ISSN: 2664-9640

Application of Olga Software in Oil and Gas Pipeline Design and Calculation

Ding Wang, Jiahao Wang

College of petroleum Engineering, Xi'an Shiyou University, Xi'an, 710065, Shaanxi, China.

Abstract

With the development of large-scale oil and gas exploitation and pipeline transportation, flow assurance has been paid more and more attention in the oil industry. As a multiphase flow transient simulation software, the steady-state simulation contained in OLGA is also of great significance in flow assurance. OLGA is widely used in complex flow process research and engineering design. This paper mainly introduces the application of OLGA steady-state simulation in various oil pipeline transportation systems, and puts forward the method of steady-state analysis of oil pipeline transportation system.

Keywords

Oil pipeline transportation, steady-state simulation, flow assurance , OLGA.

1. Introduction

Pipeline transportation is an important part of the oil production process and the artery of the oil industry. In the production, processing and sales of oil, pipeline is indispensable from beginning to end. At present, with the intensification of economic globalization and the increasing demand for energy by science and technology, less crude oil transportation loss has become a major test for storage and transportation workers. Compared with trains, ships, cars and other transportation modes, long-distance pipeline transportation has the advantages of low transportation cost, less energy consumption loss, strong continuous working ability, high degree of automation, easy remote control, and low one-time investment cost. Therefore, the comprehensive construction and optimization design of long-distance hot oil pipeline will become an inevitable trend[1].

In this paper, a crude oil pipeline in a province in eastern China is studied. The pipeline is used to transport offshore oil tankers from a port to inland refineries, and the annual pipeline throughput is 20 million tons per year. The total length of the pipeline is 305Km, and there is a slight fluctuation along the pipeline. The pipeline laying area belongs to the Archean Jiaodong Group, which is widely distributed in the northern Shandong Peninsula and constitutes the ancient crystalline basement of the Jiaobei uplift. The pipeline is located in the warm temperate monsoon region continental climate, spring drought, summer hot and rainy, autumn cool and dry, cold winter snow. Pipeline needs to transport No.1, No.2, No.3 three kinds of crude oil, three kinds of oil storage and transportation, pipeline transportation can have a small amount of mixing. Since No. 1 crude oil is heavy oil, the temperature has a great influence on the viscosity in the flow process. The higher the temperature is, the smaller the viscosity is. At the same time, the oil temperature cannot be higher than the initial distillation point of crude oil. Considering comprehensively, heating transportation is adopted in the transportation of crude oil No. 1, and the outlet temperature of each heating station is 80 ℃.

The steady-state simulation is carried out by OLGA software, and the pipeline size is selected to simulate the pressure in the steady-state process of the pipeline to ensure that the pipeline runs in the maximum allowable pressure range. At the same time, the temperature change along the pipeline is simulated to determine whether the pipeline needs to be heated. The elevation data

ISSN: 2664-9640

map of the pipeline is drawn and the anticorrosion layer and insulation layer of the pipeline with primary diameter are selected, so that the pipeline can meet the needs of oil transportation tasks under various conditions.

2. Pipeline size selection

Firstly, the OLGA software is used to analyze the elevation data in the pipeline. From Figure 1, we can see that the high and low fluctuations along the pipeline are relatively severe, so the decrease of pressure and temperature along the pipeline will also change with the elevation.

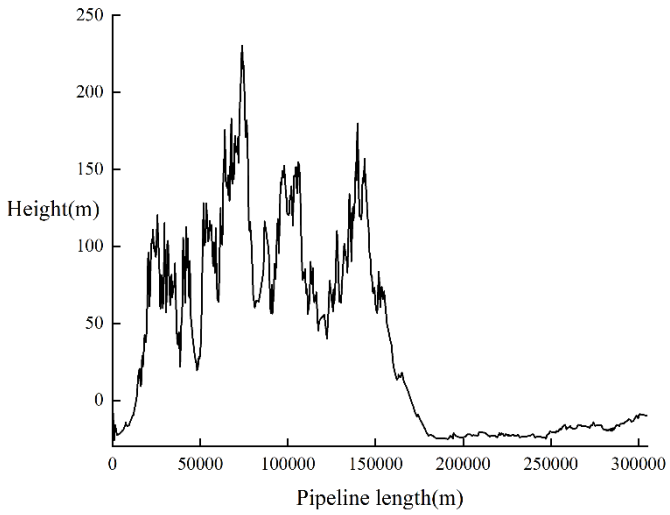

Figure 1: Height data graph in pipeline

Parameter Studies function of OLGA software is used to simulate the changes of pipeline pressure with different diameters as the output, as shown in Figure 2.

The maximum output of the oilfield is 20 million tons per year. It can be seen from Figure 2 that if only one pipeline is laid, the pipeline with diameter of 28 inch, 29 inch, 30 inch, 32 inch and 34 inch is preliminarily selected under the condition of meeting the design pressure. This pipeline has a large diameter. Firstly, the appropriate economic flow rate is selected according to the input, and then the pipe diameter is calculated by the economic flow rate. In order to confirm whether it meets the requirements of operating pressure, OLGA software is used to simulate the full length of the pipeline. It can be seen from Figure 2 that the 32 inch pipeline meets the requirements of design pressure and maximum allowable pressure[3].The wall thickness is calculated according to the wall thickness formula, and then the calculated wall thickness is rounded up to the standard wall thickness. Through calculation, the wall thickness is finally selected as 7.14 mm.

No.1 crude oil is a heavy oil, non-Newtonian fluid. So only the pipeline designed according to the flow of No. 1 crude oil alone in the pipeline can meet the other two kinds of crude oil, from the above we choose 32 inch pipeline, namely 813 mm diameter spiral seam submerged arc welded steel pipe. The pressure and economic output of the main pipeline are calculated from the above data, and different centrifugal pumps are selected to provide power for the pipeline.

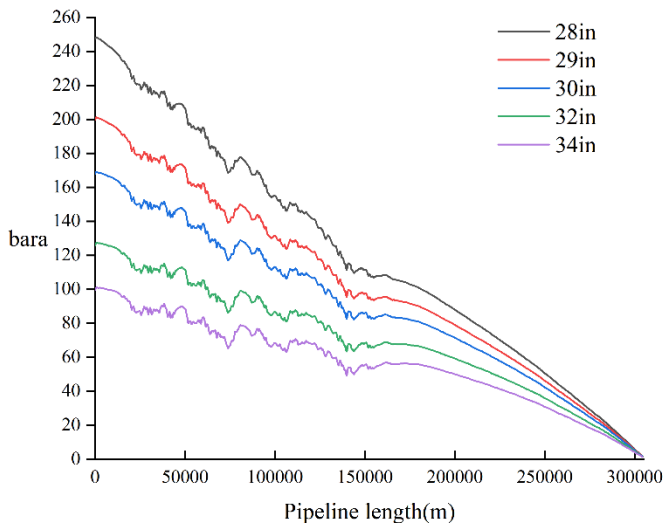

Figure 2: Pressure drop diagram of pipelines with different diameters

Then OLGA software is used to simulate the pipeline temperature change. The inlet temperature is set to 80 °C, and the simulation of 5 different pipe diameters is carried out. It can be seen from Figure 3 that the 32 inch pipeline is the best choice in the case of economic permit.

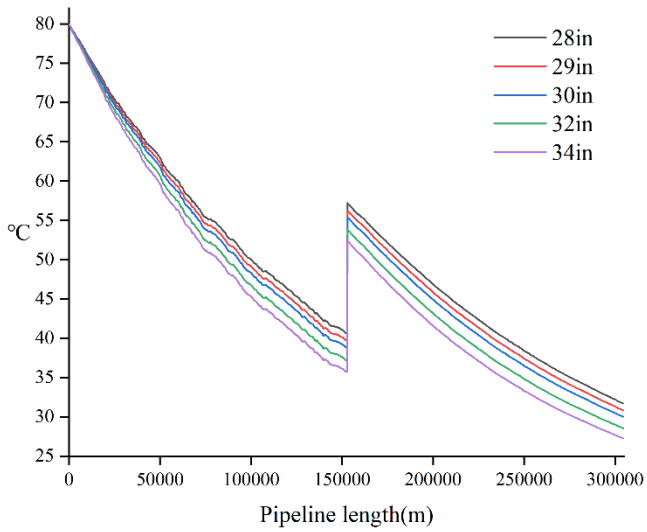

Figure 3: Temperature Drop Diagram of Pipelines with Different Diameter

3. Thermal calculation of pipeline

Anticorrosive coatings are the main barrier for pipeline protection. The selection of anticorrosive coatings should be based on the terrain and soil conditions of the specific pipeline laying environment and the use of mature anticorrosive coatings worldwide. The materials with reliable technology, reasonable economy, convenient management and maintenance and strong adaptability in site construction are selected to prevent irreversible corrosion of pipelines in long-term use. At present, the common anti-corrosion technology of pipeline outer wall in the world are petroleum asphalt anti-corrosion, three-layer PE structure anti-corrosion, polyethylene tape anti-corrosion, etc. The following are the advantages and disadvantages of the three preservative materials :

three-layer PE is formed by the combination of epoxy resin and extruded polyethylene coating. The advantages of two-layer PE and fused epoxy are integrated, and their shortcomings are overcome. The three-layer PE has various excellent properties and wider adaptability. The

corrosion resistance of the pipeline is further improved, and the service life of the pipeline is improved, but the cost is high.

The main advantages of petroleum asphalt anticorrosion are simple prefabrication technology, mature construction technology, rich experience, low cost, strong construction adaptability, but large water absorption, poor aging resistance, not resistant to bacteria, which is a relatively backward anticorrosion technology.

Polyethylene adhesive tape anticorrosive coating is an anticorrosive coating without heating construction. It has the characteristics of convenient and flexible construction, compact anticorrosive coating, low water absorption and chemical resistance, but it has the characteristics of poor soil stress resistance. The peel strength should be focused on in the performance index of adhesive tape. Usually, adhesive tape with isolation paper should be used, and the peel strength of primer steel should reach 40 N/cm.

According to the above analysis, three layers of PE with the best comprehensive performance are recommended as the anticorrosive coating of oil pipeline[5], including fused epoxy layer : 150μm, adhesive layer : 170μm, polyethylene layer : 3mm. Total thickness 3.32 mm.

No. 1 crude oil is heavy oil with high viscosity, so the calculation is based on No. 1 crude oil, and No. 2 and No. 3 crude oil can be transported at room temperature. For heavy oil, in the temperature range below 100 ℃, the viscosity-temperature curves are steep, and the viscosity reduction effect of increasing oil temperature is significant. Moreover, most heavy oil pipelines are transported in laminar flow state, and the friction is proportional to the viscosity, and the effect of increasing oil temperature and reducing friction is more significant. Therefore, the outlet oil temperature of heavy oil pipelines is high, but the oil temperature cannot be higher than the initial distillation point of crude oil. In order to reduce heat loss, there is often an insulation layer outside the pipeline. Through the OLGA software simulation of 20mm, 25mm, 30mm three insulation layer thickness pipeline temperature drop Figure 4 are shown below.

In summary, after the OLGA software is used to simulate three kinds of insulation thickness schemes, it is concluded that 30 mm is the optimal choice by comparison.

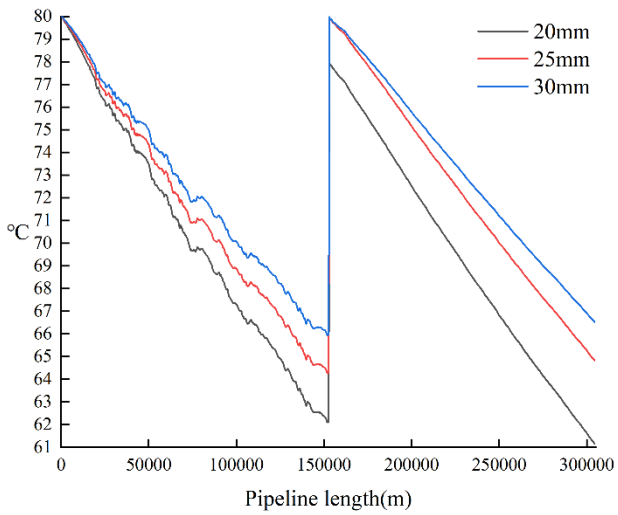

Figure 4: Temperature drop diagram of 32 inch pipeline under three insulation layers

4. Conclusion

In the design of oil and gas pipeline, the dynamic simulation of flow support is very important, but the steady-state simulation is also essential. The steady-state simulation also plays an important role in flow support. In this paper, the OLGA software is used to simulate the optimal

diameter of the oil pipeline, the thickness of the anticorrosion layer and the insulation layer, and finally the optimal scheme is combined. Compared with the traditional design and calculation of oil pipelines, a large number of thermodynamic and hydraulic calculations are needed. Using OLGA software can not only save more time, but also improve the calculation efficiency and accuracy. This shows that the application of OLGA software in oil pipeline design can play a great role.

References

[1] Liang Jun,Chen Xiaohua,Xu Deteng,Li Wang,Huang Jianxin,Qin Peng,Li Junyi.Optimization of pressure relief parameters in N station of a refined oil pipeline based on OLGA software[J].Contemporary Chemical Industry,2020,49(05):919-922.

[2] Liu Huoqiang,Xing Ya,Wang Rujun.Application of steady-state simulation based on OLGA in oil and gas gathering and transportation system[J].Petrochemical Industry Technology,2020,27(05):343-344.China National Standardization Management Committee. Specifications of Crane Design (China Standardization Press, China 2008), p. 16-19.

[3] Ding Jiaxiang,Liu Jun,Liang Deqing.Simulation of hydrate formation law of submarine pipeline based on OLGA[J].Oil & Gas Storage and Transportation,2019,38(02):235-240.

[4] Zhu Mengying,Cheng Tao,Kong Bing,Li Shaofang,Guo Yishan.Research Progress on Flow Guarantee Technology of Submarine Oil and Gas Pipeline[J].Contemporary Chemical Industry,2019,48(08):1755-1758+1762.

[5] Feng Shaoguang,Li Dongyang,Hu Bo,Zhao Jun,Yu Dongliang,Zhou Wulong,Wu Dingyong,Liu Guohao.Key parameters for peel strength test of 3PE coating[J].Petrochemical Industry Technology,2020,39(10):1165-1171.