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USE SIMPLE ALTERNATIVE METHOD FOR ESTIMATING WATER TURBIDITY

***Inas Mudhafar Khaleel Al-Aubadi, **Luma Abadalalah Sagban Alabadi, ***Luay Qussay Hashim and ***Azzam Hamoudi Al-Hadithi**

*Department of Food Science, College of Agriculture, University of Baghdad, Iraq
**College of Agriculture, University of Al-Qadisiyah, Iraq
*** Directorate of Environment and Water, Ministry of Science and Technology, Iraq
E-mail: luayalnaimmy71@gmail.com inas.alabadi76@gmail.com

Abstract

The electronic devices are used for water turbidity determination, they are more accurate comparison of manufactured devices, but they are expensive and require standard solutions for calibration during samples analysis. New device was manufactured manually from locally available materials, consist of a transparent plastic tube equipped with an injection tool for pouring water sample and a light source. Turbid water solutions were used to prepare various water turbidity levels, they were adjusted by an electronic device which was calibrated with standard solutions. These solutions were poured inside the plastic tube and used for estimation vision distances of recognized label by naked eye that placed in the bottom of tube. This device was used to estimate five levels of water turbidity of Tigris river water in Baghdad adjusted by turbid filtrate then compared electronic device. The results showed that there were no significant differences ($p>0.05$) of water turbidity values between electronic and manufactured devices which were (10.9, 12.1; 36.4, 39.9; 57.3, 60.3; 166.8, 173; 244.6, 262) NTU for both devices respectively.

***Key word*:** River water, water turbidity, manufactured device, total suspended solid

Introduction

Water turbidity test is one of the most important water quality determinants, it is indication of inorganic materials amount such as clay, silt and sand, as well as organic materials that resulted of plant decomposition by microorganisms activity, these materials contain dissolved substances like sugars link to water body by hydrogen bonds to form soluble and Semi-soluble solutions, colloid like proteins contain hydrophilic groups link to water else to form hydrogen and ionic bonds between opposite charges and suspended materials that are hydrophobic groups like little particles of silt and non-dissolved organic compounds has negative charges on its out layer which spread and constant as a suspension due to repulsion force of charges. Colloids and suspended components are almost forming the turbidity into water like metals oxides, organic compounds and non-soluble compounds. The pathogenic organisms are protected by surrounded suspended particles to prevent disinfection reach to them then reduce efficiency of water sterilization, as well as cause clogging filters of water treatment plants and cause problems in Purification and desalination of water, particles less than 0.01 mm can be stable in water body comparison to larger particles (Sulaymon *et al.*, 2013).

Water turbidity is the optical property test which disperse absorbed light and prevent its permeability through water sample (Mahmood, 2012; Al-Obeidi and Al-Naama, 2013), several factors affect of surface water turbidity like soil, human and agricultural activity and industrial development, likewise rainfall and flood cause soil erosion that increase turbidity, suspended particles and salts of water (Shaltout and Ghonam, 2008; Arguello *et al.*, 2015; Hashim *et al.*, 2015). Turbid water that 50 NTU can pass through the sand filters during water treatment, wherefore, water turbidity should not exceed 25 NTU during water treatment process to avoid problems of water treatment unites. Myre and Shaw (2006) indicate that human could detect water turbidity more than 5 NTU by using a simple manufactured device, lakes water turbidity often do not exceed 25 NTU, while muddy water contain over 100 NTU and may be exceed 2000 NTU.

Turbid water treatment and its contaminants is a high concern matter in water treatment plants of the world and a very important test for drinking water quality (WHO, 2011). The little suspended particles in water is unacceptable form due to its content of contamination which consider risk for human and decrease efficiency of disinfection to protect pure water from pathogenic organisms and reduce the efficiency of water sterilization (Al-Obeidi and Al-Naama, 2013), otherwise the particles prevent penetration of UV-visible into drink water and decrease activity of disinfections to kill pathogenic cells, wherefore it is recommended that water turbidity do not exceed 5 NTU during water treatment process (WHO, 2011).

The relationship between turbidity and suspended materials concentration is not entirely constant due to variety in size and shape of suspended particles that affect for dispersion of passed light and its absorption through water sample which is reflected on water turbidity value (Viessman and Hammer, 2005; Lee *et al.*, 2014). There are several methods to measure water turbidity, more of them their principle are measuring light intensity that pass through a water column by using electronic devices, they are more accurate comparison to other devices, but expensive and need standard solutions for calibration, as well as difficult to use in the field, therefore necessary to find alternative methods for water turbidity determination like manually manufactured device, it make from available materials, easy to apply and do not required standard solutions for calibration before experiment work. There are many manual devices used for water turbidity estimation, one of them called Jackson candle turbidly meter, consist of transparent tube, a lamp and label on bottom and Secchi Disk used for sea water turbidity evaluation, these devices were used for primary examination of raw water by naked eye (Myre and Shaw, 2006; Catherman, 2007). This research aimed to design a simple alternative manufactured device for estimating of water turbidity for various sources at accuracy attain 5 NTU.

Material and Methods

This method was worked according to experiment of Catherman (2007) with some modification as follow: -

Use manufactured device for examining water turbidity

This experiment comprised manufacture of water turbidity device using plastic tube 3-4 cm for width and 70 cm for long, divided into two areas along tube, dark and transparent areas. One of tube's end was closed by piece of plastic contained a recognized label, placed a battery lamp along the tube near to transparent area and placed a syringe at the top of tube for pouring water sample slowly on the pipe wall to avoid getting bubbles that affect accuracy for seeing label clearly by naked eye (figure 1).

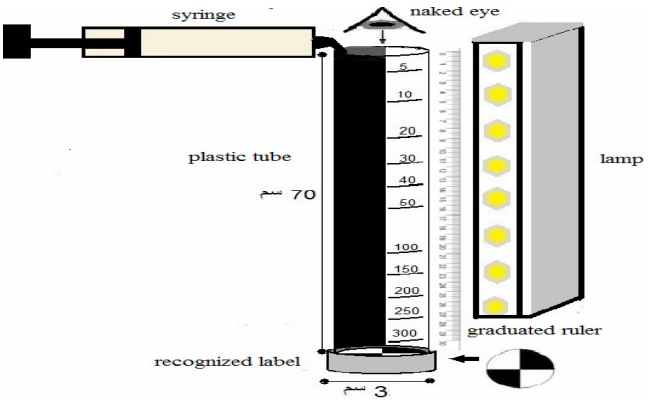

Fig. 1 : manufactured device of water turbidity measurement with its accessories like lamp, graduated ruler and syringe

Preparation of synthetic turbid water

Turbid water was prepared by adding 30 g of pure grinded and sieved clay with mesh of 0.2 mm to 1 liter of distilled water, mixed for one hour by shaker at 100 cycles/min and left for 24 hours to complete dissolving of clay (Renuka and Jadhav, 2013). turbid filtrate separated from upper zone and added into distilled water to prepare various water turbidity solutions 5, 10, 20, 30, 40, 50, 100, 150, 200, 250 and 300 NTU using calibrated electronic turbidity meter at 25 °C.

Water sample turbidity estimation

Graduated turbid water solutions were added slowly by syringe after shaking into plastic tube, than signed the degrees of turbid water on tube at vision distance by naked eye that label was became invisible (Figure 2). The various water turbidity levels that resulted by various vision distances along tube. All values of turbid water levels and distances of vision by naked eye were converted to logarithmic values to find equation of straight line values. A graduated ruler was placed along tube to measure main and secondary values for more accuracy. Water turbidity degree was calculated by inverse logarithmic values to previous value.

There is another method to directly estimate of water sample turbidity according to vision distance by naked eye when recognized label is missed to fix turbidity level of water sample (Figure 2) (Myre and Shaw, 2006).

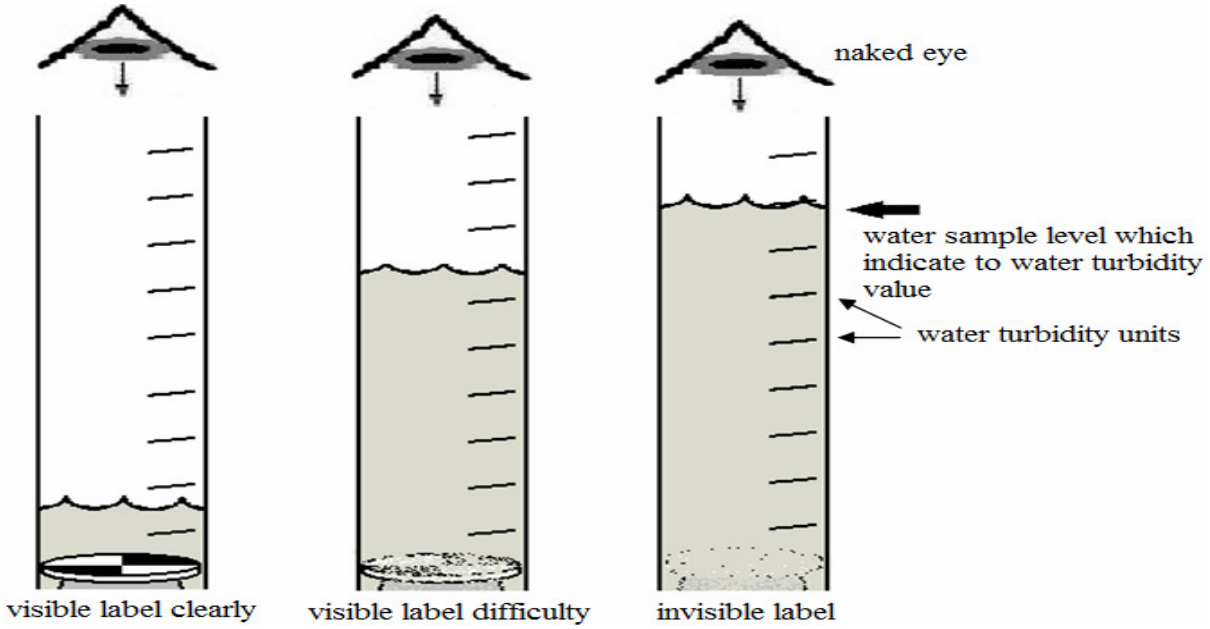

Fig. 2 : estimation of water turbidity directly according to the vision distance of label by naked eye that is indication for water turbidity

Comparison between manufactured and electronic devices for water turbidity estimating

Water sample of Tigris river in Baghdad was taken and stored in a plastic container at 5 °C according to United states environmental protection agency method (2015).

Chemical and physical tests occurred included pH and electrical conductivity (EC) and total soluble solids (TDS) by using electric conductivity meter, water turbidity, suspended solids (TSS), concentration of oil and alkalinity at 25 ºC according to standard method for the examination of water (2012). Water sample was divided into 5 samples, 1 liter per sample.

Added various filtrate of 1, 5, 10, 20 and 30 ml to samples 1, 2, 3, 4 and 5, respectively, and mixed immediately by Jar test apparatus to obtain several levels of turbid water.

Water samples turbidity were estimated by electronic turbidity device and manufactured device with three replicates. Suspended solid of five samples was estimated at 25 ºC. A statistical analysis was done to compare between two devices using SPSS program to calculate T-test between two unpaired of two samples groups**.**

Results and Discussion

Figure (3) showed relationship between logarithmic values of water turbidity and vision distance by naked eye, lowest degree of turbid water is 5 NTU recorded at highest vision distance was 66.8 cm (table 1).

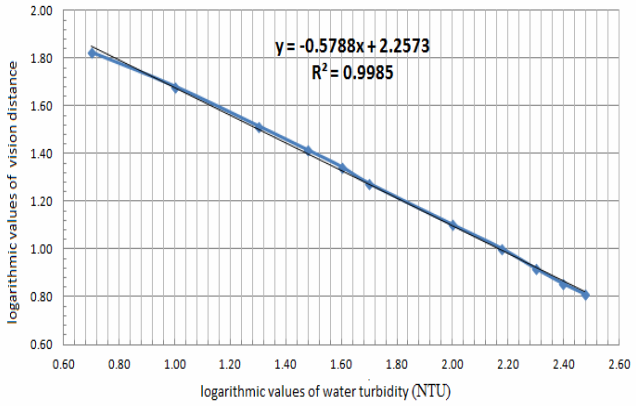

Fig. 3 : Relationship between logarithmic values of water turbidity and vision distance by naked eye of manufactured device

Table 1 : Values of water turbidity levels and distance of vision that pointed on plastic tube and its all logarithmic values

vision distance log values (cm)	turbidity log values (NTU)	vision distance(cm)	turbidity (NTU)
1.82	0.70	66.8	5
1.68	1.00	48.1	10
1.52	1.30	32.8	20
1.42	1.48	26.1	30
1.34	1.60	22.1	40
1.28	1.70	18.9	50
1.10	2.00	12.7	100
1.00	2.18	10.1	150
0.92	2.30	8.3	200
0.86	2.40	7.2	250
0.81	2.48	6.5	300

Table 2 showed chemical and physical tests of Tigris river water before add turbid filtrate for adjusting five samples of river water turbidity.

Table 2 : Chemical and physical analysis of Tigris river water

Tests	Concentration
pH	8
EC (µs/s)	899
TDS(ppm)	570
Turbidity (NTU)	**8.9**
TSS (PPM)	**8.7**
Oil (PPM)	0.04
Alkalinity (PPM)	133.8

Table (3) included comparison between electronic turbidity device and manufactured device for five river water samples turbidity levels. Result showed there were no significant differences (p>0.05) of water turbidity values means between electronic turbidity and manufactured device which were (10.9, 12.1; 36.4, 39.9; 57.3, 60.3; 166.8, 173; 244.6 and 262) NTU for five samples 1, 2, 3, 4, 5 respectively.

Table 3 : Comparison between electronic turbidity and manufactured devices of five river water samples turbidity levels

Sample	Mean of water turbidity values by manufactured device (NTU)	Mean of water turbidity values by electronic device (NTU)	p-propility (0.05)
1	**12.1**	**10.9**	0.233
2	39.9	36.4	0.217
3	60.3	57.3	0.191
4	173	166.8	0.198
5	262	244.6	0.091

Figure (4) indicated there was a positive relationship between suspended solids concentration and water turbidity when used manufactured device to exam five river water samples turbidity levels, suspended solids concentration increased according to increase turbidity of water, but this equation is not constant entirely due to variance of size and shape of suspended particles and refractive index of soluble ingredients, these factors affect dispersion of passed light and its absorption through water column that cause contrast of water turbidity degree (Viessman and Hammer, 2005; Lee *et al.*, 2014).

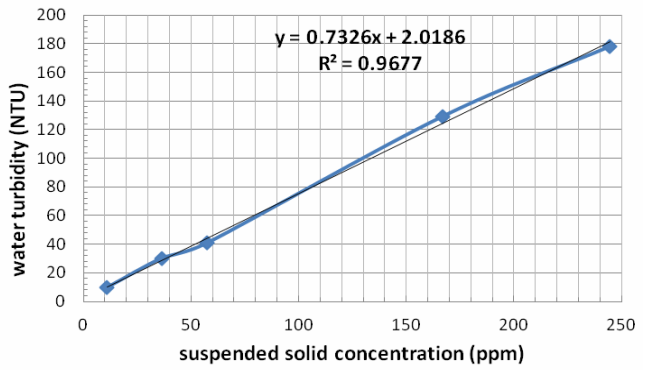

Figure (4) relationship between suspended solids concentration and water turbidity when used manufactured device to exam five river water samples turbidity levels.

The accuracy of manufactured devices are depending of device design, external factors and visual ability of person. This experiment carried out that water turbidity values and vision distances of naked eye were between 5-300 NTU and 66.8-6.5 cm respectively, it was near to experiment work of Kearns (2008), that were 5-300 NTU and 63-2.5 cm respectively, but differed of results that obtained by Myre and Shaw (2006), they were 5-240 NTU and 85.4-6.7 cm respectively. Therefore, manufactured device should be accrued by standard solutions or calibrated electronic devices according surround conditions. Also, the required light source of manufactured device should be controlled by external lamp and the dark area along plastic tube regulate the amount of light intensity that insert through water column, because sunlight source is variable according to time and season, direction of dropped sunlight on device which affect of vision distance by naked eye. The label on bottom tube could not be pointed or may be difficult recognized at

vision distance less than 5 NTU, this evidence that the accuracy of manufactured device may be reached to 5 NTU, it is enough to use this device for estimating turbidity of drinking water, because world health organization indicated that drinking water turbidity should be not exceed 5 NTU (WHO, 2011). It is recommended to use this device to exam turbid water less than 300 NTU because high turbidity may be affected accuracy of device operation and high concentration of suspended solid materials has precipitated on bottom of tube that cause difficult to see recognized label.

Conclusion

- Use simple and easy alternative methods to estimate rivers and drink water turbidity with accuracy up to 5 NTU.
- Ability to estimate suspended solid material according water turbidity by using this method.
- Use this method continually without directly calibration comparison electronic devices that should be calibrated previously through water analysis.

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