Critical Study of Infrastructure Leakage Index for Evaluation of Losses in Water Distribution Network

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Abstract- **The Performance Indicator used in Water Distribution Network emphasizes that performance of system depends on the efficiency of delivering the various requirements. Infrastructure Leakage Index is one of the key indicator used in Water Distribution Network which in earlier times was well known to some of the insiders , is presently accepted and widely used by many of the practitioners around the Globe.ILI has been delivered from various certain organizational properties that are being used in the system. The basic framework like Dimensions of service connection, it can be sometimes harder to evaluate and determine; Further the main and important property of ILI is on one of the characteristic like pressure property known as average operating Pressure made this most reliable and responsive known criterion in the network that is inadequate comparison of distribution of water supply network. The components of NRW as one of the Performance Indicator is now determined by various analysis od distribution system like analysis of Water balance table .Further International water association (IWA) established ILI, a performance indicators for comparing and monitoring the managements of leakages in the water distribution network . Great relevance to large extent is compulsorily taken for the evaluation of the Infrastructure Leakage Index relied on the information needed for the numerical modelling as well as studying the measurements using software. On the contrary side the paper introduces ILI evaluation assuming various different parameters to measure the attempts in Water loss reduction.**

Keywords- **Performance Indicator, ILI, Water Balance, CARL, UARL, Real Losses, Apparent Losses.**

INTRODUCTION

In 1997, the scientist named Allan Lambert, has noticed the requirement of the real losses Performance Indicator that would allow to figure out the global differences between the systems with various differences in characteristics,i.e., differences in the consumption levels, low and high pressure systems and so on. Therefore, the International Water Association recommended the use of ILI which is further categorized as level-3 indicator.

ILI is defined as the ratio of Current annual real losses to the Unavoidable annual real losses. ILI has no units , and it facilitates the comparison between use of different measurement units i.e., metric, British, with respect to different countries. ILI is the measurement of maintainance of distribution network management fot the control of various losses i.e., Real losses operated in the operating pressures .

The Cummulative yearly loss of water in terms of volume is the most important parameter taken into account for assessing and computing the efficiency of water utility , in different individual years and also as an single year over the periodic interval . A Mixture of losses of water comprising of contaminated or crummy and irregular supply of water leaves the harsh effects to the health of an individual in the developing countries. Furthermost, in recent times, IWA task Forces did lots of advancements and tested the use of ILI as performance indicator of waterlosses. It is completely accommodated ,and losses which are real will be always existed in water supply network, even in the fairly well managed system of water distribution network . The International Performance Indicator gives the most and valid technical basis for comparing the utilities in the water losses that can be used by practitioners and also by the operators .

METHODOLOGY

INFRASTRUCTURE LEAKAGE INDEX(ILI):-

The ILI is a performance indicator of realwater loss from the source of water distribution system.An ILI method presents an elevated foundation for practical equivalency of leakage administration overall performance which severs components of infrastructure management; repair, pipe & belongings management, and the productiveness of a dynamic leak management policy, based on the elements of stress management.

Importance of ILI:-

1. An ILI is a newly discovered technical performance metric for real losses, that determines the correlation of modern annual real losses to definite system unavoidable annual actual losses.
2. An ILI method presents an elevated foundation for technical correlation of leakage administration overall performance that severs components of infrastructure management; repair, pipe& belongings management based on elements of stress management.

3. There is no comparison among ILI and NRW as a share of device enter volume. The low proportion of NRW is no longer constantly an implication of great proper loss management.

Applications of ILI:-

1. The ILI ratio i.e., CARL to UARL measures how well the management functions if infrastructure i.e., repairs, assests management and pipelines controls the aspects of pressure management.
2. The ILI is the outcomes from the system that have appropriate data and determined strategy which manages the active policy of real losses. Since 1999, over 40 countries shown the utilities with ILI in excess of 100 as the ILI values have been calculated for the systems.
3. For any of the water distribution network has certain level of leakage beneath that is not affordable to produce the further investments or the use of further resource availability to impel the reduction of leakage to a greater extent.
4. The variations in the calculations of ILI shows the productive correlation with the connection density, i.e., as density is excessivean ILI is also excessive.
5. Real losses can be sometimes cause severe problems. The losses can remain unrevealed for several months or sometimes even years. The volume that is forfeited in the supply system depends on the characteristic of pipe network &leakage disclosure & the fixedapproachthat is prepared by the efficacy. UARL is useful and important concept because it habituated to forecast the rationalcredibility, the lowest technical annual real losses for the consolidation of certain parameters like main length if pipes, no of connections location of customer meter at the current operating pressure, conceited that the system is in ethical conditionwith certain prominent standard management of losses& there is nor economic neither the financial restraints.

Performance Indicators:-

Following are the main performance indicators used in Infrastructure Leakage Index are as follows:

1. Unavoidable Annual Real Losses
2. Current Annual Real Losses

1. Unavoidable Annual Real Losses:-

The volume of UARL which is the lowest practicallyfeasible annual real losses for a well preserved and well controlled system. UARL are typically defined as the economical, practicallyfeasible, annual real losses for a well-preserved water distribution system, that could be accomplished at ongoing operating pressure, through active leakage control in which all appreciable leaks and explosion are correctedrapidly &adequately.

$$UARL = [18L_m + 0.8N_C + 25L_P] \times P \quad \text{(lit/day)}$$

$$UARL = \left[18\frac{L_m}{N_C} + 0.8 + 25\frac{L_P}{N_C}\right] \times P \quad \text{(lit/service connection/day)}$$

Where,

L_m = Length of main pipe(without service pipes) (km)
N_c = No. of service connection
L_p = Distribution among property line& customer water meter (km)
P = Avg. operating pressure(m)

2. Current Annual Real Losses:-

$$CARL = \frac{\text{Real Losses X } 1000}{T_p} \quad \text{(lit/day)}$$

$$CARL = \frac{\text{Real Losses} \times 1000}{T_P N_C} \quad \text{(lit/service connection/day)}$$

where, T_p = No. of days in WDN is pressurised upto period of water balance calculation
Nc = No. of service connection

Calculations of ILI

Now, Determine Efficiency of Losses in Water Distribution Network of Nagpur, using ILI.
The necessary data required for the calculation of ILI is a technical indicator. The necessary data is collected from DPR on water audit, leak detection & leak reduction for Nagpur Municipal Corporation, Nagpur.
Data:-

- Length of Mains (Lm) = 2100 km
- Length of Primary pipe = 300 km
- Length of Secondary pipe = 1800 km
- No. of Service Connections (Nc) = 231200 Nos
- Total Length of Service Connection (Lp) = 0.01 km
- Avg. Pressure at Supply (P) = 13.5 m
- Number of days in which WDN is pressurized (Tp) = 365 days
- Real Losses = 147.64 MLD

Real Losses,

Real Losses = 147.64 MLD

$$= 53.8886 \times 10^6 \text{ m}^3/\text{year}$$

Average Pressure,
P = 13.5 m

Current Annual Real Losses(CARL),

$$\text{CARL} = \frac{\text{Real Losses} \times 1000}{T_P N_C}$$

$$= 638.581 \text{ lit/service connection/day}$$

Unavoidable Annual Real Losses(UARL),

$$\text{UARL} = \left[18\frac{L_m}{N_C} + 0.8 + 25\frac{L_P}{N_C}\right] \times P$$

$$= 13.007 \text{ lit/service connection/day}$$

Infrastructure Leakage Index(ILI),

$$\text{ILI} = \frac{\text{CARL}}{\text{UARL}} = 49.095$$

ILI is sensitive to pressure, if pressure increased ILI also changes

RESULT & CONCLUSION

The "24 x 7 Water supply project" is one initiative that the NMC carries out. Data from existing surveys like "water audit, leak detection, and leak reduction for NMC" were used by NMC for this study. The NMC improves supply-side efficiency under the 24 x 7 water supply project by renovating the water production facilities and the distribution network and also by enhancing the infrastructure up to the consumer meter for the entire city.

We examined at the "24 x 7 water supply project" case study and collected some data for the project. Also, some essential information that is required to assess efficiency was taken.

According to our calculations, Current Annual Real Losses (CARL) is 638.581 lit/service connection/day, Unavoidable Annual Real Losses (UARL) is 13.007 lit/service connection/day and the ILI is49.095.

We increased the value of the different parameters upto **15 %** which is necessary for the new ILI calculation. There are some variations get occurred in ILI with respect to previous ILI.

we conclude that,

1. Total Length of Mains(Lm) is increase its causes decrease in small amount of value of ILI.
2. Length of Underground Service Pipe (Lp) does not affect the value of ILI.
3. Average Operating Pressure (P) is increase its causes decrease in large amount of value of ILI.
4. Number of Days in which WDN is pressurised (Tp) is decrease its causes increase in large amount of value of ILI.
5. Total Number of service Connection (Nc) is more, hence ILI get Less.
6. Real Losses directly proportional to ILI.

The parameters which **Largely** affected the values of ILI are:

1. Average Operating Pressure (P)
2. Number of Days in which WDN is pressurised (Tp)
3. Total Number of Service Connection (Nc)
4. Real Losses

REFERENCES:

1. NMC 24x7 Water Supply Project. Draft Detailed Project Report by Dinesh Rathi and Associates, 6, Tatya Tope Nagar, West High Court Road, Nagpur – 440 015 [M.S.] India.
2. Detailed Project Report On Water Audit, Leak Detection & Leak Reduction For Nagpur Municipal Corporation Nagpur by Shah Technical Consultants Pvt.Ltd. 407, Raheja Centre, Nariman Point, Mumbai – 400 021 [M.S.] India.
3. Technical Performance Indicators, IWA best practise for water mains and the first steps in Serbia.
4. A Review Of Performance Indicators For Real Losses From Water Supply Systems.
5. Ferrari, G.; Savic, D. Economic performance of DMAs in water distribution systems. Procedia Eng. 2015, 119, 189–195.
6. Ociepa, E.; Molik, R.; Lach, J. Assessment of Water Loss Level on the Example of Selected Distribution Systems. E3S Web Conf. 2018, 44, 00131.
7. Kepa, U.; St ¸epniak, L.; Sta ´nczyk-Mazanek, E.; Przybylski, J. The sustainable management of water supply system. AIP Conf. Proc. 2018, 2022, 2002 .
8. Vairavamoorthy, K.; Mutikanga, H.E.; Sharma, S.K. Methods and Tools for Managing Losses in Water Distribution Systems. J. Water Resour. Plan. Manag. 2013, 139, 166–174.
9. Jin, H.; Piratla, K.R. A resilience-based prioritization scheme for water main rehabilitation. J. Water Supply Res. Technol. 2016, 65, 307–321.

10. Richards, G.L.; Johnson, M.C.; Barfuss, S.L. Apparent losses caused by water meter inaccuracies at ultralow flows. J. Am. Water Work. Assoc. 2010, 102, 123–132.
11. Jung, D.; Kang, D.; Liu, J.; Lansey, K. Improving the rapidity of responses to pipe burst in water distribution systems: A comparison of statistical process control methods. J. Hydroinform. 2015, 17, 307–328.
12. Dohnalik, P.; J ˛edrzejewski, Z. Efficient Water Supply System Operation. Reduction of Water Losses; LEMTECH Konsulting: Kraków, Poland, 2004.
13. Nazif, S.; Karamouz, M.; Tabesh, M.; Moridi, A. Pressure Management Model for Urban Water Distribution Networks. Water Resour. Manag. 2010, 24, 437–458.
14. Siwo´n, Z.; Cie˙zak, J.; Cie˙zak, W. Practical aspects of analyzing water losses in water supply systems. Environ. Prot. 2004, 26, 25–30. (In Polish).
15. Saez-Fernandez, F.J.; González-Gómez, F.; Picazo-Tadeo, A.J. Opportunity Costs of Ensuring Sustainability in Urban Water Services. Int. J. Water Resour. Dev. 2011, 27, 693–708.
16. Arregui, F.J.; Cobacho, R.; Soriano, J.; Jimenez-Redal, R. Calculation Proposal for the Economic Level of Apparent Losses (ELAL) in a Water Supply System. Water 2018, 10, 1809.
17. Fantozzi, M.; Lambert, A.O.; Liemberger, R. Some Examples of European Water Loss Targets, and the Law of Unintended Consequences. In Proceedings of the International Water Association's Water Loss Task Conference, Sao Paulo, Brazil, 6–9 June 2010 .
18. Pietrucha-Urbanik, K.; Studzi´nski, A. Selected Issues of Costs and Failure of Pipes in an Exemplary Water Supply System. Annu. Set Environ. Prot. 2016, 18, 616–627.
19. Carravetta, A.; Conte, M.C.; Antipodi, L. Energy efficiency index for water supply systems. In Proceedings of the 2015 AEIT International Annual Conference (AEIT 2105), Naples, Italy, 14–16 October 2015.