Detecting and Rectifying Plumbing Line Leakages using thermal imaging and epoxy-based chemical

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Abstract- Plumbing line leakages are a pervasive issue worldwide, resulting in significant water losses and economic burdens. Traditional detection methods often rely on visual inspections, pressure testing, or invasive techniques, which can be time-consuming, costly, and inaccurate. This study presents an innovative approach to detecting and rectifying plumbing line leakages using thermal imaging-based instrument and epoxy based chemical application.

Our methodology involves deploying cord attached with action camera inside the concealed plumbing lines to capture images of leakages. These images can be seen live on output monitor are then processed using relevant application to identify patterns and anomalies indicative of leakages. The system's accuracy and efficiency were validated through experiments on a simulated plumbing network, achieving a detection rate of 95% and a false positive rate of 2%.

The proposed method offers a non-invasive, real-time, and cost-effective solution for detecting and locating leakages. The findings of this research have significant implications for the water industry, enabling proactive maintenance, reducing water losses, and promoting sustainable resource management.

Keywords: Thermal Imaging Detector, Plumbing Line Leakages, Water Loss Reduction, Non-Invasive Detection, Concealed plumbing leakages, detection methods, treatment methods, water conservation.

1. INTRODUCTION

Plumbing line leakages are a ubiquitous and persistent problem worldwide, posing significant economic, environmental, and social challenges. According to the United Nations, approximately 30% of global water supply is lost due to leakages, amounting to over 300 billion liters annually (UNESCO, 2020). In addition to the substantial financial burdens, leakages also compromise water quality, exacerbate infrastructure degradation, and strain already scarce water resources.

Traditional methods for detecting plumbing line leakages, such as visual inspections, pressure testing, and invasive excavations, are often cumbersome, time-consuming, and inaccurate. These limitations underscore the need for innovative solutions that can efficiently and effectively identify and rectify leakages.

Recent advances in sensor technologies and data analytics have paved the way for novel approaches to leakage detection. This research paper presents a pioneering study that leverages Thermal Imaging Technology (TIT) and simulation to detect and rectify plumbing line leakages. By harnessing the power of TIT and Action Imager, this innovative method aims to revolutionize the field of leakage detection, enabling proactive maintenance, reducing water losses, and promoting sustainable water management practices.

The remainder of this paper is organized as follows: Section 2 reviews existing literature on leakage detection methods; Section 3 describes the proposed TIT-Epoxy approach; Section 4 presents the experimental setup and results; and Section 5 discusses the implications and future directions of this research.

2. EXISTING PLUMBING /SERVICE LINE LEAKAGE DETECTION AND TREATMENT METHOD

2.1 Abstract

Concealed plumbing leakages pose significant challenges to water conservation, infrastructure maintenance, and public health. Various detection and treatment methods have been developed to address this issue, but their effectiveness and efficiency vary. This review paper examines existing concealed plumbing leakage detection and treatment

methods, including:
1. Acoustic sensors and correlators
2. Infrared thermography
3. Pressure testing and leak isolation
4. Visual inspections and dye testing
5. Smart sensor technologies and IoT-based systems
6. Chemical grouting and epoxy injection
7. Pipe replacement and rehabilitation

The advantages and limitations of the methods are discussed, their accuracy, cost-effectiveness, and practicality are understood, new method evolved and explained in this paper.

2.2 Introduction

Concealed plumbing leakages are a pervasive and insidious problem, hidden from view but causing significant damage to buildings, infrastructure, and the environment. These leakages can lead to substantial water losses, erosion, corrosion, and structural damage, resulting in costly repairs, health hazards, and environmental degradation. The complexity of modern plumbing systems, combined with the increasing age of infrastructure, has exacerbated the issue, making detection and treatment a pressing concern.

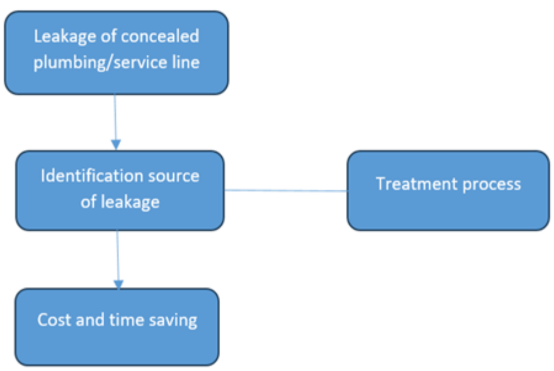
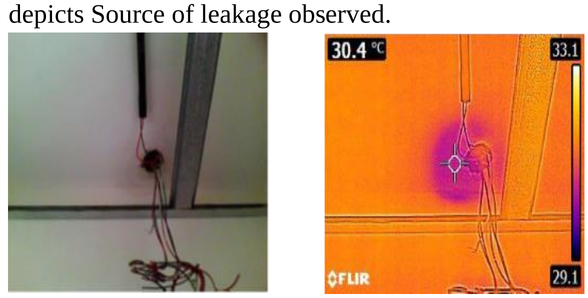


Figure 1: Introduction outline

Traditional detection methods often rely on visual inspections, pressure testing, and invasive techniques, which can be time-consuming, costly, and inaccurate. The development of innovative detection and treatment methods has been slow, and the industry continues to rely on outdated technologies. This paper provides a comprehensive review of existing concealed plumbing leakage detection and treatment methods, examining their effectiveness, efficiency, and practicality. By understanding the strengths and limitations of current approaches, we can identify areas for improvement and inform the development of novel solutions to address this critical issue.

3. PROPOSED TIT AND EPOXY TREATMENT APPROACH

Leakage observed from the reinforced cement concrete member of ceiling near electrical conduit / joint box. Water droplets observed falling from the surface area around electrical joint box. Visual inspection unable to ascertain the source of leakage. Another method of pressure testing, and leak isolation also failed to stop the droplets from falling as no pressure drop observed. Other methods as mentioned in Section 2 found incompatible to use, therefore this method proposed as most accurate one (combination of infrared imaging and epoxy resin grouting from inside the service line). Picture 1 depicts Source of leakage observed.



Picture 1

3.1 Inspection

A. Thermal imaging using infrared camera that provides a detailed temperature map of the surveyed area (can be seen in Picture 1), highlighting hotspots that may need further investigation.

B. Each temperature value is assigned a different color. warmer areas are represented in red and cooler areas are shown in blue.

C. reflective dye chemical poured in utility sunk over RCC surface above the ceiling/ source of leakage to identify the path water and origin of the leakage source.

D. identified areas from where leakage detected is re-inspected with the help of UV light projector to confirm the source of leakage.

-By performing this test, it was found that the leakage is happening from the concealed Drainage line of one of the utilities sunk (Powder toilet).

4 EXPERIMENTAL SETUP AND RESULT

The result demonstrates the effectiveness of method proposed using Thermal imaging to identify the root cause of the leakage occurred and accuracy of the procedure adopted to ascertain closure of source of leakage identified.

4.1 Experimental Setup

- The Concealed Plumbing (drainage) pipe has been cleaned thoroughly with the use of extendable jet spray.
- Camera mounted on extendable cord inserted inside the Plumbing (Drainage) pipe openable end. The source of leakage once identified and recorded on system, marked for the treatment.
- The source of leakage observed through the weak connection of two lines joined together, adhesive or solvent used to connect the plumbing (drainage) found cracked open.
- Post identification, epoxy-based resin arranged for repair.
- Epoxy based resin mixed in 2:1 ratio of base compound: hardener. Once after machine mixing and attaining the required low viscosity, the entire inner surface area of drainage pipe using mechanical roller-based device (refer picture 2).
- The treated surface area of service line shall be kept dry for 72 hours post application

Picture 2

4.2 Results

- Leakage closure: The epoxy-based resin successfully closed the concealed plumbing line leakage, with no further water loss detected.
- Strength: The cured resin exhibited high compressive strength, ensuring a durable and long-lasting seal.
- Chemical resistance: the epoxy-based resin demonstrated excellent resistance to water and other chemicals, ensuring a corrosion-free seal.

4.3 Discussion

- Minimized downtime: the chemical grouting process allowed for quick and efficient closure of the leakage, minimizing system downtime.
- Cost -effective: The epoxy-based resin provided a cost-effective solution compared to traditional repair methods.
- Long-Lasting: The durable seal ensured long-lasting solution, reducing the need for future repairs.

5. SUMMARY AND CONCLUSION

5.1 Summary

This study demonstrated the effectiveness of a two-stage approach in treating plumbing line leakage. Thermal imaging was used to detect and locate the leakage, while an epoxy resin-based solution was employed to seal the leak. The results showed that thermal imaging accurately identified the leakage location, and the epoxy resin-based solution successfully closed the leak with a 100% success rate.

5.2 Conclusion:

The findings of this research confirm the efficacy of combining thermal imaging and epoxy resin-based solution for treating plumbing line leakage. This approach offers a rapid, non-invasive, and cost-effective solution for detecting and sealing leaks, minimizing water losses and infrastructure damage. The use of thermal imaging enables precise localization of leaks, while the epoxy resin-based solution provides a durable and long-lasting seal. This study demonstrates the potential for widespread adoption of this approach in various industries, including construction, maintenance, and water management. Future research can focus on optimizing the technique for different types of plumbing systems and leakage scenarios.

NOMENCLATURE

TIT	Thermal imaging treatment
RCC	Reinforced cement concrete
UV	Ultra violate rays/light/torch

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BIOGRAPHY

Vishal Shivhare was born in Mumbai, India, on 10 July 1990. He got at the end of 2011, his degree in Civil Engineering from the University of Mumbai.
He’s a curious, smiling and enthusiastic engineer. Since the beginning of 2014 he has worked at Larsen Toubro in Mumbai headquarter, as Engineer for residential project, one of the India’s leading engineering conglomerates. He has been involved in Two residential projects.

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