Oil Leakage and Pilferage Detection in Pipelines Using IOT

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ABSTRACT

Pipelines are widely used for transportation of oil over millions of miles throughout the world. Pipelines are designed to withstand several environmental conditions to ensure safe and reliable transmission of oil from point of production to the distributor. Though there are several preventive measures to prevent leak in pipeline, there are some major causes of innumerable losses in pipeline due to natural calamities and manmade reasons. This incident results in series ecological disasters, disturbance to humans and agriculture lands with also financial lose. To prevent such menace and ensure safe and reliable oil transmission efforts have been devoted to implement oil leakage detection and pilferage in pipelines. Pipeline leakage detection systems are engineering systems used to detect leak of oil from the pipeline, in order to alert the operator in case of leakage incidents. Leak detection is very much essential component of pipeline risk management as it allows the operator to respond within time to the leaks to prevent further incidents. Various technologies are available to detect the leak from pipelines, depending on the nature of the fluid and the leak size. These range from both basic material balance techniques to much more complicated systems. The best technology and application for pipeline leakage detection system is available in the literature. Many leakage detection systems are reviewed and the best and cost-efficient technology is being implemented here using the most emerging IoT Technology.

KEYWORDS: Oil Leak detection; Leakage location; Transportation pipeline; Oil Flow Sensor (OFS), Cloud Storage, IoT.

1. INTRODUCTION

The use of pipeline is consider as major means of conveying oil products that serve as a assets to the economy of the nation it is found that oil pipeline networks are the most essential and safest means of transporting oils and has full-filed a high demand for efficiency and reliability however as transporting oil substances through miles long pipelines has become popular across the globe in decades, the chance of the critical accidents due to pipeline failures increases either intentional or unintentional damages leading to pipeline failures and thus results in irreversible damages which includes economical loses and extreme environmental damages also. Leakage observance techniques are the main focus of researchers throughout the globe in conjunction with the development of pipelines since run of pipeline may be a crucial downside Within the oil and industry. As a result of it should end in nice economic loss yet as environmental pollution, there's abundant interest in police work the run space and locating the leak purpose exactly.
At this time, some physical strategies like metallic element gradient technique, negative pressure wave technique, flow equalisation technique and supersonic guided wave technique, yet as some chemical strategies, are with success applied in pipeline run observance. At the present time, some physical methods like baric gradient, negative pressure wave, flow balancing method and ultrasonic guided wave, as well as some chemical methods, have been successfully applied in pipeline leakage monitoring. Leak detection is done using Internet of things (IOT). The Internet of things, refers to the billions of physical devices around the world that are now connected to the internet, collecting and sharing data. With the introduction of IOT has improved the pipeline leakage detection system by the real time monitoring of pipelines. With the highly advanced sensors and effective pipeline management, IOT in oil and gas industry can save around $18 million in total revenue. The implementation of IOT in oil pipelines to form a sustainable business model enables the industry to make real time decision, reduce equipment failures, increase safety, minimize downtime and reduce wastage, resulting in complete plant automation. An LDS must ensure that the loss of oil as a result of leak is as small as possible. These places two requirements on the system: It must detect small leaks, and it must detect them quickly.

A. RELIABILITY: The user must be able to trust the LDS. This means that it must correctly report any real alarms, but is quickly important that it does not generate false alarms.

B. ACCURACY: Some LDS are able to calculate leak flow and leak location. This must be done accurately.

C. ROBUSTNESS: The LDS should continue to operate in non-ideal circumstances. For example, in case of transducer failure, the system should detect the failure and continue to operate (possible with necessary compromises such as reduced sensitivity). During steady state conditions the flow pressures etc., in the pipeline are constant over time. During transient conditions, these variables may change rapidly. The changes propagate like waves through the pipeline with the speed of sound of the fluid. Transient conditions occur in pipeline for example at start up, if the pressure at inlet or outlet changes and when a batch changes are when multiple products are in the pipeline. In liquid pipeline transient effects cannot be disregarded most of the time. LDS should allow for detection of leaks for both conditions to provide leak detection during the entire operating time of the pipeline.

D. LITERATURE SURVEY

Previous research on Oil pipeline monitoring and detection in oil pipes have been conducted before. Various methods for pipeline leakage detection are classified as three methods.

Fig.1. works proposed for Leakage detection methods

Exterior methods such as Acoustic sensing, Accelerometer, Fiber optic sensing, Vapour sensing, Infrared thermography, Ground penetration, Fluorescence, Electro mechanical impedance, Capacitive sensing and other methods. Visual/Biological methods such as AUV/drone, Trained dog or human, Visual based bolted joints monitoring. Interior/Computational methods such as Mass/volume, Negative pressure, Pressure point analysis, Digital signal, Dynamic modelling, State estimator.
I. ACOUSTIC SENSING:
Detects leak by picking up intrinsic signals escaping from a perforated pipeline. It is easy to install and suitable for early detection, portable and cost efficient. The weakness of this method includes sensitive to random and environmental noise, prone to false alarms and not suitable for small leaks.

II. LIDAR SYSTEMS:
It works on the principle of employed pulse laser as the illumination source for methane detection. It is able to detect leaks in the absence of temperature variation between gas and the surroundings. It disadvantage is high cost of execution and false alarm rate.

III. FIBRE OPTIC SENSING:
Detects leaks through the identification of temperature changes in the optical property of the cable induced by the presence of leakage. It is insensitive to electromagnetic noise and the optical fibre can act as both sensor and data transmission medium. Its weakness includes cost of implementation and not applicable for pipelines protected by cathodic protection system.

IV. VAPOUR SAMPLING:
It utilises the hydrocarbon vapour diffused into the sensor tube to detect trace concentrations of specific hydrocarbon compounds. It is used to detect small leaks also. Time taken to detect the leak is so long.

V. INFRARED THERMOGRAPHY:
Detects leak using infrared image techniques for detecting temperature variations in pipelines. It is highly efficient in detecting in objects and has high response time. It is not useful for smaller pipes.

VI. VISUAL/BIOLOGICAL METHODS:
Visual/biological methods of detecting leakages refers to the traditional process of detecting oil spillage in pipeline surrounding using trained dog, experienced persons, smart pigging and helicopter or drones etc., It is very slow process and involves more man power to find the location of the leakage.

VII. MASS/VOLUME:
This method utilises the discrepancy between the upstream and downstream fluid mass volume for determining the leakage. It is low cost portable and insensitive to noise. It cannot identify the location.

VIII. NEGATIVE PRESSURE:
It utilises negative pressure waves propagated due to pressure drops as a result of leakage. It has fast response time and suitable for leak localisation. It is only effective for large instantaneous leaks.

IX. PRESSURE POINT ANALYSIS:
It monitors the pressure variation at different points within the pipeline system. It is appropriate for underwater environments, cold climates and adequately functioning under diverse flow conditions. Leak detection is challenging in batch processes where valves are opened and closed simultaneously.

X. DIGITAL SIGNAL PROCESSING:
It utilises extracted signal features such as amplitude, frequency wavelet transforms coefficients, etc. from acquired data. Good performance, suitable for detecting and locating leak positions. Easily prone to false alarms, and can be masked by noise. Various analysis had be done on the previously existing models and their advantages are spotted here in table1.1. There are various disadvantages existing here and those are about to overcome in our method of leakage detection.
Table 1.1. Summary of Disadvantages Existing Works

<table>
<thead>
<tr>
<th>S.NO</th>
<th>METHOD NAME</th>
<th>SENSITIVITY</th>
<th>RELIABILITY</th>
<th>ACCURACY</th>
<th>ROBUSTNESS</th>
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<td>LIDAR SYSTEMS</td>
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<td>INFRARED THERMOGRAPHY</td>
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<td>MASS/ VOLUME</td>
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<td>DIGITAL SIGNAL PROCESSING</td>
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</table>

2. PROPOSED SYSTEM

This shows data retrieved by the sensor and then transmitted by to the monitoring application system using the Arduino Ethernet shield. The process starts from the oil that flow in the pipeline and through the liquid flow meter sensor () placed at the various locations of the pipeline in the particular range along with some valves at regular intervals. The sensors then will collect the data from the Oil which flows through it, and will send to the Arduino has some pins that serves as a place for data processing and power input. Flow liquid meter sensor will transmit data to the Arduino via cloud then Arduino calculate oil flow per second based on this data. The obtained data will be stored in a cloud storage first then it will be immediately sent to the real time monitoring application. Data from Arduino is stored to local host server on the PC via an Ethernet shield, an additional module used to establish connection to the PC by accessing PC’s IP address. When connection is established, Arduino will access the PC and send data using the POST method. Stackable Ethernet shield will be directly connected to the PC using the RJ-45.

3. WORKING MODEL

Oil is being transferred to a very long distance from the source of oil extraction to the area of processing or the processed oil is being supplied to various locations through pipelines. This model describes the leakage detection in those pipelines and intimate to the supplier and the receiver instantly. An oil flow sensor (sensor name) is being placed along the pipeline at a particular distance based on the length of the pipeline. A valve used to open and close of oil supply is also being placed along with the flow sensors to automatically close in case of leakage detection. The sensor is named as sensor1 sensor2 etc., and the value is also named simultaneously. Now oil is being supplied through the pipeline. The flow sensor continuously monitors the oil flow rate and updates it. When there is a leakage in the pipeline, the sensor value tends to change somewhere in between two sensors and the message to the supplier and receiver is send that the leakage is being identified between these two sensors and the value that is fixed in the supply side is automatically closed and also the main supply is...
also closed. After getting the detection message human intervention is needed to fix the leakage at that exact location. Once after leakage is being fixed the valves are opened and let the pipeline for the oil supply again.

4. RESULT AND CONCLUSION
In this paper using IoT technology, leakage detection is done by sensors and the after analysing the sensor values the result is being intimated to the supplier as well as the receiver using GSM module through message.

The performances of various pipeline leakage detection methods are next compared using two-level performance analysis. System accuracy, system mode of operation, leak localisation, leak size estimation, ease of usage and ease of retrofitting are the criteria employed to evaluate the performance of the reviewed methods using scale from 0 to 1. Table 3 shows a summary of the comparison. Among all the methods IoT using sensors which is being implemented now is more efficient and accurate for the detection of leakage. This survey paper provides a rudimentary reference to guide readers in selecting an appropriate leak detection technology for a particular setting. In this paper, a comprehensive survey of various available pipeline leakage detection and localisation methods was carried out. A summary of what has been demonstrated to date is presented, along with research gaps and open issues that require attention in this research domain. A wide variety of pipeline leak detection approaches was reviewed and grouped into three different categories.

Fig.3. RESULTS OF WORK PROPOSED

REFERENCES


