Journal of Farayandno – Vol. 18 – No. 84. (2024): pp. 99-112

National Iranian Oil Refining and Distribution Company (NIORDC)

Journal of Farayandno

Review Paper

Simulating the occurrence of a leak in the 22-inch oil pipeline and comparing the accuracy of different leak detection methods

Mohsen Shahabi[1*] , Mohammad Ali Fallah[2]

[1] Senior Expert in Energy Systems Engineering, Head of oil pumping station, North East region, Iran Oil Pipelines and Telecommunications Company

[2] Senior Expert in Energy Conversion Engineerin, Operations Manager, Shahroud Oil Pump Station, Iran Oil Pipelines and Telecommunications Company

Received: 1 Sep 2023 **Accepted:** 4 Feb 2024

1. ABSTRACT

In the upcoming study, the oil products pipeline is modeled by Pipeline Studio software, the equipment needed to remove fluid from the pipe has been installed at different points of the pipeline, and a number of ten removal tests have been performed. In each test, the operational data related to the pipeline and other data are recorded and the results of each stage of the tests are compared with the outputs of the software model. In the following, two methods to identify the location of the leak in the pipeline including negative pressure waves and the intersection of the hydraulic gradient have been introduced and they have been used to calculate the location of the leak in the tests. The calculation results showed that both methods had acceptable accuracy in finding the leak location, but the comparison of the two methods showed that negative pressure waves had a better performance (11% error vs. 18%) in estimating the leak location.

The high correspondence between the diagrams extracted from the software and the real conditions ensures that the Pipeline Studio software can be used not only in the pipeline design phase but also in the analysis of operational changes and its results in a better understanding. Flow in the pipeline and other calculations of utilization.

Keywords: Leak Detection, Negative Pressure Waves, Hydraulic Gradient Line, Oil Transmission, Pipeline Studio.

2. INTRODUCTION

Until today, it was possible to determine the location of pipeline leaks in the country by calculation only in the condition that the leak is done in a static state (stopping) of the pipeline, otherwise, portable flow transmitters are used to limit the pipeline parts and reduce the inspection area. In the upcoming study, real experimental tests related to leakage from the pipeline were simulated by software, and then two methods were used to identify the location of the leak and the efficiency of each method was evaluated. These methods can be a good substitute for the previous methods. Pipeline Studio software version 4.4 was used for simulation.

3. Negative pressure waves

When a leak occurs, it causes a change in pressure and flow rate, which leads to a momentary pressure drop and a change in speed along the pipeline, and it occurs as an instantaneous pressure drop, creating a negative pressure wave at the location of the leak and the wave It spreads to the upstream and downstream ends of the pipe at a certain speed. By analyzing the signal of this wave, it is used to determine the location of the leak based on the time difference when the waves reach the end of the pipeline.Note: For the tests of which results are detailed in this abstract, the characterization methods used must be mentioned in this section [1].

3.1. Experimental method of calculating negative pressure wave speed in oil pipelines

Considering that this study was conducted on a 22-inch pipeline of petroleum products, therefore, to calculate the speed of the negative pressure wave, an innovative method was used in such a way that the setting point of the control valve at the destination of the pipeline was increased by 10 psi. And its velocity has been calculated by recording the time it took the pressure wave to reach the origin of the line, then by dividing the length of the pipeline by the recorded time difference, the velocity of the wave has been calculated as 1074 m⁄sec.

* mohsenshahabi2@gmail.com

Please Cite This Article Using:

Shahabi, M., Fallah, M.A., "Simulating the Occurrence of a Leak in the 22-inch Oil Pipeline and Comparing the Accuracy of Different Leak Detection Methods", Journal of Farayandno – Vol. 18 – No. 84, pp. 99-112, In Persian, (2024).

4. Hydraulic pressure gradient

The pressure in the pipeline is constantly dropping due to friction. The pressure changes are known as the hydraulic pressure gradient in the pipeline and it is a graphical representation of the pressure changes along the pipeline, which is shown along with the height characteristics of the pipeline [2], considering that the height is usually drawn in meters. It is easier to show the pressure in terms of meters of fluid column and the gradient line is drawn as a gradient head.In case of leakage in the pipeline, the gradient line is divided into two parts with different slopes before and after the leakage position, and the intersection of these two graphs is the leakage position.

5. Actual withdrawal tests from the pipeline

The number of ten stages of the actual test of withdrawal from the pipeline was carried out in such a way that at certain points of the active pipeline, by installing equipment on the pipe, some of the fluid in the pipe was withdrawn, the withdrawal time and withdrawal volume and other operational data were recorded. And for each test, the pipeline and oil transfer centers are modeled by Pipeline Studio and the outputs, including pressure and flow rate changes in the centers and the displacement time of negative pressure waves, have been examined and compared. In the end, the geographical location of the harvest is considered as an unknown factor and the location of the harvest has been identified by two methods of negative pressure waves and the intersection of hydraulic pivot lines.

5.1 Software simulation

Test number 1 is modeled by software. The initial initial conditions are shown schematically in "Figure1". It has been shown.

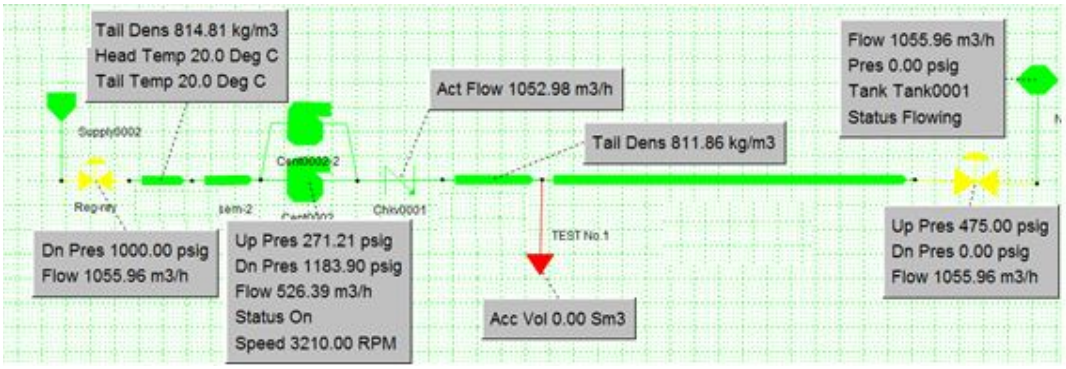

Figure 1. Test number 1 is modeled by software

6. CONCLUSION

The comparison of the results obtained from the actual sampling of the pipeline and the software simulation shows the good accuracy of the software in simulating operational changes in the pipeline, the high correspondence of the diagrams extracted from the software and the real conditions of this assurance. It creates that the Pipeline Studio software can be used not only in the pipeline design phase but also in the analysis of operational changes and its results can be used to better understand the flow in the pipeline and other calculations.

The results of the study showed that using each of the methods of negative pressure waves and interruption of hydraulic gradient lines, it is possible to estimate the location of the leak (or withdrawal) from the pipeline, using the hydraulic gradient line and combining it with Pipeline Studio simulation was used for the first time in this study and had acceptable results in finding the leak location. In the conducted tests, the negative pressure wave method has better calculation accuracy, but they are very sensitive to the correct recording of the time of changes after the leak, and every second error in recording the time leads to about 1000 meters of error in calculating the position, the accuracy of this method In the performed tests, it was 10.7%. The hydraulic gradient line interception method has also correctly estimated the extent of the leakage (or withdrawal), the average error in this method was 18.3%, some of which was due to the limitation in withdrawal tests from the pipeline, which should be done for operational reasons and Safety risks will end in a short time. This limitation has caused the pipeline to transient condition.

7. REFERENCES

[1] Adegboye, M.A.; Fung, W.-K.; Karnik, A., Recent Advances in Pipeline Monitoring and Oil Leakage Detection Technologies: Principles and Approaches, Sensors 2019, 19, 2548.

[2] E. Shashi Menon, Liquid Pipeline Hydraulics Book, Second Edition, 2013.