Assessment of Water Quality Stability And Impact of Leakages In Shirpur Water Distribution System

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Abstract- *The quality of drinking water supplied to consumers depends not only on treatment efficiency at the Water Treatment Plant (WTP) but also on conditions within the distribution system. In many Indian towns, variations in water quality are observed during distribution due to intermittent supply and increased water residence time. This study evaluates the stability of drinking water quality in the Shirpur water distribution system, Maharashtra. Water samples were collected from the WTP outlet and household taps in selected residential areas and analyzed for key physical and chemical parameters using standard methods. The results were compared with IS 10500 and WHO drinking water standards. The findings indicate that most parameters remain within permissible limits; however, a gradual reduction in residual chlorine was observed along the distribution network, mainly due to increased residence time. Pipeline leakages were found to contribute primarily to water losses and reduced supply efficiency rather than direct deterioration of water quality. The study highlights the importance of regular water quality monitoring, effective leakage control to minimize water loss, and proper maintenance of distribution infrastructure to ensure a safe and reliable drinking water supply.*

Keywords: Drinking Water Quality, Water Quality Stability, Distribution System, Pipeline Leakage, Residual Chlorine.

I. INTRODUCTION

Safe drinking water is essential for public health and urban sustainability. Although water supplied from the Water Treatment Plant (WTP) generally meets prescribed quality standards, its quality may change while passing through the distribution system. Factors such as intermittent supply, pressure variation, and increased water residence time can influence the stability of drinking water quality at consumer endpoints. In many Indian towns, pipeline leakages are a common issue and mainly result in loss of treated water and reduced supply efficiency, indirectly affecting disinfectant residuals.

Shirpur town in Maharashtra depends on a centralized water supply system to meet domestic water demand. While the treated water quality is satisfactory at the source, variations—particularly in residual chlorine—have been observed at household taps. Therefore, this study focuses on evaluating the stability of drinking water quality from the WTP to consumer points and examining the role of pipeline leakages in water loss within the Shirpur water distribution system.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The research idea was developed by recognizing growing concerns related to variations in drinking water quality within urban distribution systems, especially in small and medium-sized towns. Although treated water usually meets prescribed standards at the Water Treatment Plant (WTP), changes in water quality are often observed at consumer endpoints due to factors such as intermittent supply and increased water residence time. This highlighted the need to evaluate water quality stability beyond the treatment stage.

A review of previously published research papers, government manuals, and technical guidelines related to drinking water distribution systems, residual chlorine decay, and leakage management was carried out. Documents published by organizations such as the World Health Organization (WHO), Bureau of Indian Standards (BIS), and CPHEEO were referred to understand standard water quality requirements and common challenges faced by Indian water supply systems.

In addition, online literature searches and case studies of similar water supply systems were examined to assess the feasibility of the study. Local observations and informal discussions with residents further supported the selection of Shirpur town as the study area. Based on this background research, the present study was formulated to assess drinking water quality stability and examine the role of pipeline leakages in water loss within the Shirpur water distribution system.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

Now In the present study, drinking water quality was evaluated at different points within the Shirpur water distribution system to understand variations occurring during transmission. Water samples were collected from the Water Treatment Plant (WTP) outlet and household taps located in selected residential colonies. The study focused on assessing the stability of key physical and chemical parameters and identifying factors influencing changes in water quality during distribution.

The experimental analysis showed that most water quality parameters, including pH, total dissolved solids, hardness, alkalinity, and dissolved oxygen, remained within permissible limits at consumer endpoints. However, a gradual reduction in residual chlorine concentration was observed as water moved through the distribution network. This reduction was mainly associated with increased water residence time and operational conditions within the pipelines rather than direct contamination.

The findings indicate that while the overall drinking water quality in Shirpur is satisfactory, distribution system conditions play an important role in maintaining water quality stability. Pipeline leakages were found to primarily affect the quantity of water supplied by causing water losses, indirectly influencing disinfectant levels. These observations formed the basis for detailed experimental analysis, discussion, and interpretation presented in the subsequent sections of this paper.

IV. STUDY AREA DESCRIPTION

Shirpur town is in the northern part of Maharashtra and is administered by the Shirpur Municipal Council. The town receives drinking water through a centralized water supply system consisting of a Water Treatment Plant (WTP), storage reservoirs, pumping stations, and an extensive pipeline network. Treated water is distributed to residential, commercial, and institutional areas through pipelines of varying diameters and materials.

The distribution network includes pipelines made of PVC, cast iron, and galvanized iron, with some sections being relatively old. Due to aging infrastructure and intermittent water supply, certain areas experience pressure fluctuations and occasional leakage issues. Four residential colonies—Balaji Nagar, Milind Nagar, Dandawate Nagar, and Bhaskar Bapu Nagar—were selected for this study based on population density, reported leakage incidents, and accessibility for sampling.

Fig. 1: Map of Balaji Nagar, Shirpur

Fig. 2: Map of Milind Nagar, Shirpur

Fig. 3: Map of Dandawate Nagar, Shirpur

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Fig. 4: Map of Bhaskar Bapu Nagar, Shirpur

V. METHODOLOGY EXPERIMENTAL WORK

1. Sample Collection

Water samples were collected from the outlet of the Water Treatment Plant (WTP) and from household taps located in selected residential colonies of Shirpur town. Sampling was carried out twice a week over a period of one month to capture variations in water quality. Clean and properly sterilized containers were used during sampling. Before collecting samples from household taps, the tap was allowed to run for a few minutes to remove stagnant water from the service line and ensure representative sampling.

Fig. 5: Collection of water sample from household tap

2. Parameters Analysed

The collected water samples were analysed for key physical and chemical parameters including pH, total dissolved solids (TDS), total hardness, alkalinity, residual chlorine, and dissolved oxygen. These parameters were selected to evaluate the physical and chemical stability of drinking water as it moves through the distribution system.

3. Testing Procedures

All laboratory and field tests were performed using standard testing methods and calibrated instruments. The pH and TDS values were measured using digital meters, while total hardness and alkalinity were determined using titration methods. Residual chlorine was analysed using a colorimetric method, and dissolved oxygen was measured using a digital DO meter. The obtained results were compared with drinking water standards prescribed by BIS IS 10500 and World Health Organization (WHO) guidelines.

Fig. 6: Water samples prepared for laboratory analysis

Fig. 7: Laboratory testing of water quality parameters

VI. GET PEER REVIEWED

Here comes the most crucial step for your research publication. Ensure the drafted journal is critically reviewed by your peers or any subject matter experts. Always try to get maximum review comments even if you are well confident about your paper.

VII. RESULTS AND DISCUSSION

The water quality results obtained from the WTP outlet and household taps were analyzed to examine changes during water distribution. The pH values showed minor variation across all locations and remained within the permissible limits prescribed by BIS and WHO standards.

A slight increase in total dissolved solids (TDS) and total hardness was observed at consumer endpoints compared to the WTP outlet. These changes may be associated with increased water residence time and interaction of water with the distribution pipelines. Residual chlorine concentration showed a gradual decrease along the distribution network, indicating disinfectant decay during transmission. Dissolved oxygen values exhibited only marginal variation, suggesting that the overall drinking water quality remained stable throughout the distribution system.

Parameter	**Unit**	**Observed Value**	**BIS Permissible Limit**
pH	–	7.2	6.5–8.5
TDS	mg/L	290	500
Total Hardness	mg/L	160	200
Alkalinity	mg/L	120	200
Residual Chlorine	mg/L	0.5	0.2–1.0
Dissolved Oxygen	mg/L	6.8	–

Table 1: Water quality parameters at the WTP outlet

Location	pH	TDS (mg/L)	Hardness (mg/L)	Residual Chlorine (mg/L)	Alkalinity (mg/L)	DO (mg/L)
Balaji Nagar	6.73	301.7	171.5	0.323	167.3	5.585
Milind Nagar	7.074	304.1	171.6	0.283	175.6	5.546
DandawateNagar	7.004	301.7	172.3	0.306	170.5	5.691
Bhaskar Bapu Nagar	7.047	304	171.2	0.278	169.3	5.658

Table 2: Average water quality parameters at household taps in selected colonies

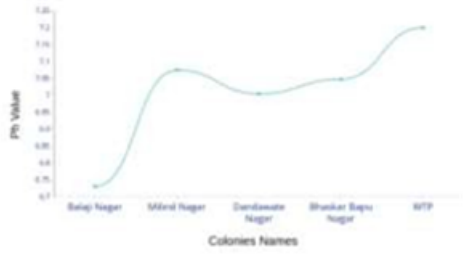

Fig. 8: Variation of pH at household taps

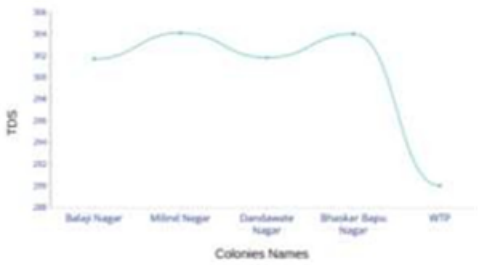

Fig. 9: Comparison of TDS from WTP to household locations

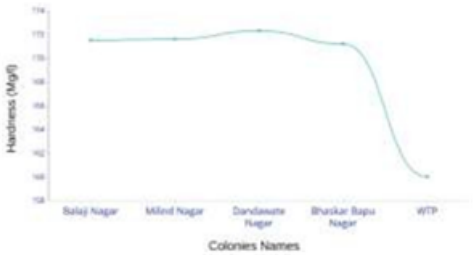

Fig. 10: Variation of total hardness from WTP outlet to consumer endpoints

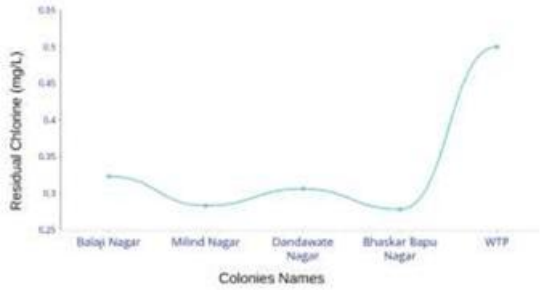

Fig. 11: Residual chlorine decay from WTP outlet to household taps

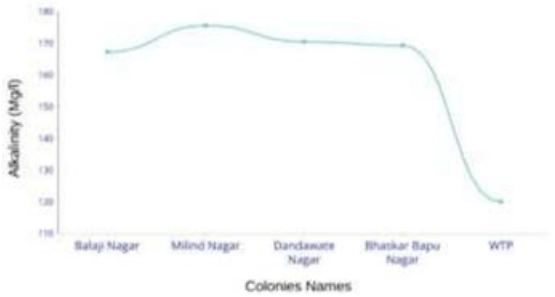

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Fig. 12: Variation of alkalinity in the distribution network

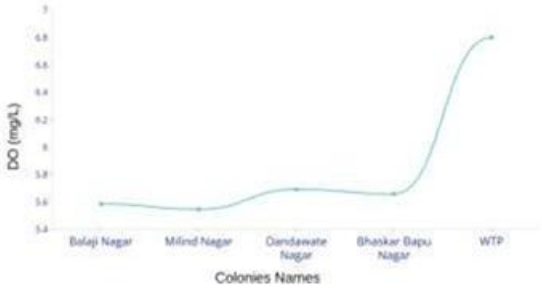

Figure 16: Variation of dissolved oxygen from WTP outlet to household taps

VIII. IMPACT OF PIPELINE LEAKAGES

Pipeline leakages in the Shirpur water distribution system were found to primarily affect the quantity of water supplied rather than directly degrading water quality. Leakage-related water losses increase the time water remains in the pipelines, which indirectly contributes to the reduction of residual chlorine levels. No major contamination was observed during the study period; however, continuous water loss reduces supply efficiency and increases operational stress on the system.

At present, leakage detection mainly relies on visual inspection and public complaints. The absence of advanced leakage detection techniques results in delayed identification and repair, leading to prolonged water losses.

IX. CONCLUSION

The study assessed the stability of drinking water quality and the impact of pipeline leakages in the Shirpur water distribution system. Most water quality parameters were found to be within permissible limits at both the WTP outlet and consumer endpoints. However, a gradual reduction in residual chlorine was observed during distribution due to increased water residence time and system conditions.

Although pipeline leakages did not directly deteriorate water quality, they contributed to water losses and reduced supply efficiency. Regular monitoring of water quality, timely maintenance of pipelines, and improved leakage management practices are essential to ensure long-term water quality stability and sustainable water supply in Shirpur.

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