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ENERGY SAVING IN OILFIELDS BY USING WASTE HEAT IN THE DISPOSED WATER

Article Highlights

- Heating brackish water used in desalter increased the desalting rate
- Heating the crude oil before shipping reduces the power of the shipping pump
- The optimum heating temperature for brackish water and crude oil was determined
- An economic study was applied to calculate the capital cost of the new heat exchangers used for heating

Abstract

The present work aims to retrofit an existing Egyptian oilfield plant to improve desalter performance and reduce the power of crude oil shipping pumps. In this work, waste heat in disposed water that represents a value is used in heating brackish water injected over desalter and in heating crude oil before shipping. ASPEN HYSYS version 11 simulation software was used. The retrofit of the considered oilfield plant is based on the implementation of two new heat exchangers to recover waste heat in the disposed water. The results showed that using waste heat to heat the brackish water in the desalter from 30 °C to 71.11 °C will increase the operating temperature of the desalter and thus increase the sedimentation and separation rate. On the other hand, using waste heat in heating the crude oil before shipping from 37.78 °C to 71.11 °C reduces the oil viscosity from 1.536 cSt to 0.9735 cSt. Reducing the viscosity of the crude oil will reduce the pressure drop of the shipping pumps, and therefore the power required to pump the oil will be reduced. The presented retrofit design can be used as a guide in upgrading existing plants and plants under the design phase.

Keywords: desalter, viscosity reduction, shipping pumps, crude oil, simulation.

Heavy crude oil production is considered uneconomic due to the intensive recovery cost from transportation, refining, and low market value. However, improved crude oil transportation using pipelines can be achieved by reducing the viscosity of the crude oil to enhance the followability of oil via pipelines. Several techniques have been demonstrated to improve the crude oil flow properties through pipelines by reducing crude viscosity [1–5]. These techniques are as follows: blending and dilution with light hydrocarbons; using core annular flow; drag reduction additives; lowering the oil pour point by using depressants (PPD); using solvent or emulsification through the formation of oil in water emulsion; heating the crude oil and the pipeline.

The blending and the dilution technique is based on decreasing the viscosity of heavy crude oil by mixing the oil with another oil having a lower viscosity. The diluent may be light crude oil [6–8], naphtha [9,10], alcohol [7,9], condensate [10,11], or kerosene [6].

The core annular flow technique is based on oil-water two-phase. First, the pipeline wall is lubricated with water. Then, the crude oil in the pipeline is surrounded by water. The water absorbs the shear stress between the pipeline wall and the oil. The water has a viscosity lower than oil, so it goes to the pipeline

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wall, which has high shear stress. The crude oil is the core, while the water is the annulus. This technique decreases the pressure drop through the pipeline [5,12,13].

Drag reduction additives are used to reduce the high frictional loss produced due to the high viscosity of the heavy crude oil for turbulent flow. The high frictional loss leads to much energy being applied to transport the heavy crude oil to compensate for the wasted energy consumed by this frictional loss [5]. The additives used for drag reduction may be surfactants [5,14], fibers, and polymers [15,16].

Heavy crude oil is composed of asphaltenes macromolecules and liquid material. These macromolecules are deposited in crude oil and contribute to its high resistance to flow in pipelines. The pour point depressants (PPD) can decrease the deposition of asphaltenes and improve oil flow properties. The pour temperature of the oil is the lowest temperature at which the oil cannot flow. Copolymers such as polymethacrylate, methacrylate, etc., are the most pour point depressants used. These copolymers can inhibit the precipitation of the asphaltenes and increase the flowability of the crude oil through the pipeline [4,17]. Waxy crude oil behaves as asphaltenes crude oil, and the PPD is used in waxy crude oil to decrease the wax deposition.

Emulsification through oil formation in water emulsion technique is the latest technology used to reduce the viscosity of heavy crude oil in pipeline transportation. First, heavy crude oil is emulsified in water and stabilized with the help of surfactants. Then, the oil is dispersed in water as droplets with the help of surfactants, and a stable oil-in-water emulsion with low viscosity is produced [1,2,4,18]. The surfactant is used to prevent the separation of the oil and water phase into two phases in the pipeline.

Heating the crude oil and the pipeline technique is the most popular for transporting heavy crude oil through pipelines [5]. This technique decreases the viscosity of heavy crude oil by increasing its temperature. Heating decreases the resistance of heavy crude oil to flow. Heating the crude oil and heating the pipeline is required due to the energy loss to the surrounding along the pipeline during transportation. Heating the pipeline is done by implementing heating stations along the pipeline [1,18].

As Santos *et al.* [6] presented, heat losses can be reduced by insulating the pipeline. Insulating the pipeline for short distances to reduce heat losses is effective in contrast with long distances. Ghannam and Esmail [19] reported that by heating medium crude oil to 30 °C, the viscosity of the crude oil decreased from 700 cP to 300 cP. However, the heating technique has high capital and operating costs, as presented by Sanier *et al.* [4] and Chang *et al.* [20], since this technique requires many heating and pumping stations along the pipeline. Heating the heavy crude oil at pumping stations is done using fired heaters, as mentioned by Martinez-Palou *et al.* [3].

A large variety of opportunities exist in the petroleum industry to reduce energy consumption while maintaining plant productivity. Studies conducted by several companies have shown the potential for energy savings in utilities. The energy efficiency improvement in the utility area has reached 30%, the heater burning area is 20%, the process improvement area is 15%, the heat exchanger area is 15%, the engine utilization area is 10%, and other areas are 10% [21]. In addition, several innovation trends are taking shape in the oil and gas industry to address sustainable energy opportunities [22–24].

No existing plants always achieve the processing goals that would be more economically beneficial. Other plants do not achieve the performance they were originally designed, which may be due to changes in feed conditions (flow, temperature, pressure, configurations), aging equipment and wear and tear, or fluctuation in production and pipeline demand. It is possible to work on retrofitting old technologies to be a profit and operational flexibility tool. The retrofit design must be based on actual operating conditions in the field. Retrofit is more complex than designing a new plant. Retrofit is centered around existing equipment as much as possible to reduce the overall cost of the retrofit design. For choosing an appropriate retrofit, it is better to try to achieve the end user's desired retrofit performance goals with a low impact on the existing plant.

In this work, an existing oilfield plant will be retrofitted to increase the performance of the desalter by increasing its operating temperature, which will increase the salt deposition rate inside the desalter unit. Also, with this retrofit, the energy consumption used in the shipping pumps will be reduced by reducing the viscosity of the oil pumped into the pipeline and the pressure drop of the shipping pumps.

Case study

The proposed retrofits have been applied to an existing oilfield plant in the western desert of Egypt. The crude oil produced from oilfields contains salts in addition to other impurities as a result of the presence of the formation water. Due to the corrosive effects of the salts on metals damage pipelines and upstream and downstream facilities, it is therefore essential to reduce the salts and water content of the crude oil before being delivered through the crude pipeline for exporting. As described in Figure 1, the feed from different wells flows through oil flow lines to Free Water Knock-Out Drum (FWKOD) system installed upstream inlet separators to improve the facility's performance and provide bulk gas and water separation. Gases in the free water knockout drum are directed to gas compression for compression and shipping in the gas pipeline. The oil flow is separated into six processing trains, A, B, C, D, E, and F, to separate the emulsion water in the oil to achieve the product specifications. The following equipment is used for each train; indirect heater, separator, heater treater, and oil feed pump. The indirect heater is a water bath heater used to heat process fluid received from the manifold to improve downstream three-phase separation efficiency to separate the emulsion water in the three-phase separator. Flashed gases from the separator will be directed to the fuel gas system, and excess gases will be flared at the flare stack. Separated water will be directed to water disposal into disposal wells. The oil from the three-phase separator is directed to the heater treater to further separate the emulsion water in the oil.

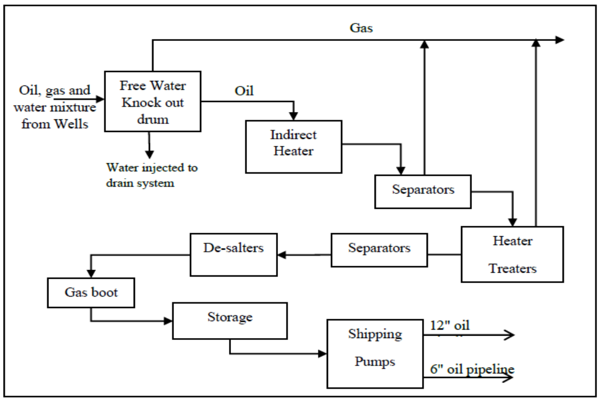


Figure 1. Case study block flow diagram.

The heater treater is used to remove the water from the oil from the production separator package unit to improve its quality and send it to the desalter package unit. The heater treater typically combines the following components inside a heater, free water knockout and oil/gas separator. The heater treater unit extracts the maximum possible water from the water/oil mixture by heating. It is designed to heat the oil and water mixture to 65 °C and to dehydrate the produced crude oil to a level of water content in oil of 3%vol. Outlet oil is pumped by an oil feed pump to desalter packages for oil desalting. Oil feed pumps are centrifugal pumps used to deliver the treated oil from the heater treater to the desalter package at a pressure that guarantees no vapor formation in the desalter to protect the transformer from ruining.

The Desalting process consists of two desalter packages. A brackish water skid feeds the two packages. Brackish water is used to wash the solid salts from the crude oil inside the desalter. Desalted oil will be flashed slightly above atmospheric pressure at the gas boot to separate dissolved gas in the desalted oil before exiting from desalters. The gas boot allows the product crude oil stream to degas to the maximum extent before flowing to the metering tanks and then exported through the pipeline to the required destination. The fluids from the desalters enter the standpipe gas boot, where gases are separated and directed to the existing flare system. Liquids are discharged through a bottom nozzle and a liquid seal to guarantee no vapor formation in the metering tanks.

Storage tanks are used to receive the daily crude oil production to provide a convenient storage volume for the product crude oil to be exported. We have six existing storage tanks that will be operated; one tank will be filled while another will be used in shipping (each cycle takes approximately 12 h). Meanwhile, the other tanks will be used for settling.

The shipping pump is sized for a differential pressure of 1034 kPa. There are two shipping pipelines with a diameter of 6" and 12", respectively, and the total shipping pipeline length is 110 km. The two pipelines are equipped with a pig launcher and receiver to enable pipeline pigging. In addition, drag-reducing agents are injected over the pipelines to increase their capacity to handle the load.

The crude oil in this case study has a high pour point of 18.33 °C which needs to be stored at a higher temperature of 60 °C to overcome the freezing problem and pipeline stoppage. But storage at a higher temperature releases gas above storage tanks, which is unsafe in the plant as storage tanks contain pig stock. Adding naphthenic base condensate will improve the pour point and save the heating cost and drag reducer injected into the oil shipping pipeline. Still, condensate is not available in this plant.

In this work, a simple retrofit of the case study was made. The crude oil that left storage tanks was heated before shipment using waste heat in the water, leaving the free water knockout drum. It will improve the oil's viscosity and keep the pipeline operating temperature above the pour point with an appropriate safety factor. In addition, this will save energy consumed by the shipping pumps and can reduce the required drag dose reducer injection.

Retrofit methodology

The proposed retrofits in the presented case study are based on implementing two new heat exchangers to utilize the waste heat in the water separated from the free water knockout drum going to disposal wells at 48.89 °C. The first heat exchanger is used to heat the brackish water injected over desalter packages. It will increase the performance of desalters by increasing the efficiency of the separation of dissolved salts and reducing the time required to achieve product specifications. Heat exchange is applied between the brackish water used in the desalter and the water leaving the free water knockout drum. The second new heat exchanger is used to heat the crude oil before shipment in the pipeline. It will reduce the viscosity of the crude oil being pumped and thus reduce the energy consumption of the shipping pumps. Heat exchange is applied between the pumped crude oil and the water separated from the crude oil from the free water knockout drum. Figure 2 shows the proposed retrofits.

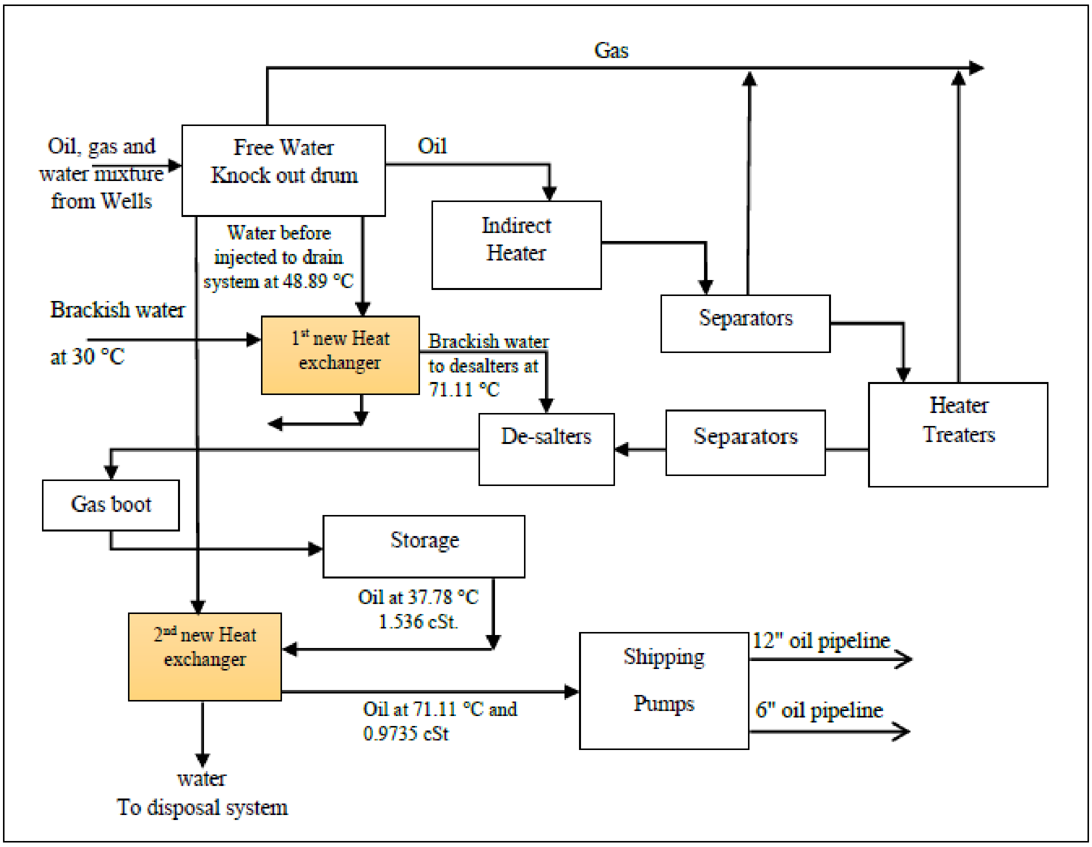


Figure 2. Case study block flow diagram with the proposed modification.

Decreasing the power of the shipping pump

In this work, decreasing the power consumption of the shipping pumps is based on decreasing the discharge pressure or the pressure drop of the shipping pump due to decreasing the kinematic viscosity of the pumped crude oil. There is a relationship between the power consumption of the pump and the kinematic viscosity according to the following equations [25–28]:

$$Power = 18.18\frac{\Delta P}{\eta} \tag{1}$$

where ΔP is the pressure drop of the pump and η is the efficiency of the pump, which is assumed to be 80%.

It is noted from Eq. (1) that the main factor affecting the power consumption is the pump's pressure drop, which is calculated according to Eq. (2).

$$\Delta P = 4\tau\frac{1}{d} \tag{2}$$

where τ is the shear stress in the pump (dyne/cm^2), and d is the pipeline's diameter (cm). The shear stress and the shear rate (γ, 1/s) are calculated from equations (3) and (4), respectively.

$$\tau = -\mu\gamma \tag{3}$$

$$\gamma = \frac{8V}{d} \tag{4}$$

where μ is the dynamic viscosity (cP), and V is the crude oil velocity (cm/s). The dynamic viscosity is obtained from the kinematic viscosity as illustrated in Eq. (5):

$$\mu = \nu\rho \tag{5}$$

where ν is the kinematic viscosity (cSt) and ρ is the crude oil density (g/cm^3).

From the previous equations, there is a direct relation between the pressure drop of the pump and the kinematic viscosity of the pumped crude oil, as presented in Eq. (6), when all the other variables (V, ρ, d) are unchanged.

$$\Delta P = 32\left(\frac{V}{d^2}\right)\rho\nu \tag{6}$$

By decreasing the kinematic viscosity of the pumped crude oil, the pressure drop of the pump will decrease. Therefore, the pump's power consumption will decrease, too, according to Eq. (7):

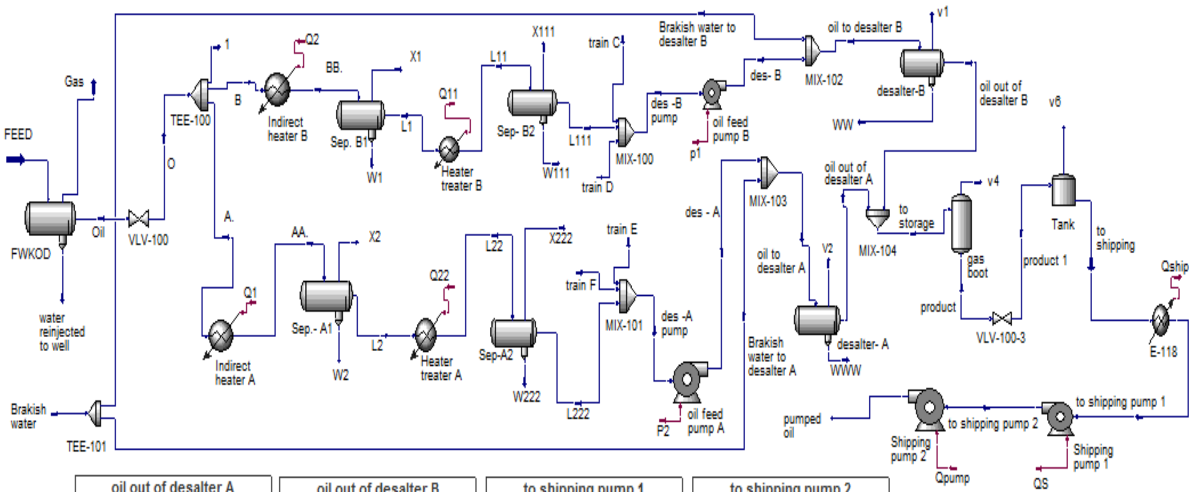
$$Power = (18.18 \times 32)\left(\frac{V}{d^2}\right)\frac{1}{\eta}\rho\nu \tag{7}$$

RESULTS AND DISCUSSION

The commercially available software ASPEN HYSYS version 11 was used to model the oil plant. Peng-Robinson equation of state has been used as it is suitable in this case. The present work aims to modify an existing oil plant to benefit from waste heat in the disposal water and study the effect of this modification on the desalter performance and power consumption of the shipping pumps. The feed stream operating conditions and composition are illustrated in Table 1. Figure 3 shows the simulated process flow diagram of the plant under study. Table 2 illustrates the simulated process's conditions of all streams.

Table 1. Feed stream compositions and specifications.

FEED composition	Mole fraction	FEED composition	Mole fraction
H_2O	0.9233	n-Pentane	0.0011
H_2S	0.0000	n-Hexane	0.0027
CO_2	0.0019	Methyl cyclopentane	0.0003
Nitrogen	0.0001	Benzene	0.0000
Methane	0.0244	Cyclohexane	0.0007
Ethane	0.0077	n-Heptane	0.00000
Propane	0.0030	n-Octane	0.00000
i-Butane	0.0006	n-Nonane	0.00000
n-Butane	0.0013	n-Decan	0.00000
i-Pentane	0.0009	C7+	0.03200
FEED conditions			
Temperature, °C		48.89	
Pressure, kPa		721.9	
Mass flow, kg/h		1008881.9035	



oil out of desalter A		
Temperature	59.25	C
Pressure	4.874	bar
Kinematic Viscosity	1.131	cSt

oil out of desalter B		
Temperature	59.72	C
Pressure	4.874	bar
Kinematic Viscosity	1.125	cSt

to shipping pump 1		
Temperature	37.78	C
Pressure	2.026	bar
Kinematic Viscosity	1.536	cSt

to shipping pump 2		
Temperature	38.06	C
Pressure	12.37	bar
Kinematic Viscosity	1.529	cSt

Figure 3. Case study simulated process flow diagram without retrofit.

Table 2. Material balance for the streams of the process shown in Figure 3.

Stream No.	T (°C)	P (kPa)	Flowrate (kg/h)	Stream No.	T (°C)	P (kPa)	Flowrate (kg/h)	Stream No.	T (°C)	P (kPa)	Flowrate (kg/h)
FEED	48.89	721.85	1008881.9	W222	65.00	73.69	0.00	V2	59.25	487.38	0.0
Gas	48.89	721.85	36231.00	train C	62.66	73.69	28095.74	WWW	59.25	487.38	7906.57
B	48.33	342.64	58695.77	train D	62.66	73.69	42143.62	to storage	59.49	487.38	254655.15
BB.	56.66	273.69	58695.77	des -B pump	63.71	73.69	127590.42	v4	59.49	487.38	0.00
W1	56.66	273.69	0.00	des- B	63.86	487.38	127590.42	product	59.49	487.38	254655.15
L1	56.66	273.69	58233.27	train E	62.66	73.69	56191.49	v6	59.62	219.86	0.0
X1	56.66	273.69	462.50	train F	62.66	73.69	42143.62	1	48.33	342.64	178755.29
X2	56.66	273.69	231.25	des -A pump	63.19	73.69	127010.63	A.	48.33	342.64	29347.88
L2	56.66	273.69	29116.63	des - A	63.33	487.38	127010.63	AA.	56.66	273.69	29347.88
W2	56.66	273.69	0.00	Brackish water to desalter B	48.89	517.08	7933.37	water reinjected into well	48.89	721.85	705851.96
L11	65.00	73.69	58233.27	Brackish water to desalter	30	517.08	7933.37	to shipping	59.62	219.86	254655.15
L22	65.00	73.69	29116.63	oil to desalter B	59.72	487.38	135523.79	to shipping pump 2	38.06	1237.03	254655.15
X111	65.00	73.69	882.20	oil to desalter A	59.25	487.38	134944.00	Oil	48.89	721.85	266798.94
L111	65.00	73.69	57351.07	oil out of desalter B	59.72	487.38	127617.72	O	48.33	342.64	266798.94
W111	65.00	73.69	0.00	WW	59.72	487.38	7906.07	product 1	59.62	219.86	254655.15
L222	65.00	73.69	28675.53	v1	59.72	487.38	0.00	to shipping pump 1	37.78	202.63	254655.15
X222	65.00	73.69	441.10	oil out of desalter A	59.25	487.38	127037.43	pumped oil	40.05	8824.03	254655.15
Brackish water	30	517.08	15866.74								

The heat exchanger is valuable process equipment in an energy-saving field. The importance of a heat exchanger in processing is to recover waste heat in some processing streams and optimize energy consumption. Disposed water has a temperature of 48.89 °C. Energy will be lost with the disposed water injected underground without reusing this energy. Therefore, it will be beneficial if we recover waste heat from produced water exiting the free water knockout drum to the disposal system to be used in heating some process and utility streams as follows:

Heating brackish water used to wash oil in desalters

According to the stock's relation, a reduction in oil viscosity would increase the velocity of the dispersed phase and the efficiency of the two-phase separation. However, an increase in temperature would result in slippage of water droplets, limiting their binding and causing shrinkage. The settling rate of salts in desalter depends highly on temperature as liquid density and viscosity decrease with increasing temperature. It means that increasing the operating temperature will increase the settling rate and therefore increase separation. Separation improvement means a larger quantity can be desalted simultaneously in a given desalter. Heating decreases the viscosity, thickness, and cohesion of the film surrounding the water droplets in the oil. Excessive heating might lead to evaporation which would result in a loss in oil volume, but the reduction in price results from API decrease [29,30]. Heating the brackish water used to wash oil in desalters is achieved through the new heat exchanger 1 (new H. Ex. 1), as presented in Figure 4. It is heated from 30 °C to 71.11 °C by heat exchange with the water outlet from the free water knockout drum. Heating the brackish water to a temperature of 71.11 °C will increase the

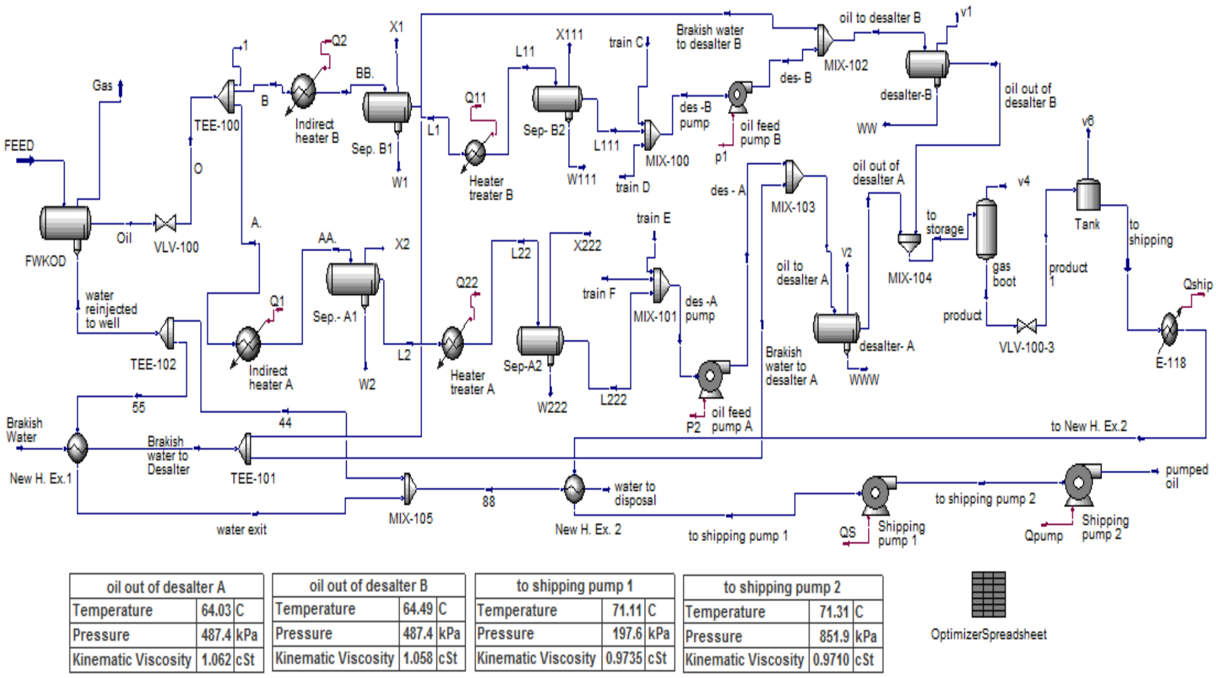


Figure 4. Case study simulated process flow diagram with proposed retrofit.

desalter operating temperature from 59.25 °C to 64.03 °C for desalter A and from 59.72 °C to 64.49 °C desalter B. Also, the viscosity is lowered from 1.131 cSt to 1.062 cSt. for desalter A and from 1.125 cSt to 1.058 cSt. for desalter B. As a result, the salt's settling rate will increase, and the required retention time inside the desalters will decrease.

Heating crude oil before shipping

The free water out of the knockout drum (FWKOD) is separated into two parts. The first is used to exchange with the brackish water in new H. Ex. 1. The other part is mixed with the first part out of the new H. Ex. 1 to give stream 88. A second new heat exchanger (new H. Ex. 2), as illustrated in Figure 4, is implemented and used to exchange the oil before shipping (to the new H. Ex. 2 stream) with the water stream 88. As a result, the oil temperature before the shipping stream increased from 37.78 °C to 71.11 °C, and the viscosity decreased from 1.536 cSt to 0.9735 cSt. This decrease in viscosity reduced the pressure drop of shipping pump 1 from 1034 kPa to 654.3 kPa. Also, the pressure drop of shipping pump 2 decreased from 7586.51 kPa to 4820 kPa. Therefore, the power consumption of these two shipping pumps decreased. The power consumption of shipping pump 1 decreased from 114.653 kW to 75.135 kW, and the power consumption of shipping pump 2 decreased from 840.1965 kW to 552.101 kW. The power energy savings for shipping pump 1 and shipping pump 2 reached 39.518 kW and 288.0955 kW, with a saving percentage of 34.47% and 34.29%, respectively. Table 3 illustrates the conditions of all streams in the retrofitted simulated process of Figure 4.

Optimization of the retrofitted case study

The optimizer in the HYSYS program is used to get the optimum heating temperatures of the outlet streams of the new heat exchanger 1 (brackish water to desalter) and the new heat exchanger 2 (to shipping pump 1). The objective function is to minimize the power consumption of the shipping pumps. The kinematic viscosity of to shipping pump stream is used as a constraint. It is adjusted below 1.0 cSt. The optimization results showed that the optimum temperature of the outlet streams from the new heat exchangers 1 and 2 is 71.11 °C. An economic study of the proposed retrofit is applied to calculate the capital cost of the new heat exchangers and the saving in operating costs.

Economic study

The economics analyzer in Hysys simulation program V.11 is used to calculate the capital and the operating costs of the case study before and after the retrofit. The results are illustrated in Table 4. In the retrofit design, two shell and tube heat exchangers are installed. This type of heat exchanger is used because most heat exchangers in the oilfield are shell and tube-type exchangers. They are relatively inexpensive and easy to maintain because tube bundles can be removed, cleaned, or replaced if needed [31]. The

Table 3. Material balance for streams of the modified process shown in Figure 4.

Stream No.	T (ºC)	P (kPa)	Flowrate (kg/h)	Stream No.	T (ºC)	P (kPa)	Flowrate (kg/h)	Stream No.	T (ºC)	P (kPa)	Flowrate (kg/h)
FEED	48.89	721.85	1008881.9	W222	65.00	73.69	0.00	V2	64.03	487.38	0.00
Gas B	48.89 48.33	721.85 342.64	36231.00 58695.77	train C train D	62.66 62.66	73.69 73.69	28095.74 42143.62	WWW to storage	64.03 64.26	487.38 487.38	7901.15 254666.06
BB.	56.66	273.69	58695.77	des -B pump	63.71	73.69	127590.42	v4	64.26	487.38	0.00
W1	56.66	273.69	0.00	des- B	63.86	487.38	127590.42	product	64.26	487.38	254666.06
L1	56.66	273.69	58233.27	train E	62.66	73.69	56191.49	v6	64.39	219.86	0.00
X1	56.66	273.69	462.50	train F	62.66	73.69	42143.62	1	48.33	342.64	178755.29
X2	56.66	273.69	231.25	des -A pump	63.19	73.69	127010.63	A.	48.33	342.64	29347.88
L2	56.66	273.69	29116.63	des - A	63.33	487.38	127010.63	AA.	56.66	273.69	29347.88
W2	56.66	273.69	0.00	Brackish water to desalter B	71.11	512.10	7933.37	water reinjected to well	48.89	721.85	705851.96
L11	65.00	73.69	58233.27	Brackish water to desalter A	71.11	512.10	7933.37	to shipping	64.39	219.86	254666.06
L22	65.00	73.69	29116.63	oil to desalter B	64.49	487.38	135523.79	to shipping pump 2	71.31	851.9	254666.06
X111	65.00	73.69	882.20	oil to desalter A	64.03	487.38	134944.00	Oil	48.89	721.85	266798.94
L111	65.00	73.69	57351.07	oil out of desalter B	64.49	487.4	127623.21	O	48.33	342.64	266798.94
W111	65.00	73.69	0.00	WW	64.49	487.38	7900.58	product 1	64.39	219.86	254666.06
L222	65.00	73.69	28675.53	v1	64.49	487.38	0.00	to shipping pump 1	71.11	197.60	254666.06
X222	65.00	73.69	441.10	oil out of desalter A	64.03	487.4	127042.85	pumped oil	63.70	6216.25	254666.06
Brackish water to Desalter	71.11	512.10	15866.74	Brackish Water	30	517.10	15866.74	water exit	47.039	716.85	352925.98
to New H. Ex.2	37.78	202.63	254666.06	44	48.89	721.85	352925.98	55	48.89	721.85	352925.98
88	47.96	716.85	705851.96	water to disposal	42.36	711.85	705851.96				

Table 4. Economic study of the original and the modified case study.

Cost item	Case study before retrofit	Case study after retrofit
Power of shipping pumps	114.653 kW for shipping pump 1	75.135 kW for shipping pump 1
	840.1965 kW for shipping pump 2	552.101 kW for shipping pump 2
Operating cost, $/y	2,247,070	2,026,460
Saving in operating cost, $/yr	220,610	
Total capital cost, $	9,068,420	9,858,630
Increasing in capital cost, $ (new capital needed)	790210	

capital cost of the two new heat exchangers in the proposed retrofit design is estimated from the HYSYS program. Their cost was $790,210. The payoff from the proposed retrofit can be seen in savings in operating costs ($220,610/year), reduced pipeline drag dose, and reduced retention time for crude oil within desalters to reach required specifications.

Reliability of the proposed retrofit

The reliability of the proposed modification depends on the continuous hot water feeding rate and the choice of materials from which the equipment is manufactured as follows: The rate of water produced by FWKOD is large and has a suitable temperature sufficient to heat the brackish water and the oil coming out of the storage tanks, and this ensures that our needs are covered by the rate of hot current; The temperature difference between the hot stream and the cold stream realizes the process of heat transfer; With the aging of production wells, the rate of water production increases and the rate of oil production decreases, and this will make the process more reliable with more water available; The selection of materials from which the devices are manufactured must be taken into account at the design stage so that the heat exchanger, pipes, and control system are suitable for the service fluid to avoid corrosion problems.

CONCLUSION

Using waste heat in water before being reinjected into wells in oilfield plants represents economic value in heating facilities. This paper makes a retrofit to an existing oilfield plant to increase the desalting unit's performance and reduce the facilities' operating costs. The retrofit was based on implementing two new heat exchangers to heat brackish water used in desalters and heat crude oil before shipping. The use of waste heat in brackish water heating was studied to improve the desalters' operating temperature and separation conditions. The results showed an increase in the brackish water temperature and an increase in the operating temperature of the desalter. In addition, it will reduce the viscosity of the oil and improve the sedimentation rate. On the other hand, the waste heat in the disposed water was used to heat the crude oil before shipping. The results showed that the viscosity of the oil decreased. The decrease in viscosity reduced the pressure drop of the shipping pumps and the power consumed to pump oil into the pipeline. Moreover, the drag dose injected through the pipeline will be reduced.

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NAUČNI RAD

UŠTEDA ENERGIJE NA NAFTNIM POLJIMA KORIŠĆENJEM TOPLOTE OTPADNE VODE

Ovaj rad ima za cilj rekonstrukciju postojećeg egipatskog naftnog postrojenja kako bi se poboljšale performanse odsoljivanja i smanjila snaga pumpi za transport sirove nafte. Toplota otpadne vodi koristi se za zagrevanje slane vode koja se ubrizgava preko odsoljivača i zagrevanje sirove nafte pre otpremanja. Korišćen je softver za simulaciju ASPEN HISIS verzije 11. Rekonstrukcija razmatranog naftnog postrojenja zasniva se na implementaciji dva nova izmenjivača toplote za rekuperaciju otpadne toplote u otpadnoj vodi. Rezultati su pokazali da će korišćenje otpadne toplote za zagrevanje slane vode u odsoljivaču podići radnu temperature sa 30 °C na 71,11 °C i time povećati brzinu sedimentacije i separacije. S druge strane, korišćenje otpadne toplote za zagrevanje sirove nafte pre otpremanja sa 37,78 °C na 71,11 °C će smanjiti viskozitet naftesa 1,536 cSt na 0,974 cSt. Smanjenje viskoziteta sirove nafte će smanjiti pad pritiska pumpi za transport, a samim tim i snagu potrebna za pumpanje nafte. Stoga se predstavljena rekonstrukcija može koristiti kao vodič u nadogradnji postojećih postrojenja i postrojenja u fazi projektovanja.

Ključne reči: odsoljivač, smanjenje viskoziteta, pumpe za transport, sirova nafta, simulacija.