International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.1 pp 491-495, 2017

Green Laser propagation in a turbulent water

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Abstract : In this work the effects of water turbulences on the propagation of a collimated green laser beam as intensity fluctuation and the beam quality , has beam studied since these characterizes have are very important in the field of the under water laser communications links. The effects of the temperature and the flow rate have beam studied experimentally. The results show that the temperature and flow rate of water is affected on the intensity, breading and wandering of the laser beam.
Key words : turbulent water, green laser, intensity, beam quality.

Introduction

Turbulence

When we speak about optical turbulence we are interested in the random fluctuation in the index-of-refraction that has an important effect on the beam quality as it travels through a medium[1]. The water in random turbulent ‘move, there will be fluctuations in the temperature and salinity of water, both in space and time[2]. This will introduce random variations in the refractive index of the medium, which affects the propagating laser beam. The laser beam propagation of communication system in water or turbulent atmosphere is scattering, there will be a spreading of the beam, beyond that normally caused by diffraction with a corresponding decrease in the beam intensity[3]. In addition, there will be scintillations of the received intensity, a decrease in the spatial and temporal coherence, a distinct wander in the beam position[4].

Experimental setup

The experimental set up used to measure the variation intensity ,position and broadening of Laser beam is shown in figure (1) . The beam of laser transmitter is pass through optical window of the water tank test at constant distance (1.5 m). The water sample is heated by used the electrical heater from (30- 45 ^{0}C), its measured by digital thermoelectrically meter and the flow rate of water is changed by using electrical pump from (2-6 L/min), its measured by flow meter. The measurements are performed in the following two ways. In the first method the beam intensity is measured using the photodiode. In the second method is the laser beam intensity profile is measured by using CCD camera with a special computer program.

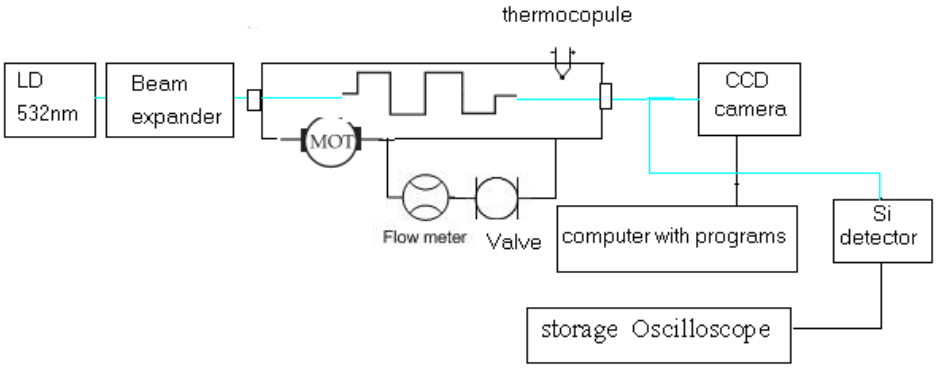


Figure 1 . laboratory simulated turbulence

Results

Received power Measurements at different water flow rate and at different temperatures.

The received power measurements in different flow rate at different temperature is show at (table 1& 2) respectively. The transmitted laser power is about (1mW). The results show that the received power decreases with increasing the water flow rate (0.305mW), while this power decreases with decreases the water temperature. Suspensions in water case scattering laser beam with increase flow rate it's and slow done the received power**.**

Table 1 Receiver power in different Flow rate

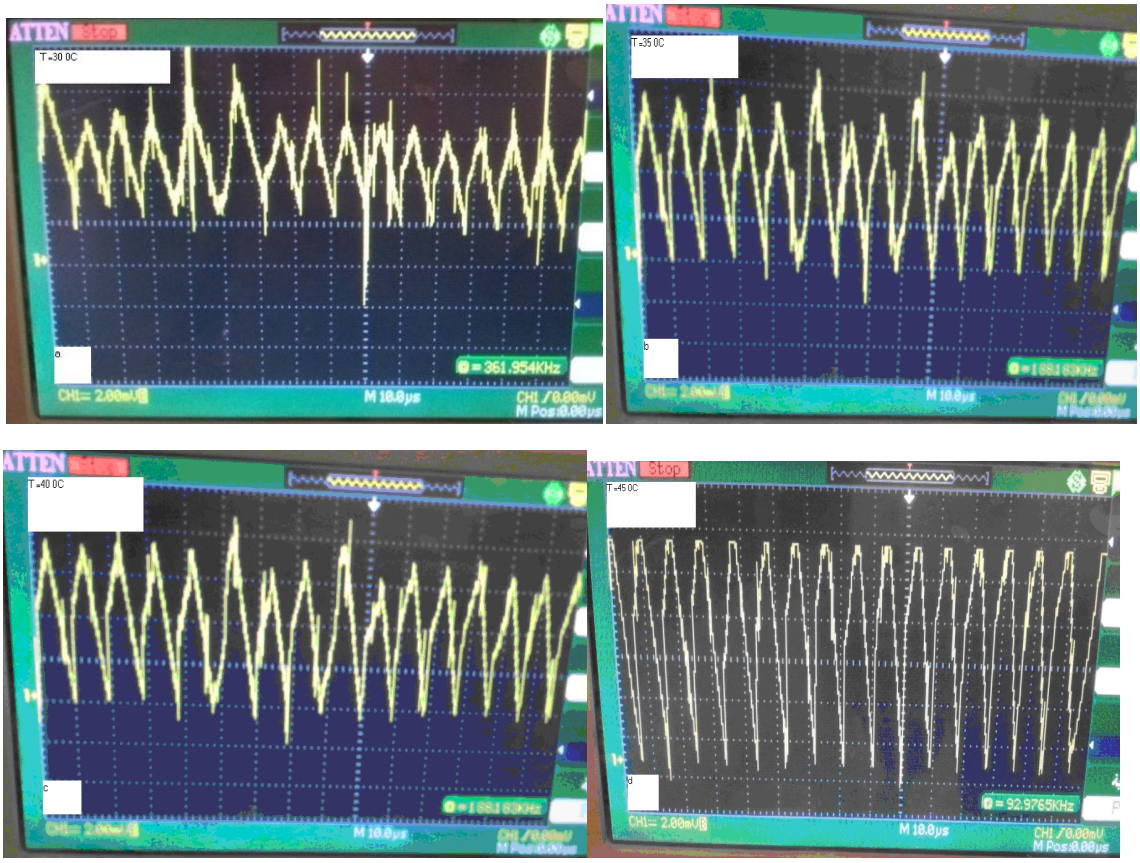
Transmitter power (mw)	**Flow rate (L/ min)**	**Receiver power (mw)**
1mw	2	0.449
	4	0.389
	6	0.305

Table (2) Receiver power in different Temperature of water

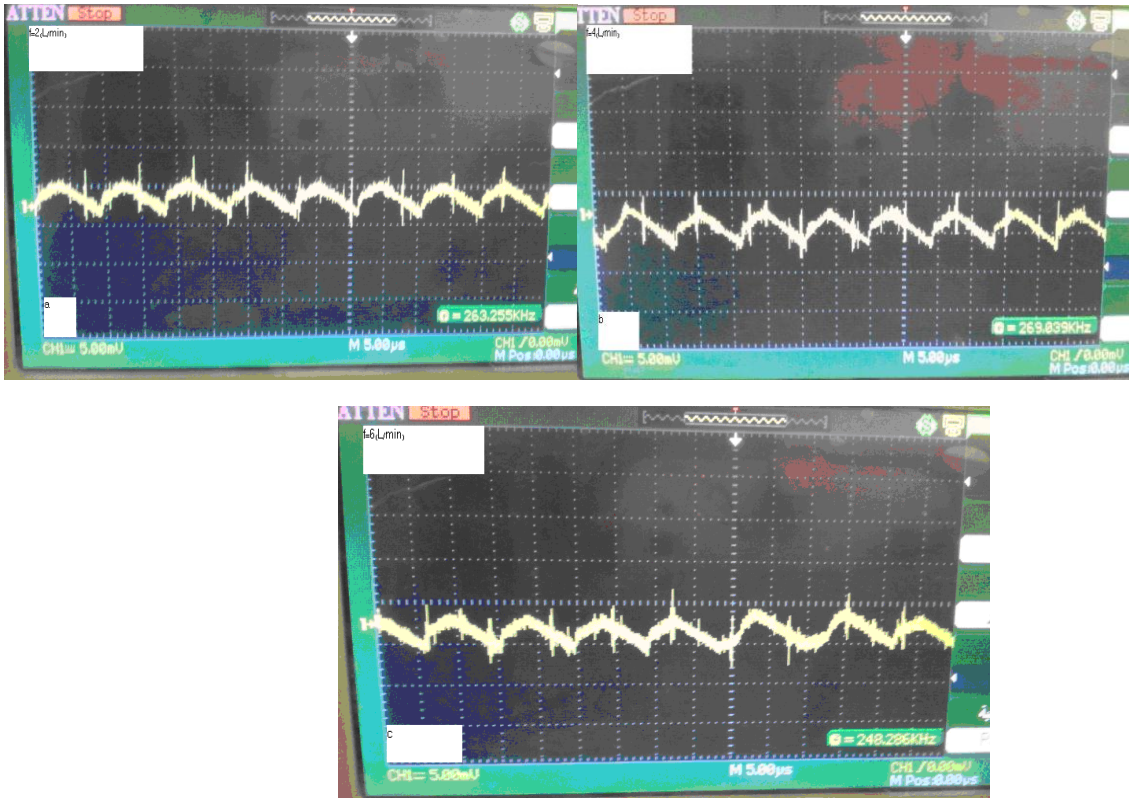
Transmitter power (mw)	**Temperature (C^0)**	**Receiver power (mw)**
1mw	30	0.060
	35	0.119
	40	0.142
	45	0.147

Intensity variation Measurements at different Flow rate and temperature of water

Figures (2a, b c and d) shows that the intensity variation is related to the water temperature. Observed that the most of the variation when temperature is high is about (0.147 mw) at T=45^{0}C, this indicated the turbulences is week, which may be explained as a result of the decrease in the water density. Figures (3 a, b and c) shows that the intensity variation is related to the flow rate of water. Observed that the most of the variation when flow rate is equal 6(L/min) the power = 0.305mw. The power will decrease when the speed of flowing increase because formed the baubles in the water cell , when the baubles formed is have small size effective in intensity of the beam only similar the sines air formed in air turbulence[5]. The variation in intensity is less than one indicated the turbulences is week.



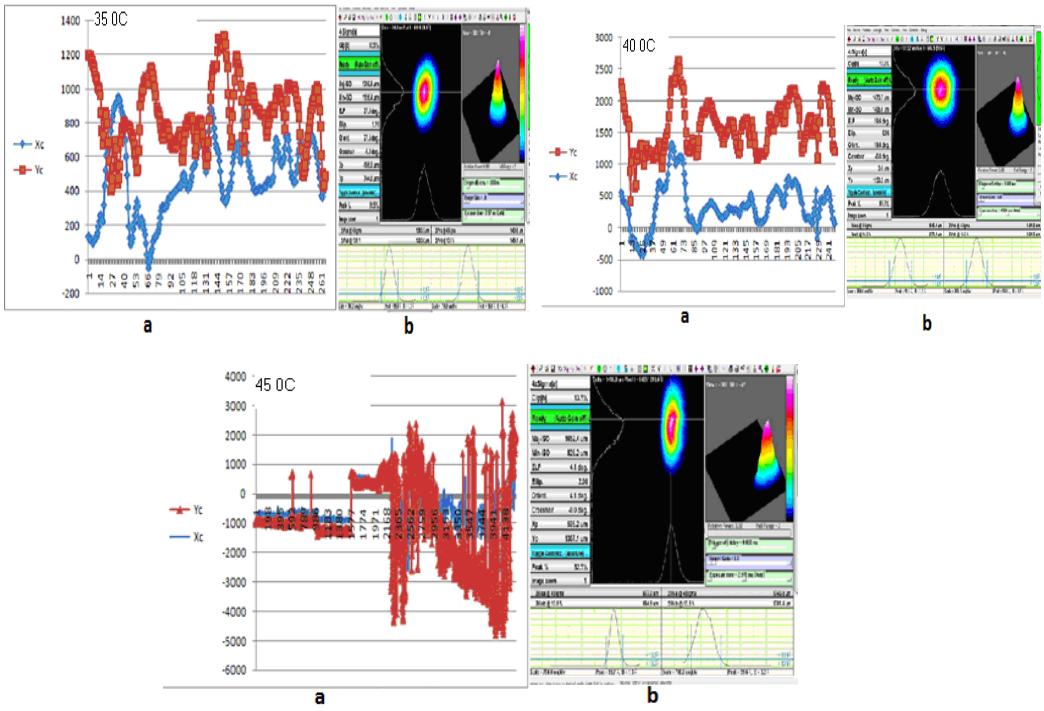
Figures (2a, b c and d) relation between beam intensity and different different temperature of water (T= 30, 35, 40, 45 oC) respectively.



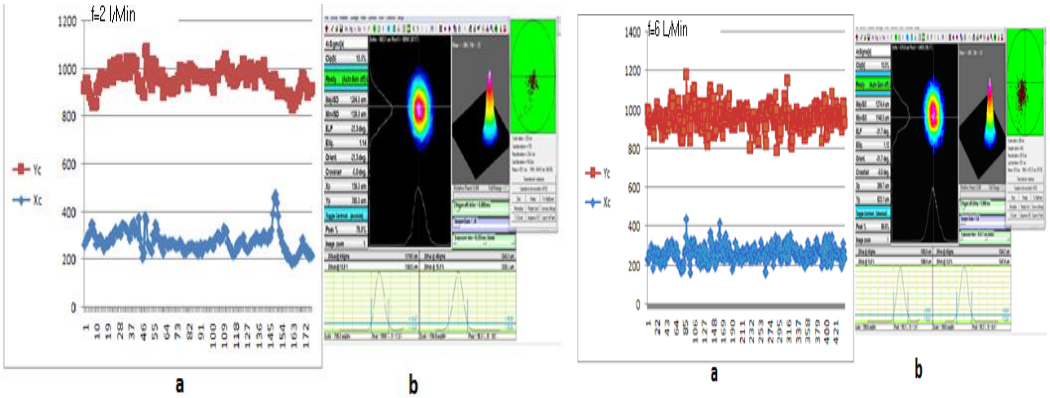
Figures (2a, b, and c) relation between beam intensity and different flow rate of water (F= 2 ,4,6 L/m) respectively.

Measurements' of the laser beam broadening and wandering at different flow rate and temperature of the water

Figures (3a, b and c) show the results of the beam wandering by using CCD camera, where the beam wandering increases with temperature randomly in the two dimensional position in a similar way that it takes place in the atmospheric[6]. This may, therefore results from the refractive index change due to the temperature rise and also to the water molecules agitation. Figures (4a and b) show the flow rate effective on the laser beam wandering. The two figures show also a breading in the laser beam width this may be as results of thermal lensing effect.



Figures (3a, b, and c) relation between position (a) , broadening (b) of beam at different temperature of water (T=35, 40, 45 oC) respectively.



Figures (4a, and b) relation between position (a) , broadening (b) of beam at different flow rat of water (f=2, 6 L/Min) respectively.

Conclusions

The behavior of laboratory simulated turbulence comparative with atmospheric turbulence it is similar .

References

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