BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF MINING & WATER RESOURCES ENGINEERING

WATER RESOURCES ENGINEERING PROGRAMME

A FINAL YEAR PROJECT REPORT

Design and Simulation of an Automatic Water Leakage Detection System in a Pipeline

(A Case of Kansanga Water Supply)

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PROJECT SUPERVISORS

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EXECUTIVE SUMMARY

Water leakage in water distribution systems is a serious problem for many cities and a huge challenge for water utilities. In most water-distribution systems, a large percentage of the water is lost in transit from treatment plants to consumers. Water loss can be attributed to several causes, including leakages, metering errors, public usage such as fire-fighting and pipe flushing, and theft. Leakage is usually the major cause.

This project analyzes and reviews the existing leak detection systems, types of pipes, categories of pipes and analyzes and inspects the likely causes of leakages and bursts in pipes for example Corrosion of internal and external surfaces of pipe network, excessive load/stresses from road traffic, excessive water pressure, water hammer, too old pipes, poor design and mechanical damage.

This research involved collection relevant data concerning Leak Detection Systems, relevant technologies that were used to design, simulate and accomplish the system. The research data collection methods included desk study, consultation, reconnaissance and document review. These were carried out with NWSC officials in order to know what likely causes of the leakages were existing, how efficiently they were determined and how fast the leakages were worked on. This information helped come up with the relevant requirements for the system and the technical information involved in water transportation through pipes so as to come up with a viable system.

The system design depended on the characterization of the parameters which were differences in flow and differences in pressure. The equation of continuity was used for flow and the Bernoulli's equation was used for pressure. The system was divided into three major categories that was the input unit, processing unit and the output unit which was the display unit.

The system was simulated using epanet with a network of pipes to act as the field and the display unit was in Microsoft visual studio. An economic analysis was carried out to prove that the system was economically viable. This was done by comparing the amount of water lost due to leakages turned into revenue as the benefit because it would be saved when the system is implemented and the cost of implementing the system. It was found that the system was economically viable.

Some recommendations considered were that the real position of the leakage be located on the pipe network.

DECLARATION

I Kwesiga Kato Edith, declare that all the material portrayed in this project report is original and has never been submitted in for award of any Degree, certificate, or diploma to any university or institution.

Signature

.....

Date

22nd May, 2015

APPROVAL

This is to certify that the project has been carried out under my supervision and this report is ready for submission to the Board of examiners and senate of Busitema University with my approval.

CO-SUPERVISOR: Mr. MARTIN SSEMBATYA

SIGNATURE: .....

DATE: .....

MAIN SUPERVISOR: Mr. OKETCHO YORONIMO

SIGNATURE: .....

DATE: 22/05/2015

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LIST OF ACRONYMS/ ABBREVIATIONS

API	American Petroleum Institute
DAC	Digital to Analog converter
EPA	Environmental Protection Agency
FV	Future Value
GPR	Ground Penetrating Radar
HDPE	High Density Polyethylene
IRR	Internal Rate of Return
IWSA	International Water Supply Association
LDS	Leakage Detection System
MNF	Minimum Night flow
NPW	Negative Pressure Wave
NWSC	National Water and Sewerage Cooperation
PN	Nominal Pressure
PV	Present Value
PVF	Present Value Factor
WDN	Water Distribution Networks

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CHAPTER ONE: INTRODUCTION

Chapter one entails the background of water usage and how it is distributed in the country and the world at large. It also talks about some water utility parastatal organizations like NWSC which is the major service provider of water in Uganda. It contains the problem statement, objectives, justification, scope and the purpose of the project.

1.1 Background of the Project

Water leakage in drinking water distribution systems is a serious problem for many cities and a huge challenge for water utilities. It is an important issue that is increasingly attracting attention from water industries, governments, and research institutes (Kleiner and Rajani, 2001; Poulakis et al., 2003). Leaks waste both a precious natural resource and money. A large percentage of water usually is lost from the distribution systems in transit from the treatment plant to the consumer. According to an inquiry made by the International Water Supply Association (IWSA), the amount of lost or unaccounted for water is typically 20 to 30 percent of total water production. Some distribution systems, mostly older ones, may lose as much as 50 percent.

Leakages occur in different components of the distribution system: transmission pipes, distribution pipes, service connection pipes, joints, valves, and fire hydrants. This causes many losses in NWSC which is the major water distribution company in Uganda. The company is charged with the responsibility to treat, distribute, test, maintain and control piped potable water. In most areas where NWSC operates, detection of water loss due to leakage from underground distribution pipes represents a major challenge to scientists and engineers. It is not easy to detect a pipe leakage in case it occurs unless a good Samaritan informs the company thus in case not informed, the water will flow over and over till it floods the place and a lot of it will be lost. Thus an automatic leakage detector is necessary to detect any leakages in the pipes to reduce excess and unexpected water losses in pipes.

Water leakage not only results in the waste of good quality water resources, but also leads to a higher risk of drinking water pollution. Furthermore, bursts in main pipelines severely disturb the public order. Therefore, the development of technologies and strategies for detecting, providing advance warning, and controlling water pipeline leakage is crucial for both the water supply companies and the public. (Kishawy and Gabbar, 2010). Leaks if not addressed are such a nuisance, they affect the reputation of an organization negatively, divert precious water from reaching the customers, increase operating costs and are a potential source for contamination of treated safe water, However if addressed, some benefits are realized like reduced Operational

REFERENCES

1) American Water Works Association (AWWA) Water Loss Control Committee. Applying worldwide BMPs in water loss control. J. Am. Water Works Assoc., 95(8), 65-79. (2003).
2) Benkherouf, A. and Allidina, A.Y., .Leak detection and location in a gas pipeline. Institution of Electrical Engineers (IEE) Proceedings. (1988). Vol 135. Pg 142-148.
3) Brunone B., .Transient Test-Based Techniques for Leak Detection in Outfall Pipes. Journal of Water Resources Planning and Management Vol. 125, 302-306 (1999).
4) Brunone B., and Ferrante M., .Detecting leaks in pressurized pipes by means of transients.. Journal of Hydraulic Research, Vol 39. 539-547. (2001).
5) Cesario L., .Modeling, Analysis, and Design of Water Distribution Systems. American Water Works Association, Denver Colorado. (1995).
6) Dr. Stuart L. Scott, Dr. Maria A. Barrufet, 2003 - Worldwide Assessment of Industry Leak Detection Capabilities for Single & Multiphase Pipelines.
7) Environment Canada. (2006). http://www.ec.gc.ca/water/en/info/facts/e_intro.html
8) EPA, "Drinking Water Infrastructure Needs Survey and Assessment," *Third Report to Congress*, 2009
9) Hargesheimer E. E., .Identifying Water Main Leaks With Trihalomethane Tracers. American Water Works Association Journal. Vol 77, Pg 71-75. November (1985).
10) Hunaidi, O., Chu W., Wang A., Guan W., 2000, Detecting leaks in plastic pipes. Journal of American Water Works Association (AWWA). Vol. 92, **2**, pp. 82-94.
11) Hunaidi, O., Chu, W., Wang, A., and Guan, W. Detecting leaks in plastic pipes. *Journal AWWA*, 92:2:82-94, American Water Works Association, 2000.
12) Kishawy H A, Gabbar H A, 2010. Review of pipeline integrity management practices. *International Journal of Pressure Vessels and Piping*, 87(7): 373–380.
13) Kleiner Y, Rajani B, 2001. Comprehensive review of structural deterioration of water mains: statistical models. *Urban water*, 3(3): pg 131–150.
14) O. Hunaidi, A. Wang, *A new system for locating leaks in urban water distribution pipes*, Management of Environmental Quality: An International Journal, Vol. 17, No. 4, Emerald (2006), pp. 450–466.
15) Tafuri A.N., .Locating Leaks with acoustic technology. American Water Works Association Journal. Vol 92, Pg 57-66. July (2000).
16) Water Quality and Health Council. (2006). http://www.waterandhealth.org/drinkingwater/safewater.html