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Modeling and Optimization of Operational-Energy of Sabzevar-Mashhad Petroleum Products Pipeline by Using Pressure Monitoring Equipment in Imam Taghi Oil Pump Station

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1. ABSTRACT

By using satellite geographic data, the control point of the Sabzevar-Mashhad pipeline has been identified. This point is located near Imam Taghi oil pump station, there is a pressure transmitter in this station. Using the results of pipeline modeling with related software, necessary calculations for placing the transmitter as a basis for pressure control in this pipeline have been done. The current state of operation and its distance to the optimal conditions are investigated and the improvement potentials are identified. In the current method of operation, the pressure at the control point is performed by performing hydraulic calculations on the profile map of the pipeline, which has led to the existence of additional pressure at the control point due to the error in this method. With the proposed operation method of this study and the continuous monitoring and control of the pressure in this pipeline using the pressure transmitter in Imam Taghi center, as an alternative solution for pressure calculations by pipeline profile maps, it is possible to use the power consumption Similarly, there was an increase in the capacity of this pipeline up to 230 million liters per year, and it is also possible to save up to 593000 m^3 of natural gas with the same transfer volume. Using this method reduces the working hours of Sabzevar turbo pumps up to 574 hours per year.

Keywords: Oil Pumping Station, Pipeline, Energy Saving, Pipeline Control Point

2. INTRODUCTION

Currently, the energy saving potential in oil transmission lines is 0.16 million barrels of crude oil per year, which is equivalent to the reduction of 0.06 million tons of CO_2 per year [1]. The extent, pressure breakers and terminal facilities has turned the country's oil transmission network into one of the most energy consumption intensive industries, this transmission network it has a significant saving capacity that can be exploited by using more accurate control systems and benefiting from new technologies [2].

In order to provide enough power to transfer oil in pipes, pumping stations are placed at certain distances depending on the flow rate and geographical location of the transmission line. These stations are divided into two main types of electropumps or turbopumps.

The oil and gas pipeline sector is one of the most consumed cases in the field of energy, which requires more management to improve energy efficiency and reduce emission levels. One of the potential opportunities for improving energy management is the optimal control of the working pressure of liquid pipelines during pumping operations.

The factors that determine the working pressure of the pipeline can be examined from two points of view, one is the minimum working pressure at the control point and the other is the maximum working pressure of the pipeline. The forces resulting from pressure increase are defined in working conditions, but the minimum working pressure is defined at the control point to protect the pipe against the cavitation phenomenon.

Until now, the importance of pressure control in pipelines for pipeline operators has been important only from the point of view of preventing the phenomenon of cavitation and consequently the internal corrosion of the pipe and preventing the occurrence of compressive stresses. But the third point of view, which is also the aim of this study, is the effect of

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proper monitoring and control of the pressure of the liquid transmission lines on the energy consumption of the pumping station and the carrying capacity of the pipeline, which we will explain in the rest of the study.

Until today, the control points in the oil pipelines due to passing through difficult and desert areas lack precision instruments for pressure monitoring. Operation and energy of the pipeline was not seen as a requirement for the installation of this equipment either. The conventional method for pressure monitoring in pipelines is to use the hydraulic level line in the profile maps of the pipelines. that in a study entitled reducing the energy consumption of oil pumping stations by using the mechanism to control the operational pressure of transmission lines [3], it has been determined that this method, especially in long oil transmission lines with several working fluids with a large head difference, has a significant error It has an effect that leads to increase or decrease of pressure in control points. In other studies in domestic and foreign articles, the above calculation error in calculating the pressure at the control point has not been mentioned and its consequences have not been studied.

In addition to identifying the factors required in determining the working pressure of pipelines and examining the current method of monitoring the pressure of the pipelines, the upcoming research examines the effect of correct pressure monitoring at the control points of the liquid transfer pipelines on energy consumption and carrying capacity and, as possible, The measurement of the use of the input pressure transmitter of Imam Taghi transmission center to control the pressure of the Sabzevar-Mashhad line.

3. System structure and modeling

Sabzevar-Mashhad pipeline and the main equipment of the line, including turbopumps and control valves, have been modeled by Pipeline Studio (TL.Net) software. A simple diagram of the pipeline profile and hydraulic gradient is shown in "Figure 4". L is the horizontal distance between the position of the pressure transmitter and the control point, A is the required head at the control point, C is the head corresponding to the control point at the transmitter position, and D is the head difference between the transmitter position and the control point. When the pipeline is active, the slope of the hydraulic gradient line, which indicates the amount of head at any point of the pipeline, changes according to the operating conditions of the line, as the flow rate in the pipeline increases, the slope of the gradient line (angle ϴ) increases and vice versa, so it is possible to first calculate the maximum flow rate of the line and then the maximum angle ϴ. In this condition, there are the most frictional losses in the line.

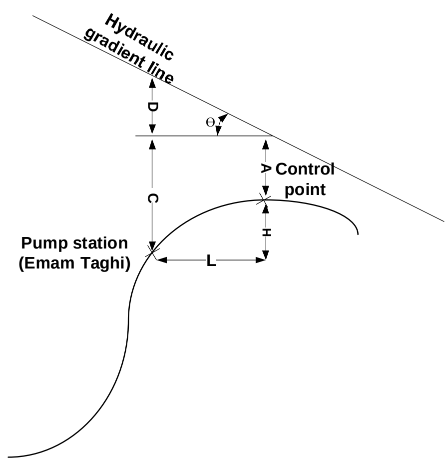

Figure 1. A simple diagram of the line profile in a dynamic state

3.1. Simulation calculations

To calculate the conditions of maximum flow, it is assumed that the center of Sabzevar is in the condition of maximum speed and up to the limit of the maximum output pressure protection switch (psi 1400 and flow rate equivalent to m^3⁄hr 1100, which due to the limitation of pump speed, it is not possible for the line to work at this flow rate) and the control valve of the Mashhad facility is opened as much as possible until the pressure at the control point reaches zero. In this way, the maximum flow rate and the maximum slope of the hydraulic gradient are obtained without the occurrence of flow separation at the control point. Considering this situation, the software model is implemented with oil-gas fluid and the hydraulic diagram corresponding to these conditions is drawn in "Figure 2". The modeling results showed that in the conditions of maximum flow, the maximum pressure difference calculated between the transmitter of Imam Taghi center and the control point is 61 psi. To verify the accuracy of the calculations, a pressure gauge was temporarily installed at the control point of the pipeline. In different operating conditions, the maximum pressure difference shown by the gauge at the control point and the pressure transmitter at Imam Taqi Center was read as 50 psi, and the accuracy of the calculations was confirmed by it confirms the modeling.

Figure 2. Pipeline hydraulic diagram

Then, using the software model of the pipeline and the main equipment of the pumping station and oil facilities, the effect of pressure increase at the control point on energy consumption and response to consumption demand has been investigated. Calculations showed that an increase of 1 psi of pressure at the control point causes an increase of 92300 kwhr in energy consumption due to changes in specific energy and a decrease in pumping flow rate in one year.

4. CONCLUSION

In this study, it was shown that for more accurate pressure monitoring at the control point of Sabzevar-Mashhad oil products pipeline, instead of using a hydraulic level line, it is possible to use the input pressure transmitter of Imam Taqi center and the conversion factor calculated by the model. Sazi used. In this way, by adjusting the pressure at the control point, the pipeline can be operated in such a way that it is far enough from cavitation and is in optimal conditions in terms of energy consumption. According to the current operating conditions, improvement potentials have also been calculated. Therefore, by modifying the operating procedures in the form of continuous monitoring and control of the pressure at the control point of this part of the pipeline using a pressure transmitter in the Imam Taghi transmission center as an alternative solution for performing pressure calculations using pipeline profile maps, Power:

- With the same energy consumption capacity up to 230 million liters per year, there was an increase in capacity in this part of the line.
- It is possible to save up to 593000 m^3 of natural gas with the same transfer volume.
- The value of fuel saved at the price of natural gas in Turkey is equal to 156,000 $.
- Operation with this method has reduced the operating hours of Sabzevar turbopumps by 574 hours per year, which in turn has reduced the cost of maintenance and overhauls.
- The results of this study can be used in other liquid transmission pipelines in the country to increase the transmission capacity and optimal energy consumption.

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