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Analysis of Some Characteristic Parameters of Potable Water and Treated Wastewater & Its Reuse

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Abstract: Physicochemical analysis of fresh potable water and treated wastewater collected from the sewage plant were carried out. The analysis of different parameters namely pH, electrical conductivity, TDS, hardness of water, Ca^{2+}, Mg^{2+}, total alkalinity, chloride, sulphates, NO_2^-, fluoride, dissolved oxygen, phosphates, sodium and potassium ions were carried out as per the standard methods. The preliminary study aimed at utility of treated wastewater and how far it is extendable upto the proper usage for different purposes.

Key words: Water, wastewater, reuse of wastewater.

Introduction

Water is an essential resource for all life on the planet. Of all the water resources available on earth, only three percent is not salty and two-thirds of the fresh water is locked up in ice caps and glaciers. Of the remaining one percent, a fifth is in remote, inaccessible areas and much seasonal rainfall in monsoonal deluges and floods cannot easily be used. At present only about 0.08 per cent of the entire world's fresh water (Fry, 2008) is exploited by mankind in ever increasing demand for sanitation, drinking, manufacturing, leisure and agriculture. Water is a chemical substance and its molecule contains one oxygen and two hydrogen atoms connected by covalent bonds. Water is a liquid at ambient conditions, but it often co-exists on earth with its solid state, ice, and gaseous state (water vapour or steam). Water also exists in a liquid crystal state near hydrophilic surfaces (Henniker, 1949; Pollack, 2011).

Clean drinking water is essential to human beings and other life forms. Access to safe drinking water has improved steadily and substantially over the last few decades in almost every part of the world (Lomborg and Bjorn, 2001; MDG Report, 2008). However, some observers have estimated that by the year 2025 more than half of the world population will be facing water-based vulnerability (Kulshreshtha, 1998). Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation. Approximately 70% of the fresh water, which is actively handled by human beings, is consumed by agriculture (Baroni et al., 2007). As world population requires both more clean water and better ways to dispose of wastewater, the demand for water reclamation will increase. Future success in water reuse will depend on whether this can be done without adverse effects on human health and the environment.

Successful management of any resources requires accurate knowledge of the resource available, the uses to which it may be put, the competing demands for the resource, measures to, and processes to evaluate the significance and worth of competing demands and mechanisms to translate policy decisions into actions on the ground. Much effort in water management is directed at optimizing the use of water and in minimizing the environmental impact of water use on the natural environment.

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Water scarcity and water pollution pose a critical challenge in many developing countries. In view of the scarcity of water, the utilized water can be purified in economical, and this waste water can be reused for purposes other than domestic like usage of water in civil and agricultural field. In order to reuse waste water, it is necessary to treat raw wastewater to meet specific needs and public safety. Some basic information on wastewater treatment technologies is given in the following. Wastewater treatment processes can be categorized into three processes:

Physical Process
Removal of physical impurities by screening, sedimentation, filtration, floatation, absorption or adsorption or both, and centrifugation.

Chemical Process
Removal of chemical impurities through coagulation, absorption, oxidation-reduction, disinfection and ion-exchange.

Biological Process
Removal of pollutants using biological mechanisms, such as aerobic treatment, anaerobic treatment and photosynthetic process (oxidation pond).

Water plays an important role in the human life; so much that we cannot stop taking care of utility in the water usage. In view of the growing demand and scarcity of water, in this paper, we are reporting the results related to waste water analysis and these are compared with parameters of fresh water for finding out the suitability other than the domestic purpose and partial reuse of treated wastewater at appropriate levels.

Materials and Methods

The samples of potable water and treated wastewater from sewage treatment plant were collected from one location. Waste water may be defined as a combination of liquid or water carried wastes removed from residences, institutions, commercial and industrial establishments together with such ground water, surface water and storm water as may be present. After treatment in the sewage treatment plant, the waste water has been collected and is analyzed for various components and these parameters are compared to the initial fresh water.

Instruments

The following instruments were used for various purposes in the analysis of fresh water and treated wastewater samples: A digital pH meter (Model 335, Systronics), Nefleometer (Model 132, Systronics), UV-visible spectrophotometer (Model 117, Systronics), Digital conductometer (Model 306, Systronics), Micro processor-based bunch pH/ion meter, Cyber scan 2100, Eutech instruments (USA) with fluoride sensitive electrode, Flame photometer (Elico, CL361) along with compressor (Elico, CL 158) and Shimadzu analytical balance (AUX 20, Shimadzu Japan).

Collection of Samples

The precautions taken in the collection of the samples as well as in the analysis part are listed in Table 1.

Table 1: Precautions to be observed during collection of samples and their analysis

S. No	*Parameter*	*Methods used for preservation*	*Test performed within*
1	Alkalinity	Refrigeration	24 hours
2	Chlorine residual	------------	Analyzed immediately
3	Conductivity	Refrigeration	------------
4	Fluoride	Preserved in polyethylene bottles	------------
5	Hardness	Preserved at pH < 2.00 using nitric acid	------------
6	Nitrates and Nitrites	Preserved at pH < 2.00 using sulphuric acid	------------
7	Dissolved oxygen	Refrigerated	30 minutes
8	pH	------------	Analyzed immediately
9	Salinity	------------	Analyzed immediately
10	Total dissolved solids	Refrigerated	------------
11	Sulphate	Refrigerated	------------

Required Chemicals

All chemicals used were of analytical reagent grade and all these solutions are prepared by using triply distilled water and wherever the carbon dioxide free water is required, it is also used. The following solutions are used for estimation of various components in fresh water and treated wastewater. Required chemicals used in these processes are standardized (Vogel, 2004) as per the available established methods.

Potassium hydrogen phthalate, potassium hydrogen phosphate and borax buffer was used for pH meter calibration. Every time the pH meter was calibrated, by using known buffer solutions and then the pH values of samples are measured. After calibration of the conductivity meter, conductivity of each sample was measured. Standard calcium carbonate, EDTA, buffer solution ($NH_4Cl + NH_4OH$), EBT indicator and muroxide indicator were used for measuring the total, calcium and magnesium hardnesses respectively. In the estimation of *p*-alkalinity and *m*-alkalinity, standard Na_2CO_3, HCl, and indicators of phenolphthalein and methyl orange indicators are used. The standard NaCl, $AgNO_3$ and K_2CrO_4 indicators were used for analysis of chloride in the samples. Through gravimetric analysis, the sulphates in the samples were analyzed using the solutions of $BaCl_2$, HCl, $AgNO_3$-nitric acid reagent and methyl orange indicator. In the analysis of estimation of nitrites, the chemicals used are standard nitrite solution, standard sodium oxalate, $KMnO_4$, $FeSO_4$, sulphanalamide, N-(1-Napthyl)-ethylenediamine dihydrochloride and 1:1 H_2SO_4. For estimation of fluorides in the samples the required solutions are stock fluoride and TISAB buffer {57 ml of glacial acetic acid, 58 gms of NaCl and 4 gms of cyclohexylene diamine tetra acetic acid (CDTA) are in 500 ml distilled water and taken in a beaker and it is kept in a cool water bath and 6.0M NaOH solution which is slowly added with constant shaking, till the solution attains a pH of 5.30-5.50. Now the solution is transferred to 1000 ml volumetric flask and remaining portion of the flask was made with triple distilled water}. For estimation of dissolved oxygen in the samples, the standard $K_2Cr_2O_7$, Hypo, 10% KI and 1% starch indicator are used.

Experimental

The pH and electrical conductivity of the samples are measured by pH meter and conductivity meter respectively. The various parameters like total dissolved solids (TDS), total hardness, calcium (Ca^{2+}), magnesium (Mg^{2+}), alkalinity, chloride, sulphates, nitrites, fluoride, dissolved oxygen, chemical oxygen demand (COD), phosphates, sodium and potassium ions in these samples are analyzed by using the established and standard (Metcalf and Eddy, 2003; APHA, 2005) methods. The results relating to the various components in the samples are presented in Table 2.

Table 2: Physicochemical parameters of fresh potable water and treated wastewater

S. No.	*Parameters*	*Fresh water (Potable water)*	*Treated waste water*
1	pH	8.05	7.84
2	Electrical conductivity	0.67	1.03
3	Total dissolved solids (TDS)	856	1,087
4	Hardness of water	292	499
5	Calcium ion (Ca^{2+})	38	75
6	Magnesium (Mg^{2+})	47	74
7	Total alkalinity	279	396
8	Chloride (Cl^-)	44	84
9	Sulphates	149	234
10	Nitrite (NO_2^-)	0.02	0.02
11	Fluoride	0.89	0.94
12	Dissolved oxygen (DO)	6.60	4.67
13	Chemical oxygen demand (COD)	10.65	39.07
14	Phosphates	0.3	0.8
15	Sodium ion (Na^+)	54.6	35.9
16	Potassium ion (K^+)	1.00	1.60

All values in ppm units except pH and electrical conductivity.

Results and Discussion

Waste water is treated to remove insoluble solids and certain impurities from used water and then the water is called as reclaimed water or recycled water. It is used in sustainable landscaping or recharge groundwater aquifers. The purpose of these processes is sustainability and water conservation, rather than discharging the treated wastewater to surface waters such as rivers and oceans. Basing on the obtained results, the treated wastewater contains the parameters with significantly more values compared to the fresh water. Though the treated wastewater can be suitable to gardening as well as landscaping, through this process we can minimize the use of utility of fresh water. In addition we are planning to use this water for irrigation particularly in the field of harvesting of vegetable crops, that is highly helpful to decrease the use of fresh water in the agricultural sector. In the world, most of the developing countries do not have reliable access to supplies of clean water. As the demand for water increases, making more efficient use of water becomes more important. Water re-use should be seriously considered before water availability is matched by water demand.

The ultimate goal of wastewater treatment is the protection of public health in a manner commensurate with environmental, economic, social and public concerns. To protect public health and the environment, it is necessary to have knowledge of constituents of waste water; impacts of these constituents when waste water is dispersed into the environment; the transformation and long-term fate of these constituents in treatment processes; treatment methods that can be used to remove or modify the constituents found in waste water, and methods for beneficial use or disposal of solids generated by the treatment systems.

When unreacted wastewater accumulates and is allowed to go septic, the decomposition of organic matter leads to nuisance conditions including the production of malodorous gases. In addition, untreated wastewater contains numerous pathogenic micro organisms that affect the human intestinal tract. Waste water also contains nutrients, which can stimulate the growth of plants, and may contain toxic compounds or compounds that potentially may be mutagenic or carcinogenic. For these reasons, the immediate and nuisance-free removal of waste water from its sources of generation, followed by treatment, reuse or disposal into the environment is necessary to protect public health and the environment.

Based on the results obtained the waste water is found to be suitable for use in gardening and plantation. We constantly observed that the treated wastewater is highly advantageous towards growth of the plants, for developing big lawns and also enhancing the groundwater level. The management of the solids and concentrated contaminants removed by treatment has been continued to be one of the most difficult and expensive problems in the field of wastewater treatment. Waste water solids are organic products; they can be beneficially stabilized by processes such as anaerobic digestion and compositing. After digestion, wastewater solids are used as a type of natural fertilizer for growth of different kinds of plants.

Reuse can help to maximize the use of limited water resources. In many locations where the available supply of fresh water has become inadequate to meet water needs, it is clear that the once used water collected from communities and municipalities must be viewed not as a waste water to be disposed but as a resource that must be reused. The concept of reuse is becoming accepted widely as other parts of world, where the water is in shortages.

Technologies that are suitable for water reuse applications include membranes (pressure-driven, electrically driven, and membrane bioreactors) carbon adsorption, advanced oxidation, ion exchange and air stripping. We should improve the research on low cost treatment of waste water to make it suitable for drinking purpose (free from bacteria). Thus we can achieve the target of decreasing the scarcity of water and help our society.

Wastewater reuse may be applied in agriculture, industry, groundwater recharge, and urban usage, including landscape irrigation and fire protection. Wastewater reuse can be adopted to meet the water demand in different fields and contribute to the conservation of freshwater resources.

Direct reuse is the planned and deliberate use of treated wastewater for some beneficial purpose, including drinking. Direct potable reuse is not popular and is limited. It is generally unacceptable to the public because of both the expense and the attitudes of the community. Indirect reuse refers to water that is taken from a river, lake, or aquifer which has received sewage or sewage effluent. Wastewater reuse can contribute to national development and the environmental damage should be minimized by reuse.

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Calendar of Events

IPWE 2013 International Perspective on Water Resources and the Environment Conference
7th to 9th January 2013
Izmir, Turkey
Website: http://www.ipwe2013.org
Contact person: Orhan Gunduz

4th International Conference on Environmental Science and Development (ICESD 2013) Conference
19th to 20th January 2013
Dubai, United Arab Emirates
Website: http://www.icesd.org/
Contact person: Mr. Lee
Organized by: Asia-Pacific Chemical, Biological & Environmental Engineering Society (APCBEES)

Global Mining Water Management 2013 Conference
30th to 31st January 2013
Las Vegas, United States of America
Website: http://www.mining-water-management.com
Contact person: Jake McNulty

Towards Sustainable Safe Drinking Water Supply in Developing Countries: The challenges of geogenic contaminants and mitigation measures (GeoGen2013) Conference
5th to 7th February 2013
Addis Ababa, Ethiopia
Website: http://www.eawag.ch/geogen2013
Contact person: Anja Bretzler
Organized by: Eawag-Swiss Federal Institute for Aquatic Science and Technology

ICWRE 2013, International Conference for Water Resources and Environment
12th to 14th February 2013
Marrakesk, Morocco
Website: http://www.icwre.com
Contact person: Ms. Amira Laribi
Organized by: GIWEH—Global Institute for Water Environment and Health

3rd International Conference on Future Environment and Energy - ICFEE 2013 Conference
24th to 25th February 2013
Rome, Italy
Website: http://www.icfee.org/
Contact person: Mr. Lee
Organized by: APCBEES

Innovations in Water Policy - Theory, Practice, and Impacts Workshop
26th to 28th February 2013
Singapore
Website: http://www.lkyspp.nus.edu.sg/iwp/Home.html
Contact person: May Cheong
Organized by: Institute of Water Policy

Water Expo 2013 Conference
28th February to 2nd March 2013
Chennai, India
Website: http://www.eawater.com/expo/
Contact person: Aarti
Organized by: EA Water Private Limited

4th International Conference on Environmental Science and Technology (ICEST 2013)
17th to 18th March 2013
Macau, China
Website: http://www.icest.org/
Contact person: Ms. Feng
Organized by: CBEES

Air and Water Components of the Environment Conference
22nd to 23rd March 2013
Cluj-Napoca, Cluj, Romania
Website: http://aerapa.conference.ubbcluj.ro/Engleza/index.htm
Contact person: Horvath Csaba
Organized by: Babes-Bolyai University Faculty of Geography

Sustainable Water Resources Management and its Effect on the Future of Cities Conference
22nd to 24th March 2013
Bursa, Turkey
Website: http://www.su2013.org/eng.pdf
Contact person: Assoc. Professor Sevinc Sirdas