pi\, \mathrm{N}\sigma^2}\sqrt{\frac{MRT}{\pi}} \quad .... \ (1)$$

Where η is the viscosity.
All the liquids display viscosity (a resistance or objection to flow).The viscosity units (poise) may simply give as follows,

$$poise = \frac{dayen/cm4 * \sec}{cm * cm3}$$
$$= dayen/cm2.*\sec$$

In 1842 Bossily presented formula which relate the coefficient of viscosity with the velocity of flow through a long fine tube as:[2]

$$\eta = \frac{\pi\, \mathrm{p}\, \mathrm{r}^4\, \mathrm{t}}{8\, \mathrm{L}\, \upsilon} \quad .... \ (2)$$

Where ν is volume of flowed liquid, t is times of flow, L is length of a fine tube, r is radius of fine tube and p is the pressure.
Liquids do not behave like gases which appear decreasing in viscosity with the rise of temperature. Experimentally a relation between η and temperature may be given by[2]

$$\mathrm{Log}\,\eta = \frac{\mathrm{A}}{\mathrm{T}} + \mathrm{B} \quad .... \ (3)$$

Where A,B are characteristic constants of the liquid under study and T is the absolute temperature .
The free volume of liquid denoted by (v – w) changes during temperature and pressure variations and this in turn effects mainly on the viscosity of liquid. For an example a viscosity will decrees if temperature is rising, as it is shown in the following relation

$$\eta = \frac{C}{(\mathrm{v} - \mathrm{w})} \quad .... \ (5)$$

Consequently we may get a formula for fluidity as [3]

$$\frac{1}{\eta} = \frac{\upsilon}{\mathrm{C}} - \frac{\omega}{\mathrm{C}} \quad .... \ (6)$$

The last relation shows that the fluidity will increases if temperature increases, and that is because fluidity is a the reciprocal of viscosity which is equal to $1/\eta$.

Table(1): shows some values for coefficient of viscosity (in Boise.)[2,3]

Liquid	0 C°	20 C°	40 C°	60 C°	80 C°
Benzene	0,912	0,652	0,503	0,392	0,329
Forth Colored Carbon	1,329	0,969	0,739	0,585	0,468
Water	1,792	1,002	0,656	0,469	0,357
Ethanol	1,772	1,200	0,834	0,592	-------
Anther Ethanol	0,284	0,197	0,197	0,140	0,118

In this work a trial is carried out to study the effect of the viscosity of some liquids on red laser intensity. The aim is to provide a simple and reliable technique with which laser beam intensity may modified according to the application underhand. Concurrently this technique also may prove useful in modifying the viscosity of a liquid by the laser intensity via mutual interaction between the laser beam and the liquid molecules [4,5,6,7].

Materials and methods:
A GaAs laser was used in this work. The laser radiates within the 0.7mu to 30 µm spectral bandwidth.
Figure (1) shows the viscometer used with a water bath at 25 C temperatures.

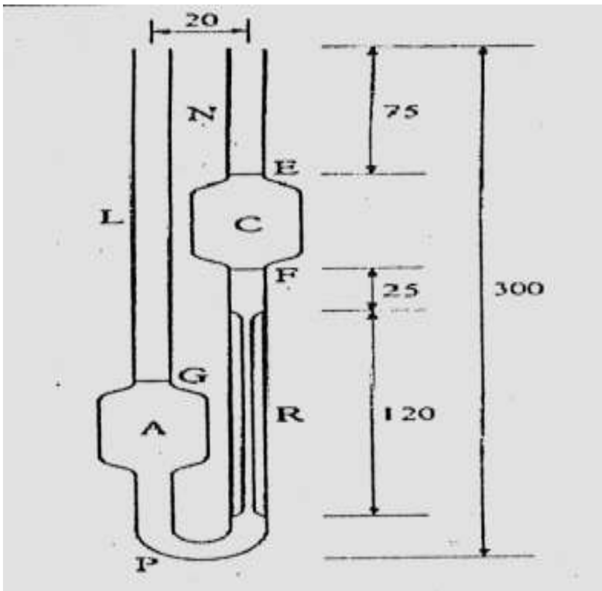

Fig (1): viscometer device

The sequence of the steps in our procedure of work was as follows:

1- A solution of chromic acid H_2SO_4 was used to clean the viscometer followed by distilled water. There was viscose meter dried in an oven at $110C^o$ for at least 30 minuet, then the viscose meter was left to cool down to room temperature.
2- Using a micro pipette, a 10 ml of ethanol was sucked taking into consideration the presence of impurities. The viscose meter was fixed in a water bath and left for five minutes to arrive at the water bath temperature.
3- A measurement of flow time of ethanol between two point B and C was recorded (Fig. 1), this measurement were repeated 3 times then the average value was taken.
4- All the steps were repeated with the presence of the laser radiation.
5- by using photo cell we calculate the voltage of the out laser radiate, then we calculate the intensity of laser theoretical.

Results and conclusion:

Table 2 lists the temperature and the water and ethanol temporal parameters recorded during the steps of the experiments that are used to calculate the viscosity in each case as indicated in the columns of the table. This set of data was recorded with the absence of the laser radiation. It is clear that we have though same fluid (ethanol) various values of viscosity. This is achieved via the temperature variations.

Table (2): listing of water and ethanol parameter at deferent temperioler with out laser radiate.

C^0	T (K)	t_1 (Sec)	t_2 (Sec)	η_1	W2 (gm)	$P_{1\ tim}$	$\rho_2 = \frac{w2 - w1}{v}$	$\eta_2 = \frac{\rho_2\ t_2}{\rho_1\ t_1}$	Log η_2	1/T (1/K)
20	293	39	78	1.002	41.9	0.99620	20.72	41.681	1.6199	0.0034
30	303	34	72	0.7975	41.7	0.99576	20.52	34.802	1.5416	0.0033
40	313	30	59	0.6529	41.56	0.99224	20.38	26.373	1.4212	0.0032
50	323	27	53	0.5112	41.39	0.98874	20.21	20.511	1.3112	0.0031
60	333	25	47	0.3705	41.12	0.98524	19.94	14.097	1.1491	0.0030

Where volume of ethanol $\upsilon=25\ cm^3$, w_1=21.18gram is weight of tube(empty tube),w_2 is weight of tube when filled by ethanol(41.7 ,41.56,41.39,41.12) gram, t_1 is time of flow for water and t_2 is time of flow for ethanol .

Table 3 lists the temperature and the water and ethanol temporal parameters recorded during the steps of the experiments that are used to calculate the viscosity in each case as indicated in the columns of the table. This set of data was recorded with the presence of the laser radiation.

Table (3): listing of water and ethanol parameter at deferent temperioler with laser radiate

C^0	T (K)	t_1 (Sec)	t_2 (Sec)	η_1	η_2 ٢٧٧	Watt\cm^2	1/T (1/K)	$P_2 = \frac{w2 - w1}{v}$
30	303	34	108	0.7975	34.802	18.5	0.0033	20.52
40	313	30	101	0.6529	26.373	20.75	0.0032	20.38
50	323	27	88	0.5112	20.511	21.0	0.0031	20.21
60	333	25	86	0.3705	14.097	23.5	0.0030	19.94

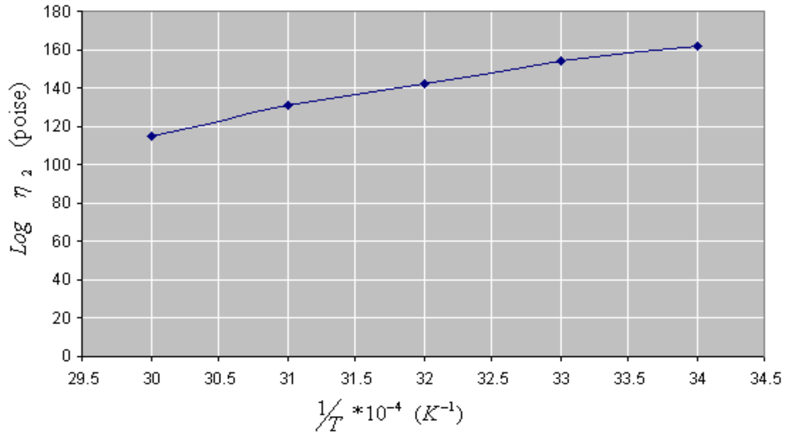

Fig (2) :viscosity –temperature relationship.

Figure (2) shows a plot log η_2 with viscosity in poise as fit of the reciprocal of temperate in Kelvin it shows that viscosity is proportional to the rise of temperature.

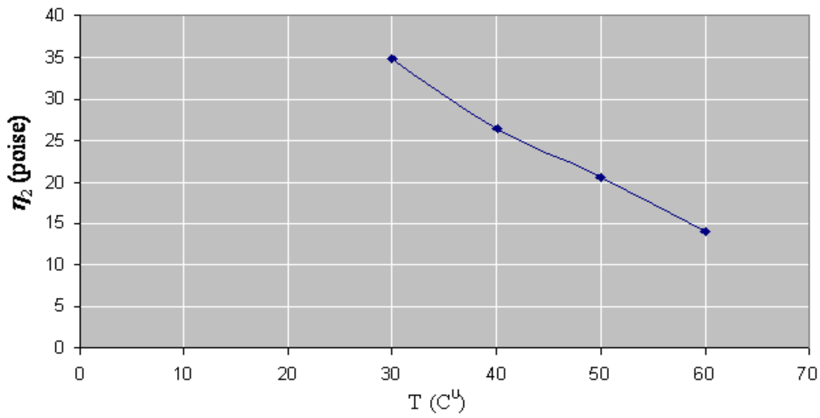

Fig (3): viscosity and temperate relation in the presence of laser radiate

Investigating the two plots log η_2 verses T, it is possible to calculate that for every certain temperature resulted during the presence of the laser radiation the viscosity changes for example at 30c° with 18.5w/cm ^{2}

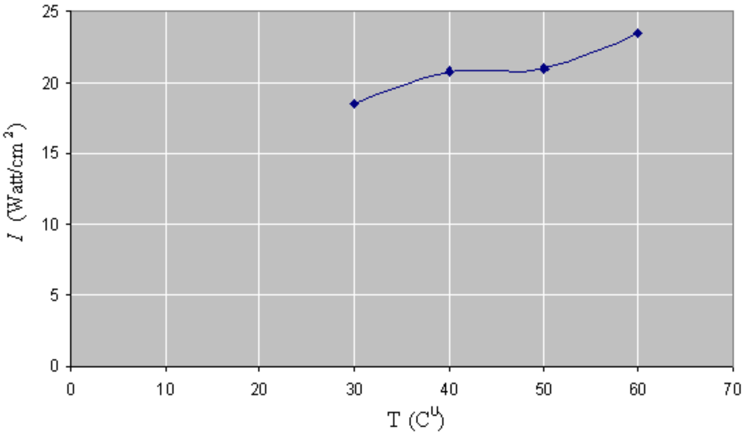

Fig (4): laser intensity and temperature.

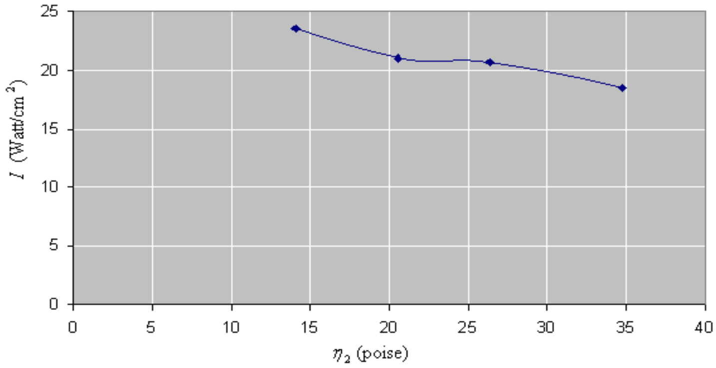

Fig (5): laser intensity and viscosity.

Figure(5)shows the intensity of laser with temperature value of viscosity is 34.8 poise while for 60c density of 23.5w/cm ^{2} the viscosity is 14 poise.

i.e. the higher power the lower the viscosity.

Since viscosity is an important parameter in the process of designing chemical and engineering devices that required fluid flow, then the result obtained may help improving the efficiency of flow leading to more efficient devices.

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تنغيم شدة ألحزمه الليزريه باستخدام لزوجة السوائل

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الملخص:

تم في هذا البحث دراسة تأثير التشعيع بأستخدام ليزر دايود ذي الطول الموجي٦٣٠nmعلى لزوجة سائل الايثانول وتعد اللزوجه من احد الصفات الفيزيائيه المهمه للسوائل.وتم ذلك باستخدام جهاز الفسيكوميتر مع حمام مائي بدرجات حرارية امتدت من c^o ٢٠ إلى c^o ٦٠ مئوية. وحيث إن العلاقة بين اللزوجة ودرجات الحرارة هي علاقة عكسية كما هو معروف ،أظهرت الدراسة إن هذه العلاقة قائمه أيضا بوجود شعاع الليزر. وأظهرت النتائج أن شدة شعاع الليزر الخارجه ازدادت من(١٨,٥– ٢٣,٥) $Watt/^{cm2}$ بزيادة درجة الحرارة وان الشدة ألخارجه لشعاع الليزر تغيرت تبعا لقيم اللزوجة من(٣٤,٨٠٢–١٤,٠٩٧) بواز.