Available online at **www.pelagiaresearchlibrary.com**

Pelagia Research Library

Advances in Applied Science Research, 2016, 7(6):45-48

ISSN : 0976-8610
CODEN (USA): AASRFC

Quantity and Quality of Water Condensate from Air Conditioners and Its Potential Uses at the University of Port Harcourt, Nigeria)

M Aline E Noutcha, Oramabo Damiete, Mathew Johnny Jr., Oparanozie Ngozi, Chinwendum U Ezera, Samuel N Okiwelu

Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt, Nigeria

ABSTRACT

Water, the universal solvent is a critical, limited, renewable resource. Conservation, which is the careful use and protection of water resources, is an important component of sustainable water use. The incessant power cuts in Nigeria have adversely affected domestic, municipal, agricultural and industrial water supply. The Faculty of Science complex at the University of Port Harcourt had been beset with irregular water supply, particularly during the peak of the dry season. The study was to estimate the quantity and quality of water condensate that could be harvested from air conditioners and its potential uses. One of the goals of the study was to harvest the water condensate and prevent the floor-tile-destroying streak it produces. Water was collected from 98 air conditioners over a 2 month period on week days. The study was repeated with 120 air conditioners. Calibrated containers were used for the collections. In the first study, the air conditioners yielded about 2416.0 L while in the second study, with more air conditioners, it was 15595.0 L. The physico-chemical values of water from both studies were generally within WHO standards. However, the bacterial counts were very high, outside the WHO limits. Although the water was not suitable for drinking, the limited volume harvested could be used for cleaning the laboratories, washing scientific equipment, watering of potted plants in greenhouses, conducting some scientific experiments and flushing toilets, etc. during periods of water scarcity, resulting from epileptic power supply. If electricity is generated regularly, air conditioners could become an alternative source of water I during periods of water crises, especially for displaced populations.

Keywords: Water conservation, Air conditioners, Water condensate, WHO standards, Nigeria

INTRODUCTION

Water, the universal solvent, is a critical limited, renewable resource in many regions on Earth [1,2]. Approximately 97% of the Earth's water is in the oceans and 2% in ice caps and glaciers. This total is unsuitable for humans because of salinity and inaccessibility. Only about 0.001% of all water on Earth is in the atmosphere at any one time [3,4]. Water conservation is the careful use and protection of water resources. It involves both the quantity of water used and its quality. Conservation is an important component of sustainable water use. Sustainable water use is the use of water resources by people in a way that allows society to develop and flourish into an indefinite future without degrading/ depleting the various components of the hydrologic cycle or the ecological systems that depend on it [5].

The University of Port Harcourt is at the outskirts of Port Harcourt metropolis. It is located in the lowland rainforest. There are two seasons: rainy (April-October) and dry (November-March). Annual temperature is usually within the range, 22°C-33°C. The University is not connected to the municipal water supply. Internally, there is no central water network scheme. Consequently, each building is served by a borehole, powered by electric pumps. In the dry season, particularly at the peak, January-February, when stored rainwater has been exhausted, there is usually a water crisis.

The incessant power cuts in Nigeria have adversely affected water supply. The Faculty of Science Complex at the

University of Port Harcourt had been beset with the problem of irregular water supply for its activities, particularly laboratory experiments, washing of scientific equipment, cleaning of laboratories, flushing of toilets, etc. A study was therefore initiated to estimate the volume and quality of water condensate produced by the air conditioners in use at the Faculty of Science complex (Offirima building), and its potential uses. The water condensate usually produces floor-tile-destroying streaks along corridors. One of the goals was to harvest the condensate, prevent soiling of floor tiles and enhance clean surroundings by reducing trails of sandy footsteps on the corridors of the complex.

MATERIALS AND METHODS

The complex is a multi-floor building, with five lecture halls, sixteen classrooms, forty-nine laboratories, two conference halls, two libraries, one hundred and sixty-two offices, five stores, sixteen shops and twenty five toilets. One hundred and twenty-six offices and fourteen laboratories have split air conditioners with their external units placed along the corridors and hallways. Containers of 11.0 L-capacity were placed under the hoses of each air conditioner. Water was collected daily, volume recorded before emptying into 120 L - drums. Collection was undertaken between 9.00 and 16.00 h on week days for 2 months. A total of 98 air conditioners were used. Collected water was subjected to physico-chemical and microbial analyses. Parameters determined were pH, turbidity, conductivity, total dissolved solids, chloride, copper, iron, lead, total hardness, alkalinity and bacterial count. Hanna pH meter measured pH; samples were compared to Frizine standard to obtain turbidity in Nephlometric Turbidity Unit (NTU); Consort 532C Conductivity meter determined conductivity; Hanna TDS/EC/NaCl meter measured Total Dissolved Solids; copper was determined by Hach DR/4000 µ spectrometer; Total Hardness was determined by titration. Metals were analyzed using an Atomic Absorption Spectrophotometer. The microbial load was determined by the Pour Plate Method. This study was subsequently repeated five years later, for one month during the rainy season. One hundred and twenty air conditioners were used. Collections were made during the period 08.00-16.00 h on weekdays. Physico-chemical parameters of water that were determined included: pH, Nitrate, Total Hardness, Phosphate, Conductivity, Chloride, Total dissolved Solids.

RESULTS

In the 1st month of the first study, when electricity was available sporadically for 48 h over 11 days, the total volume of water collected was 1459.5 L (Table 1). In the second month, electricity was available for 36 h over 8 days; the total volume of water collected was 956.5 L (Table 2). The total volume of water condensate over the 2 month period was 2416.0 L. The ranges of physico-chemical data among air conditioners were uniformly narrow: pH (6.43-7.22); Turbidity (5NTU); TDS (11.9-18.2 mg/L); Conductivity (114.7-130.4mg/L); Copper (Non-detectable); Lead (0.03-0.06); iron (Non-detectable); Alkalinity (12-17 mg/L); Total Hardness (4.5-7.0 mg/L); Bacterial Count (1.7×10^2–4×10^2 CFU/ml) (Table 3). The volume of water collected by different brands of air conditioners during the second 1 month study is in Table 4. The volume of condensate per air conditioner varied, 113.3-218.5 L, over the month of study. The highest production was from Hyundai and the least from Sharp. The range among the remaining brands was narrow, 141.7-157.2 (Table 4). The ranges were pH (7.01-7.35), Hardness (10.12-15.35), Conductivity (20.30-29.16), Total Dissolved Solids (10.85-16.44), Phosphate (3.39-5.62), Chloride (4.13-6.48), Nitrate (12.79-18.32). Detailed physic-chemical values appear in Table 5.

DISCUSSION

The development of benefits of water conservation Best Management Practices (BMP) has focused on homes municipal, industrial and agricultural sectors. In homes, the money-saving aspect, the prevention of pollution of nearby lakes, rivers and local water sheds, extension of the life of the septic system in reducing soil saturation and

Table 1: Quantity of water from air conditioners in 1st month from the first study

Weeks	Electricity Availability (Days)	Electricity Availability (h)	Volume of water (L)
1	2	7	222.6
2	3	9	300.6
3	3	14	469.4
4	3	18	466.9
Total	11	48	1459.5

Table 2: Quantity of water from air containers in 2nd month from the first study

Weeks	Electricity availability (Days)	Electricity availability (h)	Volume of water (L)
1	2	9	272.8
2	2	9	286.9
3	2	10	213.2
4	2	8	183.6
Total	8	36	956.5

Table 3: Physico-chemical and microbial properties of water from air conditioners from the 1st study

Parameters	WHO LIMITS	AIR CONDITIONERS						
		I	II	III	IV	V	VI	VII
pH	6.5-8.5	6.48	6.58	7.22	6.43	6.83	6.76	6.73
Turbidity (NTU)	10	5	5	5	5	5	5	5
TDS (mg/L)	<500	18.2	12.9	16	22.9	17.4	12.4	11.9
Conductivity (µ.m/cm)	-	51.9	14.6	29.2	33.1	25.9	22.7	30.4
Chloride (mg/L)	<251	129.4	114.7	128.4	130.4	117.8	129.6	115.8
Lead (mg/L)	0.1	0.06	0.03	0.03	0.03	0.03	0.06	0.05
Copper (mg/L)	1.0-2.0	0.01	ND*	ND	ND	ND	ND	ND
Iron (mg/L)	0.3	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)	-	17	17	15	12	16	13	16
Total Hardness (mg/L)	75-150	6.6	4.7	7	4.5	5.3	5.5	6.0
Bacterial Count (CFU/ml)	500	3.6×10^2	4×10^2	4.4×10^3	1.5×10^3	2.2×10^3	1.7×10^3	2.4×10^3

*ND: Non Detectable

Table 4: Volume of water collected during the 1 month of the second study

Air-Conditioner Brands	Weeks	1	2	3	4	Total	Litre/Air Conditioner
	Number sampled	Volume Per Week (L)					
Hyundai	4	228	240	210	196	874	218.5
LG	63	2380	2197	2488	2576	9641	153.0
Midea	1	50	35	25	35	150	150.0
Panasonic	11	411	486	409	423	1729	157.2
Samsung	2	90	78	70	76	314	157.0
Sharp	3	60	82	86	112	340	113.3
Thermocool	18	612	614	707	619	2552	141.7
Total		3831	3732	3995	4037	15595	

Table 5: Physico-chemical values of water from air conditioners in the second study

ACs#	Parameter Values (mg/L)						
	pH	Nitrate	Hardness	Phosphate	Conductivity (µm/cm)	Chloride	Total Dissolved Solids
1	7.26	17.14	11.13	4.66	21.50	6.29	10.85
2	7.35	17.20	10.60	4.67	21.70	6.30	13.22
3	7.12	16.80	12.42	4.83	20.30	6.48	11.46
4	7.16	15.40	11.28	3.39	27.66	5.87	12.30
5	7.07	18.32	13.16	4.27	29.16	5.40	11.28
6	7.01	16.74	12.20	4.50	28.41	5.43	14.20
7	7.18	14.27	15.44	5.14	22.45	5.75	16.44
8	7.15	16.88	12.13	5.62	21.27	5.42	12.64
9	7.18	14.13	11.88	5.17	21.73	6.13	11.87
10	7.25	13.20	10.12	4.52	22.16	4.13	11.42
11	7.17	13.62	12.88	4.67	22.82	4.82	12.10
12	7.28	15.39	12.30	4.14	23.62	5.19	11.69
13	7.28	12.79	12.45	4.60	25.22	5.47	13.21
14	7.16	13.72	12.13	4.16	27.13	5.80	13.17
15	7.18	13.40	13.27	4.50	26.80	5.88	13.43
WHO	6.5-8.5		100-300	< 5.0	1000	259	<600

Air Conditioners

pollution due to leaks have been highlighted [6]. The goals of municipal water conservation are divers: preventing land subsidence addressing short-term and long term water shortages, providing environmental protection, avoiding or postponing the high costs of new water system improvements. Industrial water users have made advances in water use efficiency over several decades. Agricultural growers have pioneered water efficiency by the use of low-pressure irrigation methods [7,8]. These improvements have involved technological advances [9-11].

The current study explores a new terrain; it extends water harvesting and conservation to a University with unique water problems. Although the volume of water condensate harvested was limited, it could be used for cleaning laboratory glassware and similar items, cleaning the laboratories, watering potted plants in green houses during the peak dry season, with its usual water shortages. The fact that the physic-chemical values were generally within WHO limits, makes the water suitable for some laboratory experiments. However, the high microbial values when the collecting containers were opened make it grossly inadequate for drinking. Further studies are planned to critically evaluate the variation in water condensate harvested from different brands of air conditioners of same capacity. An important outcome of the harvesting of the floor title-destroying water condensate was clean corridors.

REFERENCES

[1] Gleick PH. An Introduction to global fresh water issues In: Water in crisis. Gleick P (edtr), Oxford University Press, New York, **1993,** 3-12.

[2] Gleick PH. Water conflict chronology. *Pacific Institute for Studies in Development, Environment and Security,* **2003**.

[3] Raven PH, Berg LR, Johnson GB. Environment. Harcourt brace college publishers. Fort Worth, **1995**, 569.

[4] Botkin DB, Keller EA. Environmental science. Earth as a living planet, John Wiley**, 2003**, 688.

[5] Gleick PH, Loh P, Gomez SV, Morrison J. California Water 2020, a sustainable Vision. *Oakland California Pacific Institute for Studies in Development, Environment and Security*, **1995.**

[6] http://eartheasy.com/livewatersaving.com/live

[7] National Drinking Water Clearing House. Fact sheet - Water conservation measures, **1998**, 4.

[8] Texas Water development Board. Water Conservation: Best management Practices (BMP) Guide, **2005,** 81.

[9] Howe C, Dixon J. Inefficiencies in water project design and operation in the third world: An Economic Perspective. *Water Resources*, **1993**, 29: 1889-1894.

[10]Le Moigne G, Kuffner U, Xie M. Using water efficiently: Technological options. Technical Paper, **1993**.

[11]International Development Programme HDRA. Water harvesting and Conservation, **2005**, 24.