

Study on Physicochemical Status, Bacterial Analysis and its Correlation

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Abstract:

Swimming pool, as a recreational facility is now a part of current lifestyle that offers social and health benefits. More demand for hotels with swimming pool facility and are highly used during peak seasons. However swimming pool could become a pooling medium of various bacteria came from the bathers, air and soils thus risk of water-borne disease and impose hazard to human health. Therefore, a well disinfected swimming pool that meets the minimum standard requirement must be reached. This study aimed to assess the status of physicochemical parameters including free chlorine, pH, and temperature and to assess status of bacteria analysis of swimming pool water samples. 11 swimming pool water samples were taken from hotels in Klang valley, Malaysia. The physicochemical parameters were tested using colorimetric method using N,N-diethyl-1,4-phenylenediamine and bacteria analysis were obtained by standard plate count (SPC) method. Results are presented in mean and standard deviation. Correlation coefficient is obtained by Pearson's correlation statistical test. Results showed mean of temperature $29.64 \pm 1.430^\circ\text{C}$, pH 7.56 ± 0.40 , free chlorine 1.22 ± 1.16 ppm and bacterial SPC $4,825.64 \pm 8,409.16$ cfu/ml. Correlation-coefficient between temperature and SPC r: 0.71. The findings showed current physicochemical status of hotel swimming pool water samples met the minimum standard requirement. However, the bacterial SPC is highly above acceptable range and positively correlated to temperature. This indicates bacterial count increase with temperature rise despite of acceptable chlorine level. The acceptable level of chlorine as disinfectant is insufficient to oxidize bacteria thus may put the swimming pool water at risk of spreading water borne diseases. This finding suggests increase dosage of chlorine is required to maintain swimming pool sanitation during hot season in order to provide a safe water recreational facility. However, larger sample size is required to confirm the findings website.

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I. INTRODUCTION

Swimming pool, as a recreational facility is now a part of current lifestyle that offers social and health benefits. More demand for hotels with swimming pool facility and are highly used during peak seasons. However swimming pool could become a pooling medium of various bacteria came from the bathers, thus risk of water-borne disease and impose hazard to human health (Drasko Pekovic., et al., 2015).

Contaminated water due to body shedding of bathers includes body fluid such as urine, saliva, vomit, hair, breathing (release of respiratory), digestive, genital bacteria and also other harmful bacteria from skin (Karami, et al, 2015). Apart from that, chemicals that is used for maintenance and balance of the water quality and environmental contaminants also contribute as part of health risk for human (Drasko Pekovic., et al., 2015).

In order to ensure a safe water recreation facility, World Health Organization has published a guideline to maintain water recreational facilities (2006) that emphasis on optimum

swimming pool water quality that covers physicochemical, water disinfection, safety, water quality evaluation and microbial assessment.

Evaluation of physicochemical status and bacteria analysis is crucial in swimming pools water to provide a safe facility for the bathers. Physical and chemical factors such as adjusted pH, chlorine residual, turbidity, total alkalinity and temperature may affect biological factor or neutralize to each other and later increasing microbial activity in the pool water (Karami et al, 2015). If there is no control over swimming pools water quality, it may risk serious bacterial contamination (Hoseinzadeh et al, 2013).

This study aimed to assess the status of physicochemical parameters and to assess status of bacteria analysis of swimming pool water samples and its correlation from hotels in Klang Valley, Malaysia.

II. METHODOLOGY

A. Sample collections

Swimming pool water samples were used in this study collected from 11 different hotels in Klang Valley, Malaysia. Samples were collected not less than 1 feet below the water surface using a sterile 500ml scotch bottle and away from water return inlet. Duplicate sample were taken.

B. Physicochemical Analysis

The samples were tested using a Pentair Rainbow pool and spa test kit to measure pH, free chlorine, total alkalinity using N,N-diethyl-1,4-phenylenediamine colorimetric method. The tests were directly done after sampling. Temperature of the swimming pool water has been determined by dipping the thermometer 1 feet depth into the swimming pools water and the reading will be taken in one minute.

Table 1: Physicochemical Analysis

Sample no	1	2	3	4	5	6	7	8	9	10	11	Mean \pm SD	Standard range for swimming pool water
pH	8.2	7.8	7.8	7.6	7.8	7.6	7.6	6.8	6.8	7.6	7.6	7.56 \pm 0.40	7.2 – 7.6
Free chlorine /ppm	0.5	1.5	0.3	0.3	0	3	3	3	1	0.5	0.3	1.22 \pm 1.16	1.0 – 3.0 ppm
Total alkalinity / ppm	30	30	30	30	30	30	30	40	30	30	40	31.82 \pm 3.86	80 – 120 ppm
Temperature / $^{\circ}$ C	31	28	31	32	31	29	30	28	28	28	30	29.64 \pm 1.43	No standard

Table 2: Bacterial analysis

Sample no	1	2	3	4	5	6	7	8	9	10	11	Mean \pm SD	Standard for swimming pool water
SPC / cfu/ml	452	364	8,288	27,894	13,626	152	188	704	572	388	454	4,825.64 \pm 8,409.16	<200 cfu/ml

A. Bacteriological Analysis.

Samples were diluted by serial dilution and bacteria colony counted using standard plate count method as described by Standard Methods for examination of water (American Public Health Association, 1985). Diluted samples were inoculated on nutrient agar plate before incubated for 24 hours in 37 $^{\circ}$ C. Average colony count were then obtain and calculated to gain colony forming unit per ml sample.

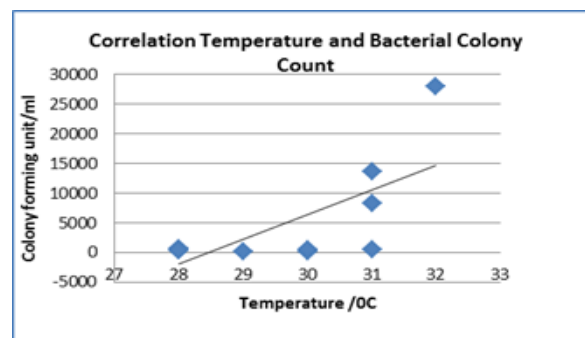


Chart 1 : Correlation between Bacterial colony count and Temperature

III. RESULT

Use The physicochemical analysis (pH, free chlorine, total alkalinity and temperature) is presented in Table 1 below while the bacterial analysis presented in Table 2

The results showed that pH range from 7.6 to 8.2 with mean 7.56 \pm 0.40. Free Chlorine result from 0.3 to 3.0 ppm with mean 1.22 \pm 1.16 ppm. Total Alkalinity from 30 to 40 ppm with mean 31.82 \pm 3.86 ppm and temperature range from 28 to 31 $^{\circ}$ C with mean 29.64 \pm 1.43 $^{\circ}$ C.

Results of the bacteriological analysis of the water sample are presented in Table 2. The standard plate counts for all water samples spread from 152 to 27,894 cfu/ml with mean 4,825.64 \pm 8,409.16 cfu/ml.

Correlation study between water temperature and bacterial colony count from sample as shown in Chart 1 revealed a strong positive correlation between the parameters with correlation coefficient r : 0.70.

While correlation study between free chlorine and bacterial colony count as shown in Chart 2 result in a weak negative correlation between the parameters with correlation coefficient r : -0.46.

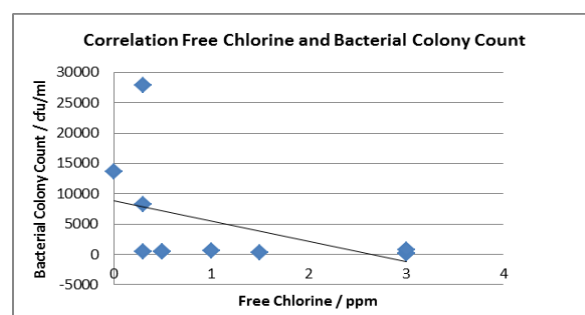


Chart 2 : Correlation between Bacterial colony count and Free Chlorine

Correlation test for Water pH and total alkalinity show weak correlation with correlation coefficient $r = 0.36$

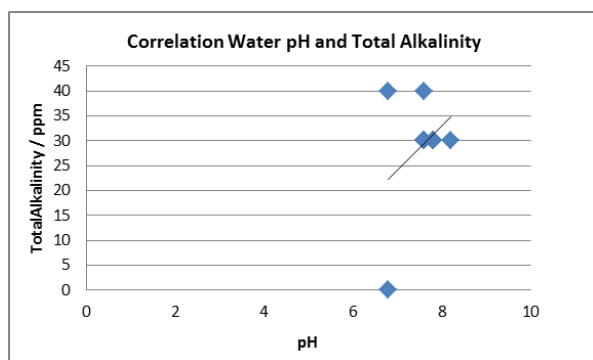


Chart 3 : Correlation water pH and Total Alkalinity

IV. DISCUSSION

The findings showed current pH level and free chlorine concentration status of hotel swimming pool water samples met the minimum standard requirement for swimming pool water as published by International Standard Organization (BS EN ISO 7393-2:2000). The total alkalinity status was extremely below standard but do not influence the pH level of the water samples that falls in the standard range. The bacterial analysis revealed high number of bacterial colony count from the sample with unacceptably high mean compared to safety standard for swimming pool by Guidelines for Safe Recreational Water Environments (WHO, 2006). The bacterial colony count showed parallel pattern with increase temperature of swimming pool water despite of sufficient concentration of free chlorine. Since standard plate count were reliable and practical indicators for the efficiency of the disinfection process and safety of swimming pools (Nikaeen et al, 2009), this current finding indicates acceptable level of chlorine as disinfectant is insufficient to oxidize bacteria in the swimming pool water thus may put the swimming pool at risk of spreading water borne diseases (Leoni et al, 1999)

V. CONCLUSION

This finding suggests the increase dosage of chlorine is required to maintain swimming pool sanitation during hot season in order to provide a safe water recreational facility. However, larger sample size is required to confirm the findings.

REFERENCES

1. International Organization for Standardization BS EN ISO 7393-2:2000 (2000) Water quality. Determination of free chlorine and total chlorine. Colorimetric method using N,N-diethyl-1,4-phenylenediamine for routine control purposes
2. Leoni, E; Dr, a; Legnani, P. A; Guberti, E. b; Masotti A. b; (1999) Risk of infection associated with microbiological quality of public swimming pools in Bologna, Italy. Public Health. Volume 113, Issue 5, Pages 227-232
3. Lutz, J. K. and Lee, J. (2011) Prevalence and Antimicrobial-Resistance of *Pseudomonas aeruginosa* in Swimming Pools and Hot Tubs. Int. J. Environ. Res. Public Health, 8, 554-564
4. Nikaeen M1, Hatamzadeh M, Vahid Dastjerdi M, Hassanzadeh A. 2009. Predictive indicators of the safety of swimming pool waters. Water Sci Technol. 60(12):3101-7.

5. Richardson, S. D; DeMarini, D. M; Kogevinas, M.; Fernandez, P.; Marco, Esther; et al. (2010) What's in the Pool? A Comprehensive Identification of Disinfection By-products and Assessment of Mutagenicity of Chlorinated and Brominated Swimming Pool Water. Environmental Health Perspectives 118.11: 1523-30.
6. W Shittu, O.B., Olaitan, J.O. and Amusa, T.S. (2008) Physico-Chemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria. African Journal of Biomedical Research, Vol. 11 ; 285 – 290.
7. World Health Organisation. 2006. Guidelines for safe recreational water environments. VOLUME 2. ISBN 92 4 154680 8.
8. Wyczarska-kokot J, (2009) Effect of Disinfectant Methods on Microbiological water quality in Indoor Swimming Pools. Architecture Civil Engineering Environment, Poland, No4/2009, 145-152
9. Karami, A., Mahvi, AH., Sharafi, K., Khoshravi, TT. And Moradi, M., 2015. Comparing and Evaluating microbial and physicochemical parameters of water quality in men's and women's Public Swimming pool in Kermanshah, Iran. A Case Study. Int j Env Health.
10. Retrieve from <http://www.ijehe.org/text.asp?n=22nd Apr 2016>.
11. MN Uddin, K Techato, J Taweekun, M. Mofijur, M. G. Rasul. An overview of recent developments in Biomass pyrolysis technologies. Energies, 2018.
12. M. Mofijur, M. G. Rasul, S Hasan, AK Azad, MN Uddin. Effect of small proportion of butanol additive on the performance, emission, and combustion of Australian native first- and second-generation biodiesel in a diesel engine. Environmental Science and Pollution Research, 2017.
13. MN Uddin, K Techato, J Taweekun, M. M Rashid, MA Rahman. Investigation on producing silica from rice husk biomass. international journal of renewable energy resources. University of Malaya journal, 2018.
14. MN Uddin, MA rahman, k techato, j taweekun, m. mofijur, m. g. rasul. Sustainable biomass as an alternative energy source: bangladesh perspective, Energy procedia, Elsevier 2019.
15. MN Uddin, MA Rahman, K Techato, J Taweekun, M. Mofijur, M. G. Rasul. Waste Coffee oil: A promising source for Biodiesel production. Energy Procedia, Elsevier 2019.
16. MN Uddin, K Techato, J Taweekun, M. Mofijur, M. G. Rasul, MA Rahman. Enhancement of Biogas generation in up-flow sludge blanket from POME. Energy Procedia, Elsevier 2019.
17. MN Uddin, MA Rahman, K Techato, J Taweekun, M. Mofijur, M. G. Rasul. Renewable Energy in Bangladesh: status and prospects. Energy Procedia, Elsevier 2019.
18. M. Mofijur, M. G. Rasul, MN Uddin. Investigation of exhaust emissions from a stationary diesel engine fueled with biodiesel. Energy Procedia, Elsevier 2019.
19. TMI Mahlia, M Mofijur, MN Uddin. Energy Efficiency Analysis in Building Walls in Tropical Climate Using Thermal Insulation System. Encyclopedia of Renewable and Sustainable Materials, Elsevier 2019.
20. M. N. Uddin, M. M. Rashid, MA Rahman. Development of Automatic Fish feeder, Global Journal, 2016.
21. Md. Nasir Uddin, M. M. Rashid, N. A. Nithe "Low Voltage Distribution Level Three Terminal Upfc Based Voltage Regulator for Solar Pv System". ARPN Journal of Engineering and Applied Sciences. VOL. 10, NO 22, 2006.
22. M. A. Aziz, Arifuzzaman, Fahmida Shams, M. M. Rashid, Md. Nasir Uddin "Design and development of a compressed air machine using a compressed air energy storage system" ARPN Journal of Engineering and Applied Sciences. VOL.10, NO 23, 2015.
23. M. N. Uddin, M. M. Rashid, M. Parvez, M. F. M. Elias, N.A Rahim, M. M. Sultan, N. A. Nithe "Hybrid Fuzzy and PID Controller Based Inverter to Control Speed of AC Induction Motor". International Conference on Electrical & Electronics Engineering (ICEEE), Rajshahi University of Engineering Technology, 4-6 November 2015.
24. Md. Nasir Uddin*, M M Rashid, M Rubaiyat, aBelayet Hossain, bS M Salam, cN A Nithe "Comparison Of Position Sensorless Control Based Back-EMF Estimators in PMSM". International Conference on Computer and Information Technology (ICCIT), Military Institute of Science and Technology, 21-23 December 2015.
25. Md. Nasir Uddin*, M M Rashid, N A Nithe "Custom MPPT Design of Solar Power Switching Network for Racing Car". International Conference on Computer and Information Technology (ICCIT), Military Institute of Science and Technology, 21-23 December 2015.
26. Md. Nasir Uddin*, M M Rashid, N A Nithe, JI Rony "Performance and Cost Analysis of Diesel Engine with Different Mixing Ratio of Raw

- Vegetable Oil and Diesel Fuel” Proceedings of the International Conference Biotechnology Engineering, ICBioE '16, IIUM, Malaysia.
27. Md. Nasir Uddin*, M M Rashid, N A Nithe, JI Rony “An Investigation on the Performance of a Single Cylinder Diesel Engine Using Biodiesel” Proceedings of the International Conference Biotechnology Engineering, ICBioE '16, IIUM, Malaysia.
 28. Md. Nasir Uddin*, M M Rashid, N A Nithe, JI Rony “Investigation of Physical and Thermo-Chemical Characteristics of Biomass Fuels from Local Agricultural Residues” Proceedings of the International Conference Biotechnology Engineering, ICBioE '16, IIUM, Malaysia.
 29. Md. Nasir Uddin*, M M Rashid, ^aBelayet Hossain, ^bS M Salam, ^cN A Nithe, SZ Ahmed “Automated Queue Management System”. Global Journal of Management & Business Research (A) Volume XVI, Issue-I, Version-I, Pages: 51-58, 2016.
 30. Md. Nasir Uddin*, M M Rashid, N A Nithe “Comparative Study of Integrated Transceiver for Real Time Monitoring in Rescue Operation” Einstein Journal of Civil Architecture Engineering, 2016. V-1,i-1
 31. Md. Nasir Uddin*, M M Rashid, ^aBelayet Hossain, ^bS M Salam, ^cN A Nithe “New Energy Sources: Technological Status and Economic Potentialities”. Global Journal of Science Frontier Research Volume XVI, Issue I, Version I, Pages: 25-37, 2016.
 32. MN Uddin, MT Islam, MH Chakrabarti, MS Islam “Adsorptive removal of methylene blue from aqueous solutions by means of HCl treated water hyacinth: isotherms and performance studies”. Journal of Purity, Utility Reaction and Environment 2, 63-84, 2013.
 33. A Saghafinia, S Kahourzade, A Mahmoudi, WP Hew, M Nasir Uddin “Broken rotor bar fault detection of 3-phase induction motor using online adaptive continuous wavelet transform and fuzzy logic” International Review Of Electrical Engineering-Iree, 2012.

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