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Optimization of Crude Oil Transmission Process by Installing Electric Heat Tracing in Off-Plot Piping

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ABSTRACT - Crude oil transmission is distributing crude oil from one plane to another. Problems that often occur in the crude oil transmission process are freezing or crystallization of paraffin when the temperature in the environment reaches the Pour Point Temperature. Usually, this can be overcome by injecting Pour Point Depressant into crude oil. However, using Pour Point Depressant is still ineffective if used continuously. This is because Pour Point Depressant can affect the quality of crude oil and increase environmental risks and if the transmission process is carried out on a large scale, it will also require large costs to meet these needs. Therefore, this research examined the application of constant wattage type Electric Heat Tracing as an alternative to Pour Point Depressant in the off-plot piping section, precisely in the PT ABC transmission pipe network. By carrying out transient simulations using OLGA version 2022.1.1 software, several scenarios for the most optimal Electric Teat Tracing installation in the crude oil transmission process were developed while minimizing the costs incurred. From the simulations carried out, it is known that the constant wattage type Electric Teat Tracing with a capacity of 3 x 100 kW can maintain the pipe temperature above the Pour Point Temperature value, namely 111ºF with 2 installation spots KP 1+700 to KP 3+200 and KP 5+800 to KP 7 +300. Apart from that, the use of Electric Heat Tracing is also more economical compared to Pour Point Depressant injection.

Keywords: crude oil, transmission, electric heat tracing, pour point depressant, OLGA.

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INTRODUCTION

A problem that often occurs in the crude oil transport industry is the crystallization of paraffin to form wax which can inhibit flow in pipes. For example, PT ABC, which operates in crude oil, especially the Sumatran Light Crude transmission sector, has experienced this case. Factors that cause this include the location of PT. ABC's pipe network underground, making the temperature around the pipes lower than average. Apart from that, the high paraffin content in crude oil causes wax to form quickly when the temperature reaches the Pour Point Temperature. Otherwise, Pore system in a carbonate reservoir is very complex compared to the pore system in clastic rocks. According to measurements of the velocity propagation of sonic waves in rocks, there are three types of carbonate pore classifi cations: Interpartikel, Vugs and Crack. Due to the complexity of various pore types, errors in reservoir calculation or interpretation might occur. It was making the characterization of the carbonate reservoir more challenging (Wardhana, R. et al. 2022).

Pour Point Temperature is the lowest temperature at which fluid cannot flow because it begins to freeze. Meanwhile, wax is a heavy paraffin compound that completely dissolves in a mixture of hydrocarbons at high temperatures, but this compound will precipitate and form a solid if the surrounding temperature drops below the Pour Point Temperature (Ding, L. et al. 2019). The wax that is formed will accumulate on the pipe walls because, generally, the pipe walls have a lower temperature than the temperature at the center line of the pipe. Furthermore, the accumulated wax will form a layer of sticky solids and inhibit the rate of fluid flow in the pipe. As a result, wax deposition occurs where the fluid flow rate decreases progressively, the pipe pressure increases and finally a total pipe blockage occurs (Giffary, F. et al. 2021).

Crude oil have some value of total iron, turbidity and oil content in injection well are bigger than discharge pump while TSS has little fluctuation. It's will be deterioration carbon steel pipeline has effect to reduce quality water injection become worst and effect of roughness of pipeline due to carbon steel deterioration can make the pressure drop is higher in accordance with the length (Migel, A. et Al. 2020). But the characteristic of crude oil distributed by PT ABC is that it has a fairly high wax content and a high Pour Point Temperature value. Therefore, if the temperature around the pipe decreases to the Pour Point Temperature value, the crude oil will freeze and cannot flow until it finally forms a solid and becomes trapped in the pipe. To overcome this, PT ABC applies chemical treatment by injecting Pour Point Depressant at each transmission process. Pour Point Temperature is a chemical compound that prevents the accumulation of wax and disperse the wax that is starting to form, reducing the PPT value in crude oil. Pour Point Depressant injection can indeed increase Pour Point Temperature up to ±25ºC, but its use will not be optimal if the transmission process is carried out on a large scale. This is because the effectiveness of Pour Point Temperature will decrease or even disappear if the temperature in the environment decreases very drastically. Apart from that, Pour Point Depressant can also change the physical and chemical properties of crude oil, increase environmental risks, and even require quite large supplies at large costs (Kumolo, S. T. et al. 2019).

Therefore, we are looking for another alternative that can be used to replace Pour Point Depressant at a cheaper and more effective cost, namely using a heating system or what is called Heat Tracing. Heat Tracing is a method for maintaining the temperature of the pipe and the fluid flowing within it by providing heat to the pipe to compensate for heat loss that occurs due to the environmental temperature being lower than the temperature of the fluid within it (Muhidin, D. & Rose H. M. 2020). The application of heat tracing has also been carried out by through his research which compared the thermochemical method (injecting chemical compounds) and the heat tracing method with a heat source via electric current or what is called electric heat tracing on crude oil in wells X-1 and X-2 , the results show that the *Electric* Heat Tracing method can increase profits by 27% and reduce payout time (POT) by up to 25% compared to thermochemical. Therefore, in this research the author will apply electric heat tracing as an alternative to Pour Point Depressant in overcoming cases of freezing in crude oil.

Electric Heat Tracing is a heating system that works by attaching a heating cable to the outer pipe wall. The heat generated by the cable will be kept from escaping into the environment around the pipe with the help of thermal insulation (Okta, V., et. al., 2023). The type of electric heat tracing that can be applied is constant wattage. Constant wattage is a type of electric heat tracing that is capable of producing constant power output along the cable so that each pipe will get the same heat. However, to minimize costs, heating cables are not installed along the pipe but only at several points that are indicated to have temperatures close to Pour Point Temperature (Pangindoman, M. I., et. al., 2022).

To determine the optimal installation location for electric heat tracing, temperature logging data originating from a thermal logger is needed. The thermal logger is a sensor developed by PT ABC to detect the temperature in pipes (Prabowo., 2021). This thermal logger is then attached to the pig's body during the pigging process. Pigging is the process of cleaning the pipe from the remaining dirt stuck to the pipe walls by throwing the pig's body from the luncher to the receiver. So when the body pig moves in the pipe, the thermal logger will also move to measure the temperature along the pipe (Pramana D.N., et . al., 2023). The results of the thermal logger in the form of temperature logging will be simulated using OLGA software. OLGA or Oil and Gas Simulator is a multiphase flow simulator that can be used on wells and pipe networks. In this research, OLGA was used to determine the electric heat tracing installation point and the required heater capacity. Then, an economic analysis was carried out to determine the feasibility of investing in electric heat tracing, which will be applied to the transmission pipe network. Therefore, this research is entitled "Optimization of Crude Oil Transmission Process by Installing Electric Heat Tracing in Off Plot Piping."

METHODOLOGY

The initial stage of this research is identifying problems. After that, it was continued with field studies and literature studies. Field studies are carried out to determine actual conditions in the field, while literature studies are needed to analyze problems that occur in the field in accordance with theory or previous research. Next, data collection was carried out through observation, random interviews and documentation with the parties responsible for the crude oil transmission process (Purwanto, H., et. al. 2020).

The data required includes environmental conditions around the pipe, Pour Point Depressant purchase data, *Sumatran Light Crude* characteristics data, flowline size data, logging temperature data. flowrate and pressure data during operation, and ambient condition data (Sianturi, A. S., 2018).

After that, the data obtained will be input into a transient simulation using OLGA software version 2022.1.1 which consists of several models or scenarios. Case 1 simulation was carried out in low temperature conditions (pigging conditions after rain), while case 2 simulation was carried out in high temperature conditions (night pigging conditions). The simulation for cases 1 and 2 aims to find a temperature profile that suits the conditions during pigging using a thermal conductivity (k-value) approach that focuses on the wet soil around the pipe. The simulation output for cases 1 and 2 is to determine the simulation scenario that produces the highest heat loss calculation so that it can be used as a reference for the next simulation.

Before simulating cases 3 and 4, it is necessary to verify the simulation results for cases 1 and 2. Heat loss calculation is a calculation of the total heat lost in the pipe and to verify the simulation results for case 1 and case 2. Heat loss calculation is carried out using 2 methods, namely the 2017 Institute of Electrical and Electronics Engineers (IEEE) 515 method and calculation of simulation results for cases 1 and 2.

Then, cases 3 and 4 were carried out to determine the installation spot for Constant Wattage type electric heat tracing. There are 4 scenarios for each case which are carried out under the same conditions (according to the simulation results for cases 1 and 2) but with different heating power and type and size of thermal insulation. The simulation results for cases 3 and 4 are then analyzed to determine the best scenario based on the amount of heating power required and the type and size of thermal insulation that is effective in isolating heat in the pipe.

RESULT AND DISCUSSION

The software used for transient simulation modeling on the transmission pipe network that supplies SLC is OLGA version 2022.1.1 The data used comes from pigging data in low temperature conditions (pigging during rain) and high temperature (pigging at night). The OLGA simulation scenario consists of case 1 to case 4 simulations. Case 1 and 2 simulations were carried out to obtain the thermal conductivity (k-value) value for the wet soil material using the trial method. After cases 1 and 2, a heat loss calculation will be carried out to verify the results of the previous simulation as well as a basis for simulating cases 3 and 4. Finally, case 3 and 4 simulations will be carried out to simulate the installation of a constant wattage type EHT at a certain location. The EHT installation point is determined based on temperature data from simulation results or if the temperature reaches 120 ºF with the assumption that the cable length per point is 1,500 m. The following is a network model simulating the crude oil transmission process using OLGA software. Transient analysis was carried out to verify the simulation model using data from the temperature logger during pigging and describing the pressure, temperature and viscosity profiles. The following is a description of the case for each simulation:

Simulation Case 1 (Low Temperature)

Case 1 simulation was carried out to determine the temperature profile resulting from the OLGA simulation which is close to the logging temperature profile in pigging conditions after rain using a thermal conductivity (k-value) approach carried out on a trial basis. The data used is maximum landing pressure and minimum landing temperature data as well as flowrate and temperature during pigging. After carrying out several trials on a number of k-values with certain conditions, a simulated temperature profile was obtained which showed results close to actual conditions using the 2 thermal conductivity (k-value) approach, namely K1 = 0.43 W/m.K at KP 0+0 up to KP 3+200 and K2 = 0.575 W/m.K at KP 3+300 up to KP 10+751.

Simulation Case 2 (High Temperature)

Case 2 simulation was carried out to determine the temperature profile from the OLGA simulation which is close to the temperature logger data at high temperature conditions or pigging temperatures at night using a thermal conductivity (k-value) approach carried out on a trial basis. The data used is maximum landing pressure and minimum landing temperature data as well as flowrate and temperature during pigging (Souas, F. et al. 2021). Just like case 1, the temperature profile of case 2 is obtained from several trials at certain k-values. Figure 4.13 is a simulation result that is close to actual conditions using a 1 value thermal conductivity (k-value) approach, namely K1 = 0.43 W/m.K at KP 0+600 to KP 3+850 and KP 8+800 to KP 10+571.

Heat Loss Calculation

Heat loss calculations were carried out to verify the simulation results for cases 1 and 2 and to determine the correct heater capacity in designing the heating system for the pipeline. The heat loss calculation was carried out using two methods, namely the IEEE 515 method and the simulation results for cases 1 and 2. The simulation calculation results are more accurate because the recorded lift represents the heat loss along the pipe using data at table 1. Meanwhile, the IEEE calculation results are more conservative because they only use 1 thermal conductivity for all types of soil along the pipe.

IEEE method

Low Temperature

$_{soil,rain} = 0{,}575\ W/m^{2}\cdot{}^{o}C$

$T_{a,rain} = 77^{o}F = 25.00^{o}C$

$$q_{loss} = \frac{T_p - T_a}{\frac{ln\,(\frac{D_2}{D_1})}{2 \times \pi \times K_1} + \frac{ln\,(\frac{D_3}{D_2})}{2 \times \pi \times K_2} + \frac{ln\,(\frac{D_4}{D_3})}{2 \times \pi \times K_3} + \frac{1}{\pi \times D_4 \times h_a}} \quad (1)$$

$$q_{loss} = \frac{46{,}11 - 25.00}{\frac{ln\,(\frac{108{,}46}{102{,}36})}{2 \times \pi \times 54} + \frac{ln\,(\frac{111{,}46}{108{,}46})}{2 \times \pi \times 0{,}299} + \frac{ln\,(\frac{1611{,}46}{111{,}46})}{2 \times \pi \times 0{,}575} + \frac{1}{\pi \times \frac{1611{,}46}{100} \times 6{,}5}}$$

$q_{loss} = 27{,}5\ W/m$

$q_{total} = 27{,}5\ W/m \times 10741\ m$

$q_{total} = 295{,}382\ kW$

Table 1
Operation data

Parameter	Nilai
Suhu maintenance pipa	$T_p = 115^{o}F = 46{,}11^{o}C$
Suhu ambient minimum (kondisi hujan)	$T_{a,hujan} = 77^{o}F = 25{,}00^{o}C$
Suhu ambient minimum (kondisi malam)	$T_a = 80^{o}F = 26{,}67\ ^{o}C$
Inside diameter of pipe	$D_1 = 4{,}03$ in = 102,36 mm
Outside diameter of pipe	$D_2 = 4{,}27$ in = 108,46 mm
Coating thickness	3 mm
Outside diameter coating	$D_3 = 11{,}46$ mm
Pipeline burial of soil	1,5 m
Outside diameter of soil	1611,46 mm
Thermal conductivity of pipe, carbon steel	$_{pipe} = k_1 = 54\ W/m^{2}\cdot{}^{o}C$
Therma conductivity of coating, 3LPE	$_{coat} = k_2 = 0{,}299\ W/m^{2}\cdot{}^{o}C$
Thermal conductivity of soil (kondisi hujan)	$k_{soil,hujan} = k_{3,hujan} = 0{,}575\ W/m^{2}\cdot{}^{o}C$
Thermal conductivity of soil (kondisi malam)	$K_{soil} = k_3 = 0{,}435\ W/m^{2}\cdot{}^{o}C$

q_{total} is the total heat lost from the fluid. To compensate for lost heat, a heater with a capacity of 3 × 100 kW is needed.

High Temperature

$_{soil}$ = 0,435 W/m2.ºC

T_a = 80ºF = 26.67ºC

$$q_{loss} = \frac{T_p - T_a}{\frac{ln\left(\frac{D_2}{D_1}\right)}{2\times\pi\times K_1} + \frac{ln\left(\frac{D_3}{D_2}\right)}{2\times\pi\times K_2} + \frac{ln\left(\frac{D_4}{D_3}\right)}{2\times\pi\times K_3} + \frac{1}{\pi\times D_4\times h_a}} \quad (2)$$

$$q_{loss} = \frac{46{,}11 - 26.67}{\frac{ln\left(\frac{108{,}46}{102{,}36}\right)}{2\times\pi\times 54} + \frac{ln\left(\frac{111{,}46}{108{,}46}\right)}{2\times\pi\times 0{,}299} + \frac{ln\left(\frac{1611{,}46}{111{,}46}\right)}{2\times\pi\times 0{,}435n} + \frac{1}{\pi\times\frac{1611{,}46}{100}\times 1{,}5}}$$

q_{loss} = 19,33 W/m

q_{total} = 19,33 W/m x 10741 m

q_{total} = 207,62 kW

q_{total} is the total heat lost from the fluid. To compensate for lost heat, a heater with a capacity of 2 × 100 kW is needed.

Calculation of Simulation Result

Low Temperature

Calculation of heat loss from simulation results in low Ttmperature conditions (pigging after rain). From the case 1 simulation results, the heat transfer parameters per unit length of pipe to inner fluid (W/m) are obtained, so that:

$$Q_{total} = \int_{KP=0}^{KP=end} QIN \quad (3)$$

Q_{total} = - 268.496,5781 W

Q_{total} = - 268,50 kW

Qtotal is the heat lost from the fluid. To compensate for the lost heat, a capacity of 3 × 100 kW is needed. Then, the amount of heating power on the EHT cable can be calculated as follows:

$$Q = \frac{268{,}50\ kW}{10791\ m} \quad (4)$$

Q = 24,99 W/m

Therefore, to compensate for the lost heat, a heating power of 24.99 W/m is needed by installing cables along the pipe.

High Temperature

Calculation of heat loss from simulation results under high Ttmperature conditions (night pigging). From the case 2 simulation results, the heat transfer parameters per unit length of pipe to inner fluid (W/m) are obtained, so that:

$$Q_{total} = \int_{KP=0}^{KP=end} QIN \quad (5)$$

Q_{total} = - 148.340 W

Q_{total} = - 148,34 kW

Qtotal is the heat lost from the fluid. To compensate for the lost heat, a capacity of 2 × 100 kW is needed. Then, the amount of heating power on the EHT cable can be calculated as follows:

$$Q = \frac{148{,}34\ kW}{10741\ m} \quad (6)$$

Q = 13,81 W/m

Therefore, to compensate for the lost heat, a heating power of 13.81 W/m is needed by installing cables along the pipe.

Validation Test

Validation is carried out to prove that the simulation results show actual results in the field. Validation calculation parameters are taken from the qloss values that occur in low temperature and high temperature conditions.

Table 1
Validation Test

Parameter	IEEE 515	Simulation Result	Error (%)
q_{loss} (Low T)	27,5	25	0,1001
q_{loss} (High T)	19,33	13,8	0,3996

Based on validation carried out by comparing IEEE 515 calculations with the simulation results of case 1 and case 2, the error was found to be less than 1%. This means that the simulation results have succeeded in describing existing conditions in the field. Then, because the heat loss calculation results show that case 1 experiences the most heat loss, the next simulation, namely cases 3 and 4, will only be carried out at low temperature conditions or pigging temperatures after rain.

Simulation Case 3 (Low Temperature)

Case 3 simulation was carried out to simulate the installation location of the constant wattage type EHT in the pipeline. This simulation uses airgel and glasswool insulation with a thickness of 1 in and 2 in and is coated with a PVC outer jacket with a heating power of 100 W/m (50% of the constant wattage cable capacity) in low temperature conditions.

Simulation Case 3 (a)

Simulation case 3 (a) analyzes the application of a 1,500 m long constant wattage type EHT with 1 in thick airgel insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing the EHT at this point can maintain a crude oil temperature of 105.82 ºF. However, this temperature is still below the target temperature, namely >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 3 (a) simulation was carried out with the addition of EHT installation at the second point, namely KP 8+600 to KP 10+100. This second simulation succeeded in maintaining the crude oil temperature at 143.06 ºF, meaning it had met the desired temperature target.

Simulation Case 3 (b)

Simulation case 3 (b) analyzes the application of a 1,500 m constant wattage type EHT with 2 in thick airgel insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing the EHT at this point can maintain a crude oil temperature of 106.13 ºF. However, this temperature is still below the target temperature of >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 3 (b) simulation was carried out with the addition of EHT installation at the second point, namely KP 8+700 to KP 10+200. This second simulation succeeded in maintaining the crude oil temperature at 145.48 ºF, meaning it had met the target temperature.

Simulation Case 3 (c)

Simulation case 3 (c) analyzes the application of a 1,500 m constant wattage type EHT with 1 in thick glasswool insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing the EHT at this point can maintain a crude oil temperature of 104.57 ºF. However, this temperature is still below

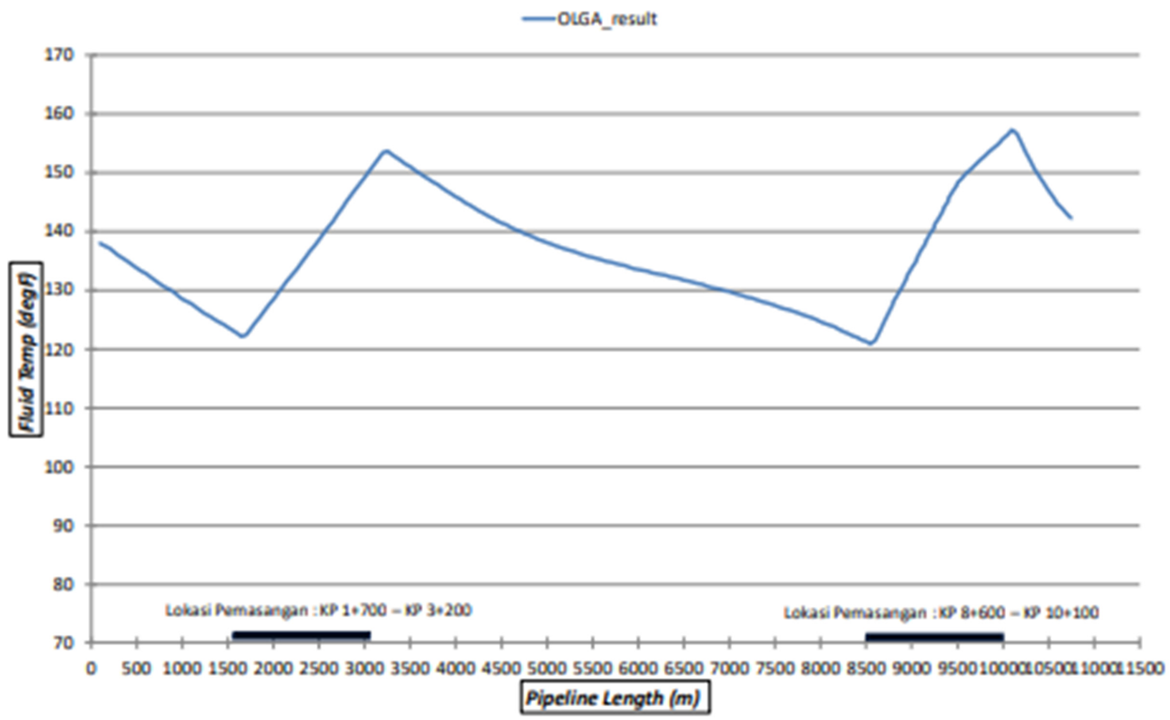

Figure 1
EHT simulation results at 2 installation points

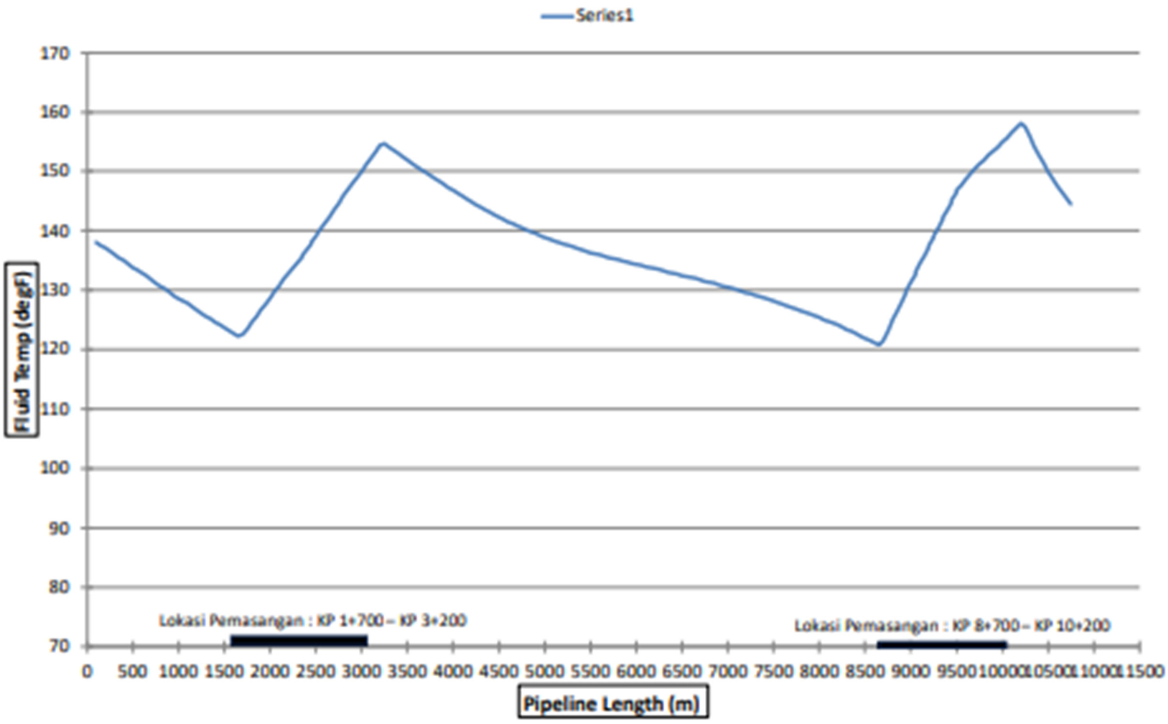

Figure 2
EHT simulation results at 2 installation points

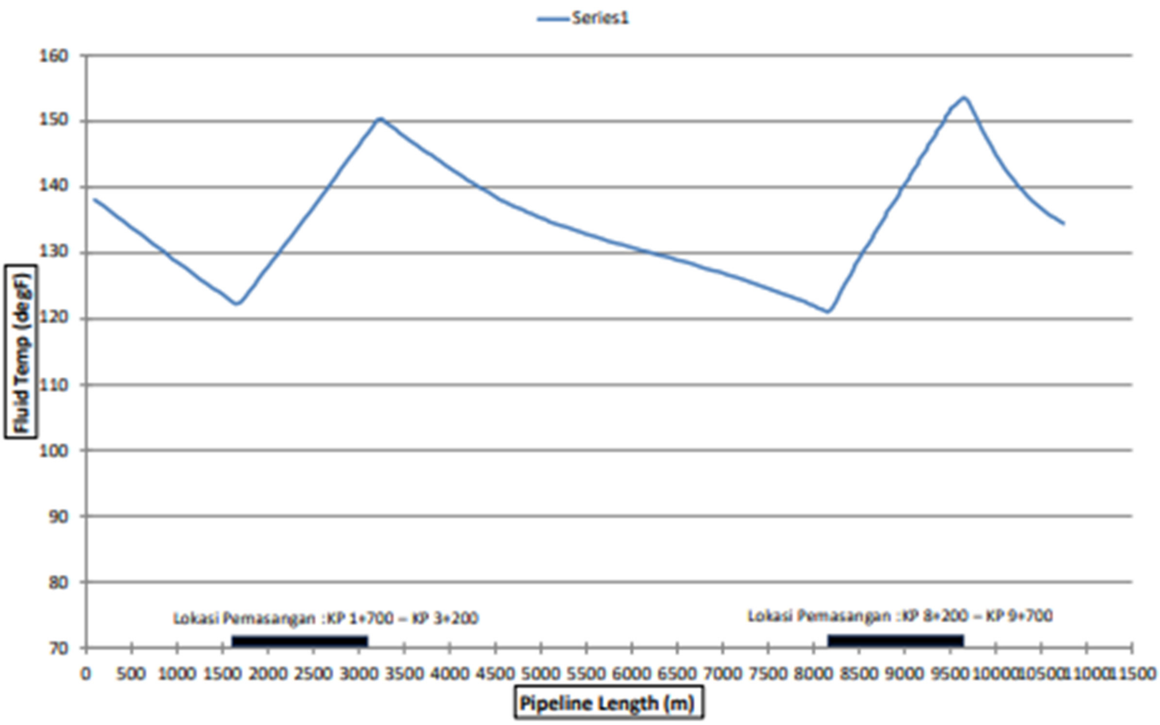

Figure 3
EHT simulation results at 2 installation points

the target temperature, namely >110 ºF. Because the temperature obtained still did not meet the target temperature, a second case 3 (c) simulation was carried out with the addition of EHT installation at the second point, namely KP 8+200 to KP 9+700. This second simulation succeeded in maintaining the crude oil temperature at 134.85 ºF, meaning it had met the target temperature.

Simulation Case 3 (d)

Simulation case 3 (d) analyzes the application of constant wattage type electric heat tracing along 1,500 m with 2 in thick glasswool insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing electric heat tracing at this point can maintain a crude oil temperature of 105.23 ºF. However, this temperature is still below the target temperature, namely >110 ºF. Because the temperature obtained still did not meet the target temperature, a second case 3 (d) simulation was carried out with the addition of EHT installation at the second point, namely KP 8+400 to KP 9+900. This second simulation succeeded in maintaining the crude oil temperature at 139.27 ºF, meaning it had met the target.

Based on case 3 simulations which have been carried out in 4 scenarios, it is known that to maintain crude oil temperatures above 120 ºF, each scenario requires 2 spots for installing electric heat tracing cables.

Simulation Case 4 (Low Temperature)

Case 4 simulation was carried out to simulate the installation location of the constant wattage type EHT in the pipeline. This simulation uses airgel and glasswool insulation with a thickness of 1 in and 2 in and is coated with a PVC outer jacket with a heating power of 50 W/m (25% of the constant wattage cable capacity) in low temperature conditions.

Simulation Case 4 (a)

Simulation case 4 (a) analyzes the application of a 1,500 m constant wattage type EHT with 1 in thick airgel insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing electric heat tracing at this point can maintain a crude oil temperature of 99.83ºF. However, this temperature is still below the target temperature of >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 4 (a) simulation was carried out with the addition of EHT installation at the second point, namely KP 6+100 to KP 7+600. This second simulation succeeded in maintaining the crude oil temperature at 115.74 ºF, meaning it had met the target temperature.

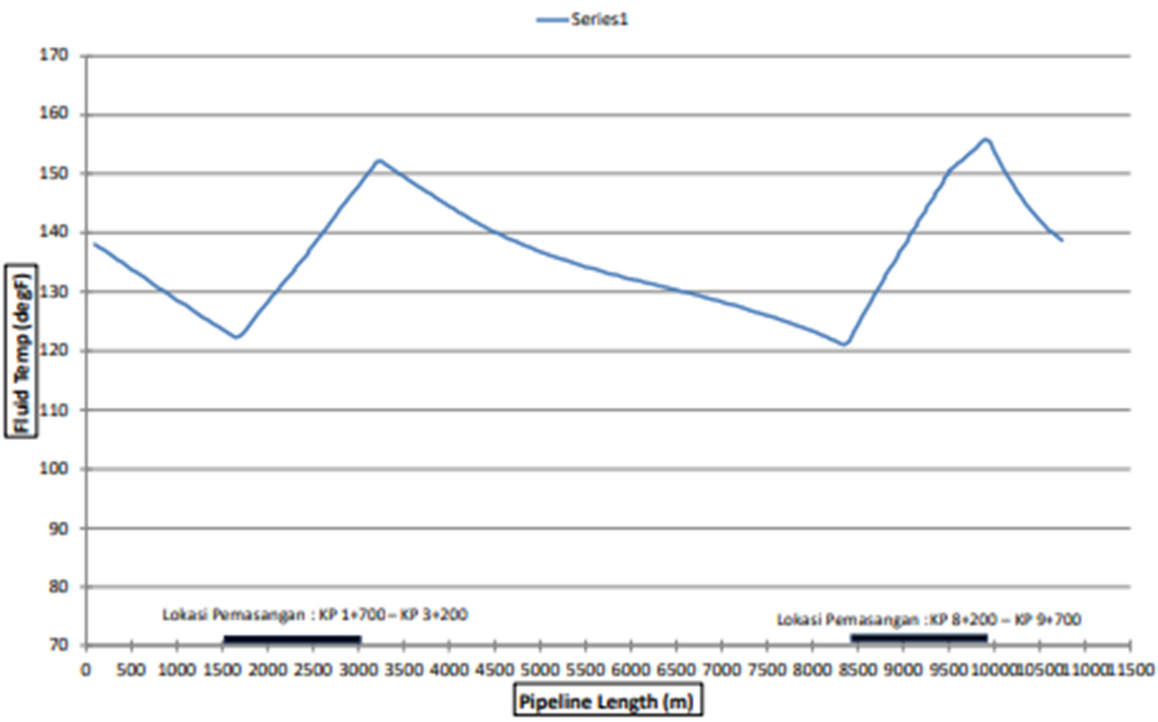

Figure 4
EHT simulation results at 2 installation points

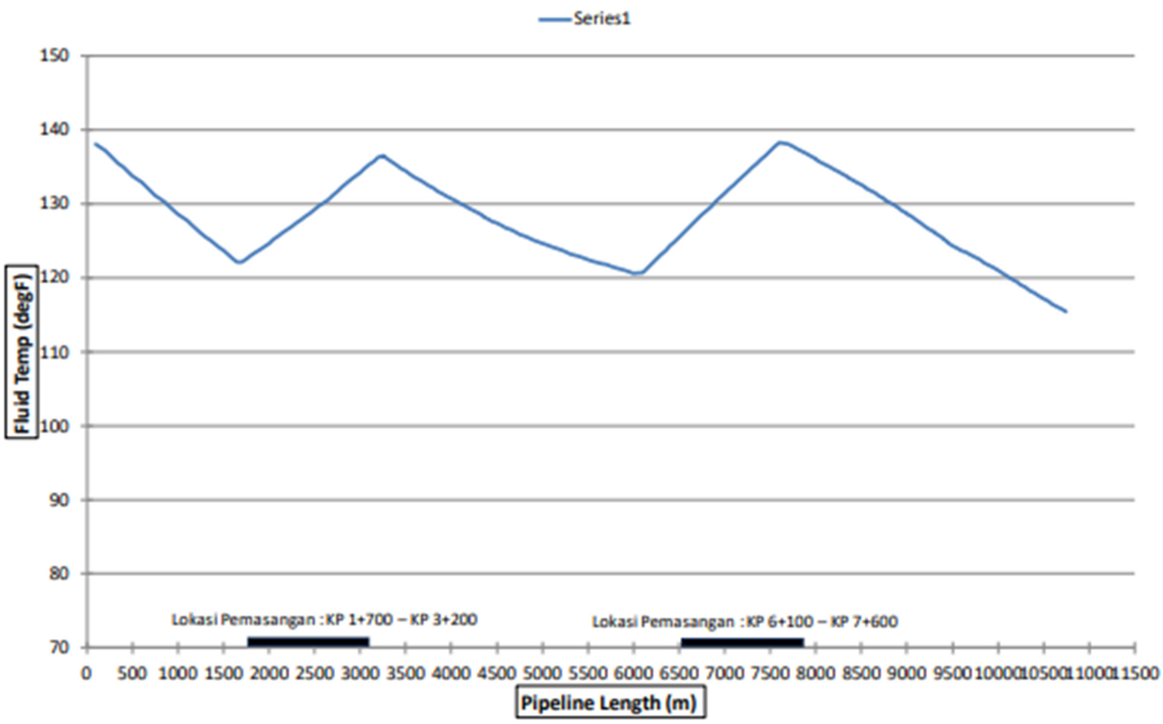

Figure 5
EHT simulation results at 2 installation points

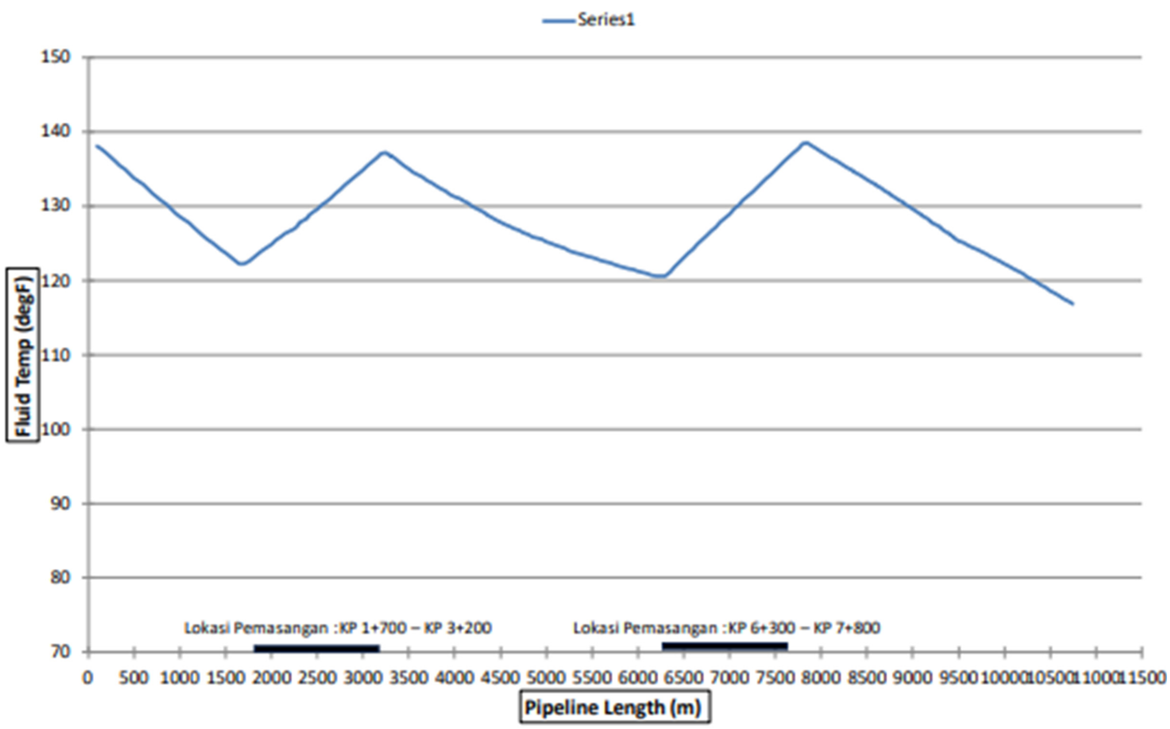

Figure 6
EHT simulation results at 2 installation points

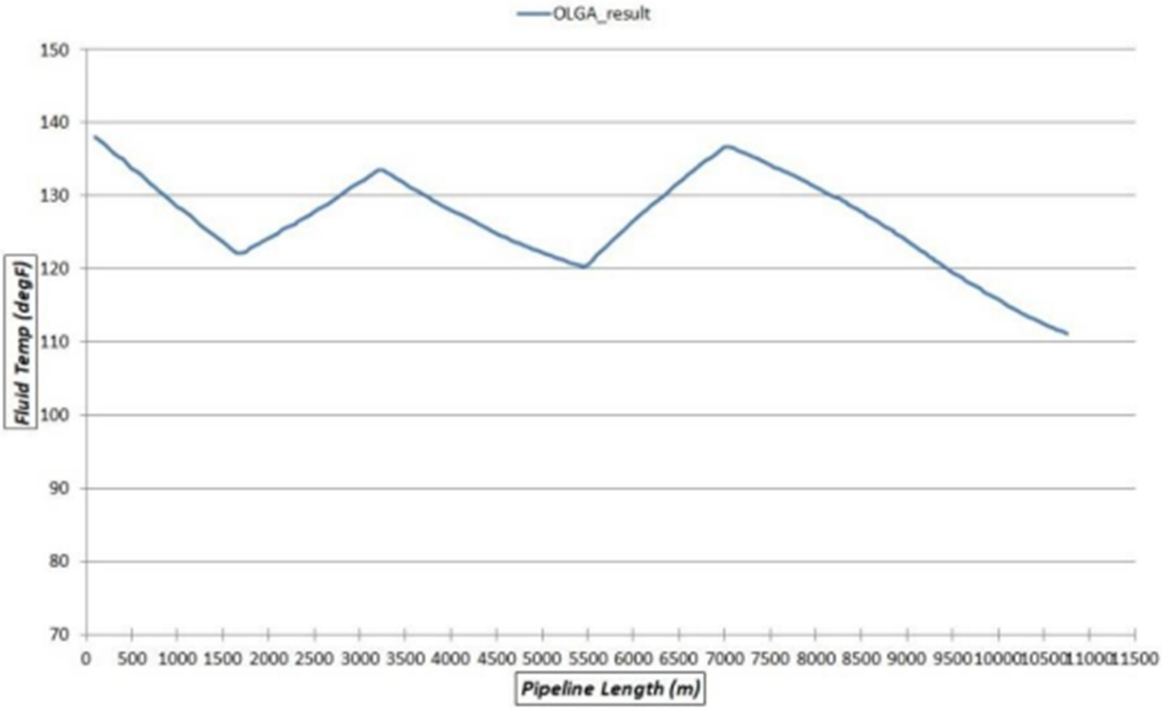

Figure 7
EHT simulation results at 2 installation points

Simulation Case 4 (b)

Simulation case 4 (b) analyzes the application of 1,500 m of constant wattage type EHT with 2 in thick airgel insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing electric heat tracing at this point can maintain a crude oil temperature of 100.12ºF. However, this temperature is still below the target temperature of >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 4 (b) simulation was carried out with the addition of EHT installation at the second point, namely KP 6+300 to KP 7+800. This second simulation succeeded in maintaining the crude oil temperature at 117.19 ºF, meaning it met the target.

Simulation Case 4 (c)

Simulation case 4 (c) analyzes the application of 1,500 m of constant wattage type EHT with 1 in thick glasswool insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing electric heat tracing at this point can maintain a crude oil temperature of 98.72ºF. However, this temperature is still below the target temperature of >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 4 (c) simulation was carried out with the addition of EHT installation at the second point, namely KP 5+500 to KP 7+000. However, this second simulation only produced a crude oil temperature of 111.44 ºF, meaning it had met the target.

Simulation Case 4 (d)

Simulation case 4 (d) analyzes a 1,500 m long constant wattage type EHT with 2 in thick glasswool insulation in low temperature conditions with one point installation at KP 1+700 to KP 3+200. Based on the simulations that have been carried out, it is known that installing the EHT at this point can maintain a crude oil temperature of 99.30ºF. However, this temperature is below the target temperature of >110ºF. Because the temperature obtained still did not meet the target temperature, a second case 4 (d) simulation was carried out with the addition of electric heat tracing at the second point, namely KP 5+5800 to KP 7+300. However, this second simulation only produced a crude oil temperature of 113.9 ºF, meaning it had met the target.

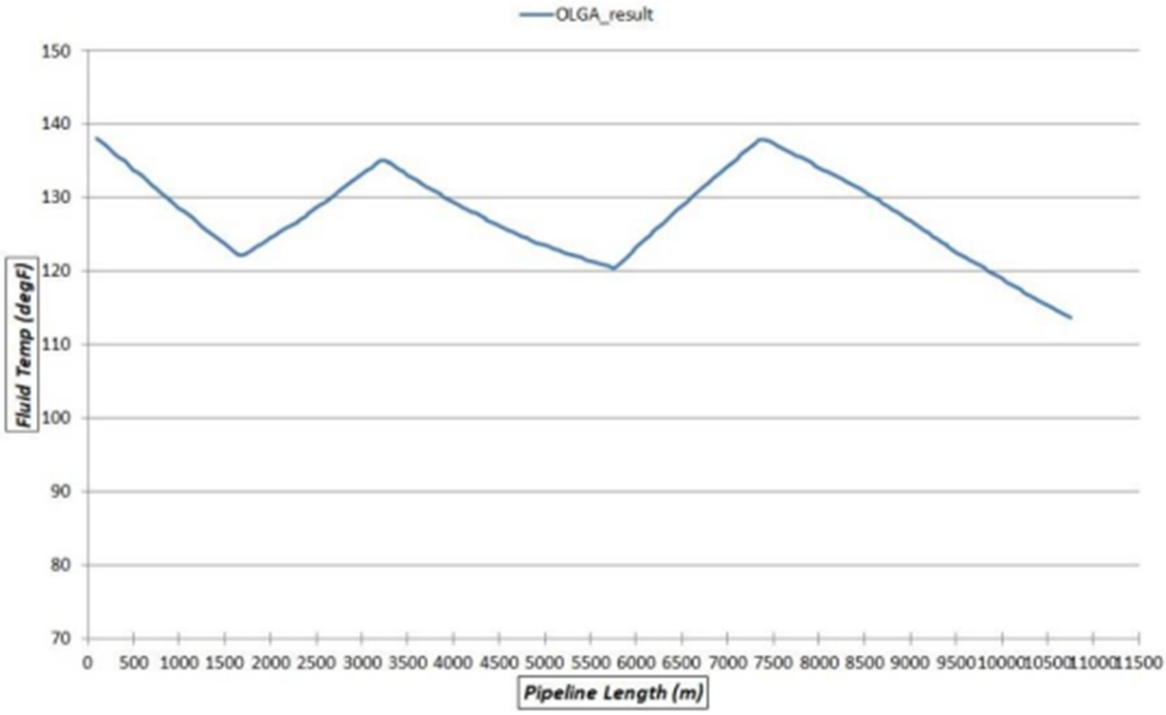

Figure 8
EHT simulation results at 2 installation points

CONCLUSION

Based on the heating power and type of insulation used, case 3 (c) simulation with add itional 1 inch glasswool insulation and heating power of 50 W/m, is the best constant wattage type EHT installation scenario because it can maintain a temperature above 111ºF with 2 installation spots. in KP 1+700 to KP 3+200 and KP 5+800 to KP 7+300. From the simulations carried out, it is known that the constant wattage type Electric Teat Tracing can maintain the pipe temperature above the Pour Point Temperature than Pour Point Depressant. Apart from that, the use of Electric Heat Tracing is also more economical compared to Pour Point Depressant injection, namely.

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GLOSSARY OF TERMS

Unit	Definition	Symbol
ASTM	American Standard Testing and Material	
OLGA	Oil and Gas Simulator	
IEEE	Institute of Electrical and Electronics Engineers	
EHT	Electric Heat Tracing	W/m
KP	Thermal Conductivity	

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