

# Effectiveness of Residual Disinfectant in Distribution System for Belagavi City South-A Case Study

Ashwini.B.Hubballi<sup>1</sup>, Arjun.S.Virupakshi<sup>2</sup>

<sup>1</sup>M.Tech Student, Dept. of Environmental Engineering, KLE's Dr.MSSCET, Belagavi-590008, Karnataka, India

<sup>2</sup>Assistant Professor, Dept. of Civil Engineering, KLE's Dr.MSSCET, Belagavi-590008, Karnataka, India

\*\*\*

**Abstract** - Treated water is supplied to the consumers through the distribution networks, chlorination is the most common method of disinfection in the treatment process. Chlorine not only kills the pathogens but also provides the residual effect. The main aim of the study was to analyze the effectiveness of the residual disinfectant in the distribution system of Belagavi South. The samples were collected in five different localities of study area and were analyzed for the parameters like color, odor, pH, turbidity, TDS, conductivity, residual chlorine and MPN for the three successive months i.e. March, April and May. All the sampling stations had parameters well within the limits of Bureau of Indian Standards while pH was below the prescribed limit and residual chlorine found varying in the range of 0.1mg/l to 0.5 mg/l. During the study, it revealed that in spite of presence of residual chlorine, one of the sampling station gave positive MPN results exhibiting microbial contamination, on further microbial analysis, *Klebsiella* bacterium was found to be present in the water sample. Microbial growth and survival is due to age of pipelines in distribution networks, pipe material, hydraulic effects, age of biofilm and nutrient availability.

**Key Words:** Water distribution system, Disinfection, Residual chlorine, microbial contamination.

## 1. INTRODUCTION

Water is one of the conspicuous assets for survival of the living being among different substances on the planet earth. It is a precious gift to the humankind from the mother earth and is considered as one of the most convenient natural resources. It is the first and foremost basic requirement, from domestic activities to complex works like drinking, cleaning, washing, cooking, gardening, manufacturing, diluting waste etc. The increasing population, urbanization and industrial growth have lead to unbalanced hydrological cycle and thus water crisis [1]. It has also caused significant damages to the environment. Nearly two third nations in the world will get affected by water stress by 2025 [2]. 2.6 billion People or 39% of world's population live without access to improved sanitation and the maximum live in Asia and Sub-Saharan Africa. 3.8 billion Or 57% of the world's population gets their drinking water from piped connections [3]. To assess the efficiency of disinfectant and the quality of water, the study was undertaken in Belagavi city south. Belagavi is the fourth largest city in Karnataka situated in north western region at 15.87°N latitude and 74.5°E longitude with average elevation of 751meters and has area

of 94.08 km<sup>2</sup> with a population of 4,92,157 [4]. Belagavi city has been further divided into two, namely Belagavi-North Belagavi-south for administrative purposes, raw water is obtained from Rakaskop and Hidkal dam is 40MLD and 54.55 MLD respectively is treated in Laxmitek water treatment plant situated in military camp area and then supplied to the city.

## 2. STATEMENT OF THE PROBLEM

On basis of 2011 census, Belagavi population is 4,90,045. The city gets raw water supplied from two reservoirs namely Rakaskop and Hidkal. Belagavi city gets treated water supplied from Laxmitek water treatment plant. Every year people of southern Belagavi register 1000's of cases of waterborne diseases like Diarrhea, Cholera, Typhoid, Gastrointestinal problems etc in Civil Hospital, KLE Hospital, Venugram Hospital. The study was undertaken to assess the quality of water in distribution system and its networks.

## 3. OBJECTIVES

- To analyze the presence of chlorine in distribution system such as pipe network and storage points for parts of Belagavi City- South.
- To conduct the physical, chemical and bacteriological test for the water at various points in distribution system.
- Identifying the species of micro-organism if present.
- To recognize the areas where the community is susceptible to waterborne diseases.

## 4. METHODOLOGY

Belagavi south was considered as a study area and it gets treated water supply from Gummatmal storage cum pumping station. The facility has four storage tanks each of 5 lakh gallons and over head tank of 30,000 gallon capacities. Alum was added to the tanks when the treated water becomes turbid especially in the rainy season. Water samples were collected from the distribution network of Belagavi south which included Rani Chennamma Nagar, Old Belagavi, Shahpur, Angol, and Majagaon. The samples were analysed for parameters like color, odor, pH, conductivity, TDS, turbidity, residual chlorine and most probable number (MPN) at Environmental Laboratory of KLEMSSCET, Belagavi.

#### 4.1 Analysis

The water samples collected during the study were analysed for physical, chemical and biological tests at Environmental Laboratory of KLEMSSCET, Belagavi using standard techniques and equipments as per APHA standards and were compared to IS:10500-2012.

- Physical analysis like odor, color was done to the collected water samples by visual examination.
- Chemical analysis like pH, Conductivity, TDS and Turbidity were done in laboratory. Residual chlorine was checked onsite using portable chlorine kit with orthotolidine as an indicator.
- Microbiological analysis was done using multiple tube fermentation technique.

**Table-1:** Sampling stations and distances from Gummatmal water supply

Station no.	Station name	Distance (km)
1	Rani chennamma nagar PS	2.7
2	Old belagavi PS	2
3	Shahpur	1.3
4	Angol	3.3
5	Majagaon	4.8

PS: pumping station

#### 5. RESULTS AND DISCUSSIONS

The samples were collected from five different areas and were tested for physico-chemical and microbiological parameters.

1. The water samples were collected on the day of supply from Rani chennamma nagar for the months of March, April and May and were immediately taken to laboratory for analysis, the results of the analysis are represented below in the table 2.

**Table-2:** Physicochemical and microbiological characteristics for station 1 for March, April, May months

Parameters	Months		
	March	April	May
Color and odor	acceptable	acceptable	acceptable
pH	6.62	6.76	6.80
Turbidity	0	0	0
Conductivity	92.6	94.3	93.36
TDS	46.95	48.24	48.05
Residual chlorine	0.1	0.1	0.1
MPN	Negative	Negative	Negative

The sample of the station had all the parameters within the limits of BIS standards but residual chlorine was lesser than the range of standards but still water was consumable (Table 2).

2. The samples of water were collected from Old Belagavi for the months of March, April and May and were assessed for physical, chemical, biological parameters and are as follows.

**Table-3:** Physicochemical and microbiological characteristics for station 2 for March, April, May months

Parameters	Months		
	March	April	May
Color and odor	acceptable	acceptable	acceptable
pH	6.55	6.56	6.59
Turbidity	0	0	0
Conductivity	96.33	100.8	93.32
TDS	49.16	51.83	50.4
Residual chlorine	0.1	0.1	0.1
MPN	Negative	Negative	Negative

The water test samples had physical, chemical and biological parameters in the range of BIS standards and were fit for drinking (table 3).

3. The water samples were collected on the day of supply from Shahpur for months of March, April and May and were immediately taken to laboratory for analysis, the results of the analysis are represented below in the table 4.

**Table-4:** Physicochemical and microbiological characteristics for station 3 for March, April, May months

Parameters	Months		
	March	April	May
Color and odor	acceptable	acceptable	acceptable
pH	6.62	6.75	6.67
Turbidity	0	0	0
Conductivity	89.5	88.52	87.6
TDS	45.12	42.7	43.1
Residual chlorine	0.1	0.1	0.1
MPN	Positive	Positive	Positive

The sample of the station 3 had all physico-chemical parameters within the limits of BIS standards but there was microbial contamination of 10, 12, 17 MPN numbers seen in 3 months respectively in the presence of residual chlorine and water was not fit for drinking (Table 4).

- The water samples were collected in Angol for three months March, April and May and were analysed for the physical, chemical and biological characteristics and are represented below.

**Table-5:** Physicochemical and microbiological characteristics for station 4 for March, April, May months

Parameters	Months		
	March	April	May
Color and odor	acceptable	acceptable	acceptable
pH	6.7	6.75	6.67
Turbidity	0	0	0
Conductivity	82.65	83.97	83.05
TDS	41.72	44.44	41.21
Residual chlorine	0.1	0.1	0.1
MPN	Negative	Negative	Negative

The sample of the station had all the parameters within the limits of BIS standards but residual chlorine was lesser than the range of standards and still water was consumable (Table 5).

- The water samples were collected in Majagaon for three months March, April and May and were analysed for the physical, chemical and biological characteristics and are represented below.

**Table-6:** Physicochemical and microbiological characteristics for station 5 for March, April, May months

Parameters	Months		
	March	April	May
Color and odor	acceptable	acceptable	acceptable
pH	6.65	6.76	6.68
Turbidity	0	0	0
Conductivity	87.49	86.9	85.77
TDS	43.35	43.29	43.58
Residual chlorine	0.1	0.1	0.1
MPN	Negative	Negative	Negative

The sample of the station had all the parameters within the limits of BIS standards but residual chlorine was lesser than the range of standards and still water was consumable (Table 5).

## 6. CONCLUSIONS

The following conclusions were drawn based on the results obtained.

- Samples were collected in distribution network of Belagavi city South from Rani Chennamma Nagar, Old Belagavi, Shahpur, Angol and Majagaon.

- On testing the collected water samples from sampling points, the physico-chemical characteristics like color, odor, pH, TDS, conductivity were found to be in the permissible range during the study period.
- The water samples were also analyzed for the presence of residual chlorine, and it was found varying from 0.1 - 0.5mg/l and was within the standards of limit.
- Water sample collected from Kore galli, Shahpur sampling point was found to be contaminated in the presence of residual chlorine of 0.1 mg/l.
- The presence of Klebsiella (pathogen) species was identified in the distribution system where the disinfectant was present in the range of 0.1-0.2 mg/l in the form of residual chlorine.
- Klebsiella is more likely to be present in the old distribution networks hence gradual replacement of older pipes should be done with the new.
- Monitoring of distribution system can be done by hydraulic flushing method for cleaning of network system if renewal of the old pipe lines is not possible.

## REFERENCES

- R.K. Sharma, M. Yadav, R. Gupta, "Water Quality and Sustainability in India: Challenges and Opportunities", Chemistry and Water, ISBN 978-0-12-809330-6.
- Ellen J. Lee and Kellogg J. Schwab, "Deficiencies in drinking water distribution systems in developing countries", journal of water and health, 2005.
- www.who.int
- Draft Final Report: Environmental and Social Assessment (ESA) for Continuous Water Supply in Belagavi.
- www.wateraid.org
- www.unwater.org
- H. Leclerc, L. Schwartzbrod, E. Dei-Cas, "Microbial Agents Associated with Waterborne Diseases", Critical Reviews in Microbiology, 28(4):371-409 (2002).
- "British columbia guidelines (microbiological) on maintaining water quality in distribution systems", Drinking water officers' guide 2017, Version 1 / August 2016.
- Husnain Haider, "Disinfection techniques of rural water supplies in developing countries", 2014.
- [http://www.who.int/water\\_sanitation\\_health/publications/2011/dwq\\_guidelines/en/](http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/)
- Environmental Protection Agency Act, 1992.

- [12] Guidelines for drinking water quality by world health organization.
- [13] Vincent P. Olivieri, Michael C. Snead, Cornelius W. Kruse, and Kazuyoshi Kawata, "Stability and Effectiveness of Chlorine Disinfectants in Water Distribution Systems", *Environmental Health Perspectives* Vol. 69, pp. 15-29, 1986.
- [14] Shaukat Farooq, Imran Hashmi, Ishtiaq A. Qazi, Sara Qaiser, Sajida Rasheed, "Monitoring of Coliforms and chlorine residual in water distribution network of Rawalpindi, Pakistan", *Environ Monit Assess* (2008) 140:339-347.
- [15] Mark W. Lechevallier, William Schulz, Ramon G. Lee, "Bacterial Nutrients in Drinking Water", *Applied and environmental microbiology*, Mar. 1991, Vol. 57, p. 857-862.
- [16] Markku J. Lehtola, Ilkka T. Miettinen, Tiia Lampola, Arja Hirvonen, Terttu Vartiainen, Pertti J. Martikainen, "Pipeline materials modify the effectiveness of disinfectants in drinking water distribution systems", *Water Research* 39 (2005) 1962-1971.
- [17] C.L. Moe, M.D. Sobsey, G.P. Samsa & V. Mesolo, "Bacterial indicators of risk of diarrhoeal disease from drinking-water in the Philippines", *Bulletin of the World Health Organization*, 69(3): 305-317 (1991).
- [18] Pierre Payment, "Poor efficacy of residual chlorine disinfectant in drinking water to inactivate waterborne pathogens in distribution systems", *Can. J. Microbiol* 45: 709-715 (1999).
- [19] Marcopropato, James G Uber, "Vulnerability of Water Distribution Systems to Pathogen Intrusion: How Effective Is a Disinfectant Residual?", *Environ. Sci. Technol.* 2004, 38, 3713-3722.
- [20] Kelly A. Reynolds, Kristina D. Mena, Charles P. Gerba, "Risk of Waterborne Illness Via Drinking Water in the United States", *Rev Environ Contam Toxicol* 192:117-158.
- [21] Gwy-Am Shin, Mark D. Sobsey, "Inactivation of norovirus by chlorine disinfection of water", *water research* 42 (2008) 4562-4568.
- [22] Mark w. lechevallier, Cheryl d. cawthon, Ramon g. lee, "Factors Promoting Survival of Bacteria in Chlorinated Water Supplies", *applied and environmental microbiology*, mar. 1988, p. 649-654.
- [23] Mohammad I. Al-Berfkani, Anies I. Zubair, Husham Bayazed, "Assessment of chlorine resistant bacteria and their susceptibility to antibiotic from water distribution system in Duhok province", *Journal of Applied Biology and Biotechnology* Vol. 2 (06), pp. 010-013, Nov-Dec, 2014.
- [24] Benoit Barbeau, Vincent Gauthier, Karine Julienne and Annie Carriere, "Dead-end flushing of a distribution system: Short and long-term effects on water quality", *Journal of Water supply: Research and Technology-Aqua* (2005) 54(6): 371-383.
- [25] Makhmoo Rather Ahmed, Ahanger Faroz Ahmed, Sharma Harendra K, "Assessment of microbiological quality of drinking water treated with chlorine in the Gwalior city of Madhya Pradesh, India", *African Journal of Environmental Science and Technology*, Vol 9(5), pp. 396-401, May 2015.
- [26] Draft Final Report: Environmental and Social Assessment (ESA) for Continuous Water Supply in Belagavi.
- [27] <https://en.climatedata.org/asia/india/Karnataka/belagavi-4076/?amp=true>
- [28] APHA1998
- [29] Control of Biofilm Growth in Drinking Water Distribution Systems, EPA/625/R-92/00, June 1992.