Original Research Article

Investigating the Impact of Wash Water Pump Rate on the Efficiency of Desalting Process, a Case Study of X-Field in Iraq

ABSTRACT

Desalting is an essential process in the oil industry to remove salts from crude oil. These salts, which include fine saline water droplets and salt crystals, can have a significant impact on the crude refining process. If left untreated, they can foul heat exchangers, block pipelines, cause scales, corrosion, foaming, plugging and affect the overall performance of other equipment. To avoid these salt-related problems, it is crucial to remove salts from the crude oil, This paper presents a case study of the effect of wash water pump rate on the efficiency of the desalting process for crude oil in the X-field in Iraq. The desalting process was evaluated based on the wash water pump rate. Crude oil samples were collected downstream of the desalter at various wash water flow rates.on weekly basis for ten months, and the average salinity were measured in parts per million (ppm). The results of the investigation show that there is an inverse relationship between the salinity of the crude oil and the wash water pump rate. As the salinity of the crude oil increases, the wash water pump rate decreases. At wash water pump rate of 6 m3/hr. and below, the salinity of the crude oil exceeds the 30-ppm export specification; implying that a lower wash water pump rate leads to inadequate desalting of the crude oil. The study also unraveled the causes and consequences of inadequate wash water pump rate such as: clogged inlet or outlet, insufficient power supply, passing valve, worn-out or damaged impellers, mechanical failure, piping issues, sealing problems, and increased operational costs. To optimize the wash water pump rate, a procedure was also developed in this study. This method addresses the identified causes and consequences of an inadequate wash water pump rate in effectively desalting crude oil. This study has unraveled the importance of the wash water pump rate in the desalting process and t highlights the need to maintain an optimal pump rate to effectively remove salts and avoid associated problems in the refining process.

Keywords: wash water pump, pump rate, dehydrating, desalting, salinity, crude oil, efficiency

1. INTRODUCTION

Crude oil dehydration and desalting processes are based on the removal of water droplets from the crude oil. In the case of crude oil desalting, the dehydration process is preceded by wash water dosage upstream of the desalter, which reduces the salinity of the remnant water in the crude oil [1]. Crude oil dehydration and desalting processes are employed to remove water and salts, ensuring that the crude oil meets specified quality requirements and industry standards. These processes are critical in preventing corrosion, fouling, and catalyst deactivation in refining equipment, as well as maintaining product quality [2]. Effective dehydration and desalting processes are essential to meet specific moisture content, salt content, and other quality parameters to ensure optimal refinery performance and to comply with regulatory standards and ensure the efficient refining and utilization of crude oil [3]. Additionally, the water of salt inoculated by tanker during shipment might subside to the total content of salt at the refinery. In most of the circumstances, the crude oil's salt content comprises the dissolved salt in tiny water droplets which are distributed in crude oil [1]. The limit of the salt content of the remnant water in oils as received at petroleum refineries is usually in the range of 10 to 300 PTB (pounds of salt per thousand barrels of oil), based on spot samples of many different crude oils as delivered to refineries [4]. The presence of salt water presents serious corrosion and scaling problems in transportation and refinery equipment. Also, it causes fouling problems in pipes and heat transfer equipment and deactivation of catalysts employed at the refinery. The oil phase will be needed such treatment involves emulsion treatment, dehydration and desalting processes [5].

Treatment of emulsions has always ranged from simple methods such as a gravity settlement to highly sophisticated methods such as microwave desalting and dehydration systems [6,7]. The development of treatment systems has always been evaluated in terms of quantities of salt and water being removed. Desalting process is to make an emulsion and to break this emulsion. Make an emulsion in order to contact all existing dispersed salts (chlorides) in the untreated crude and collect them by means of added fresh water [8,9].

Hanoon et al,[1] conducted an experimental study of desalting crude oil on AL-NOOR crude oil. They observed that the process of desalting was difficult for these reasons, that the variance amongst the oil density and water density was small and the oil viscosity was relatively large so that the rate of droplet settling of water was few in the desalter. They also added that heavier oil as well tend to include additional amount of natural emulsifiers in comparison to the lighter crude oil, this behaviour aided coalescence of a water droplet and allowed the formation of stable emulsions in the desalter More so, they proposed a method to extract water from crude oil emulsion, which involved determining the conductivity of the water in crude oil which in turn aided in the determination of the amount of salt in the emulsion and the volume of extracted water from crude oil. Their method addressed the removal of reservoirs water from crude oil in order to reduce the wear and tear of equipment for storing and transporting crude oil, which contributes to reducing costs and maintaining environmental integrity

Al-otaibi et al,[6] investigated experimentally the effect of five factors (gravity settling, chemical treatment, freshwater injection, heating, and mixing) on the efficiency of the dehydration/desalting process for a Kuwaiti crude oil and a commercial demulsifier. They varied these factors systematically and analysed the efficiency of the desalting system. They defined two efficiencies: a Salt Removal (SR) efficiency and a Water Cut (WC) dehydration efficiency. They carried out the investigation through changes made to a single factor at a time as well as multiple variations of factors and based on experimental data, showing the variation of the two efficiencies as a function of the various factors. They drew two main conclusions for the system they conducted study on. They reported that excessive amounts of a demulsifying agent had adverse effects on the desalting/dehydration process and that, the most important factor that improved both efficiencies (S=R and W=C) were found to be the settling time. Efficiencies up to 75% were obtained at settling times of 5 minutes. This factor was simulated and confirmed profitable for both major and marginal fields and, stressed that the traditional settling-tank technique would be inadequate, and other means of improving production quality become a must in the experimental runs, through the use of a centrifuge. The implication of their findings was that future desalting/dehydration systems for oil and demulsifier study should be based on centrifugal techniques. Their findings raised the issue of new technologies to be applied in the field of emulsion treatment. They observed that as water content increases with crude oil, wellhead pressures decrease, and the lifting costs also increases.

Bai and Wang [10] conducted an experimental study of crude oil desalting using hydro cyclones and observed that dilute dispersion/emulsion of ultrafine water droplets containing a variety of salts is usually present in crude oil and stressed the need to remove the water and the dissolved salts, so that corrosion, plugging, and fouling of equipment can be prevented. They averred that electrical desalter is an effective method in crude oil desalting. However, they observed that to overcome the shortcomings of electrical desalting system, such as larger equipment volume, complex high tension electricity system, they proposed a new process of crude desalting that was based on hydro cyclone technology. They added that preliminary industrial experiments have been carried out to prove the feasibility of desalting using hydro cyclone. However, they studied the effects of several dimensionless units, such as Reynolds number, Euler number and pressure drop ratio and observed that an increase in inlet Reynolds number will decrease the pressure drop ratio and with an increase in inlet Reynolds number, Euler number increases gradually. They also observed that the inlet Reynolds number has distinct effect on dehydration efficiency of the hydro cyclone and that under the condition of inlet Reynolds number less than 5400, an increase in inlet Reynolds number will improve the separating efficiency and reported that the separating efficiency reached maximum when Reynolds number is close to 5400, and that a further increases in Reynolds number cause performance deterioration. They concluded that the salt concentration can be reduced from 8mgL-1 to 3 mg L-1, and that the dehydration efficiency ranges from 86% to 99% with the feed flowrate of 2.7-3.0 m3h-1 through the hydro cyclones.

Desalting of crude oil is the first step in the refining process and essential for problem free plant operation. Raw crude oil contains water, salts, and other impurities. If these salts and heavy metals are not removed, they can react with heat forming acids that corrode equipment used in subsequent processes. Additionally, salts can cause the accumulation of deposits, leading to the obstruction of heat exchangers or the blockage of trays in process towers. To wash down this salt content, wash water is injected into the crude oil stream through the use of wash water pump.

This study investigates the effects of wash water pump rate on the efficiency of the desalting process for crude oil in the X-field in Iraq. X-field is designed to process crude oil to meet the vapour pressure and water content specifications required for the downstream desalting/dehydration units, which further process oil to meet 0.5% Basic Sediment and Water (BS&W) content and less than 30 ppm of salt in the final crude.

Causes and Consequences of Inadequate Wash Water Pump Rate

The following are the causes and consequences of inadequate wash water pump rate during refining of crudes. The causes of inadequate wash water pump rate are:

1. **Clogged or blocked inlet or outlet:** When the inlet or outlet of the pump is clogged with debris, sediments or foreign objects, they can inhibit flow of water and reduce the discharge flow rate.

2. **Insufficient power supply:** Inadequate or insufficient power supply to the pump, may hinder the pump not to operate at its full capacity, resulting in a lower discharge flow rate.
3. **Passing valves:** If the valve on the re-circulation line back to the wash water tank is passing, this implies that some volume of the discharged wash water will flow back to the tank. This can disrupt the flow of water and reduce the discharge flow rate.

4. **Worn-out or damaged impeller:** The impeller is responsible for generating the centrifugal force that moves water through the pump. If the impeller is worn-out, damaged, or misaligned, it can impede the flow, leading to a decrease in the discharge flow rate.

5. **Mechanical failure:** Various mechanical issues, such as a faulty bearing, damaged shaft, or worn-out seals, can hinder the pump's performance and result in a decreased flow rate.

6. **Piping Issues:** Problems in the piping system, such as undersized or blocked pipes, excessive bends, or inadequate pipe supports, can cause flow restrictions and reduce the discharge flow rate.

The consequences of inadequate wash water pump rate

A low wash water pump flow rate in a desalting system can have several consequences, such as:

I. **Poor Desalting Performance:** The wash water pump plays a crucial role in the desalting process by flushing out impurities and maintaining the efficiency of the system. A low pump flow rate can lead to inadequate flushing, resulting in reduced desalting performance and lower production of fresh water.

II. **Fouling and Scaling**: Inadequate wash water flow can contribute to fouling and scaling within the desalting system. Without sufficient wash water, salts, particulate matter, and other contaminants may accumulate on the system's surfaces, leading to decreased efficiency, increased energy consumption, and potential damage to equipment.

III. **Increased Operational Costs:** Limited wash water flow may necessitate more frequent system shutdowns for maintenance and cleaning, leading to increased operational costs. Additional expenses may arise from the need to replace or repair fouled equipment and membranes due to reduced efficiency and performance.

To maintain optimal desalting performance and to prolong the life of the system, it is important to ensure an adequate wash water pump flow rate and ensure a proper maintenance procedure in place.

2. METHODOLOGY

The study area for this research work is the desalting unit in the crude oil processing plant at X-field in Iraq located in the southern part, approximately about 20 km south-west of Basrah as shown in Figure 1.

Figure 2 is a simplified overview of a crude oil separation, dehydration, and desalting system in X-field. The overview represents the process flow path in the treatment plant. The purpose of the crude oil separation, dehydration and desalting system is to receive well fluids from X-field Flow Station through an individual oil processing train, de-gas, dehydrate, de-salt and cool the crude oil to meet storage and export specifications.

Figure 1: Map showing the study area where field X is located for dehydration and desalting processes.

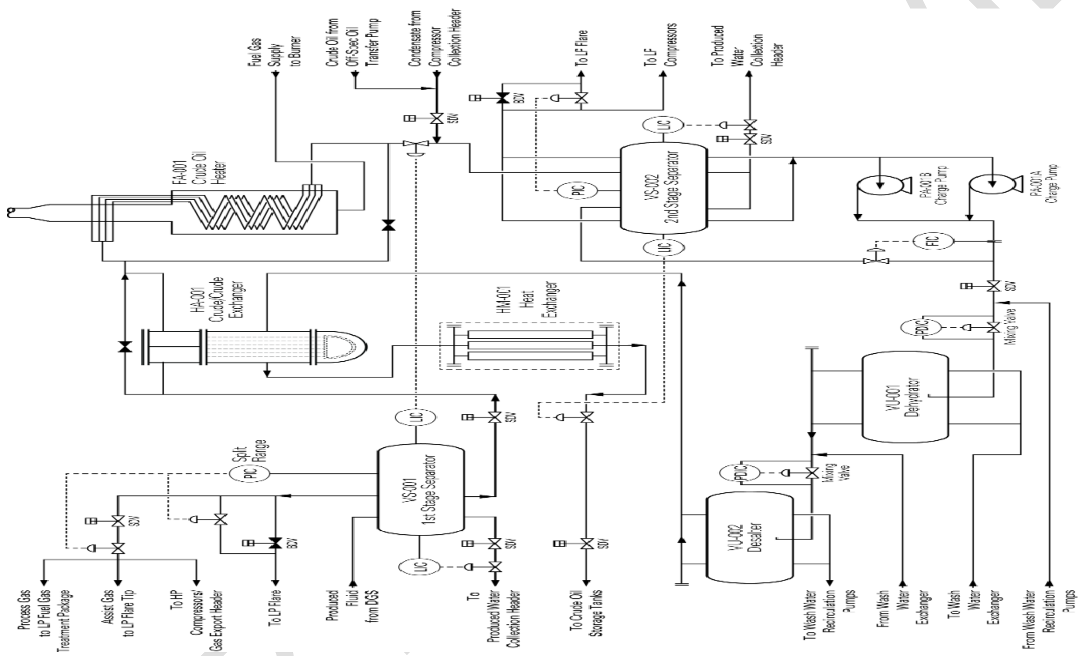

Figure 2: Simplified Overview – Crude Oil Separation, Dehydration and Desalting System (X-field, 2023).

The crude oil separation, dehydration and desalting system consist of a 1st stage separator, crude/crude exchanger, crude oil heater, a 2nd stage separator, charge pumps, dehydrator, desalter, wash water recirculation pumps and a crude oil rundown cooler. The oil production train is sized to process and deliver 45,000 bopd. The system is designed to process crude oil to meet the vapour pressure and water content specification of 5% required for the downstream desalting/dehydration units; which on further processing is expected to meet 0.5% volume of Basic Sediment and Water (BS&W) content and less than 30 ppm of salt in the final crude. A Sand Handling System is provided to allow online jetting of the separators, dehydrators and desalters to take place. This process removes any deposited solids (sand) or scale build-up in the bottom of the vessels by the injection of produced water. The sand slurry from the dehydrator and desalter is routed to the De-sanding System.

Figure 3 is a process and instrumentation diagram for the desalter unit in X-field and, it represents the combination of process field instruments, components and the piping arrangement for the purpose of an effective water and salt removal. It also shows an in-depth information about the configuration of the treatment vessel

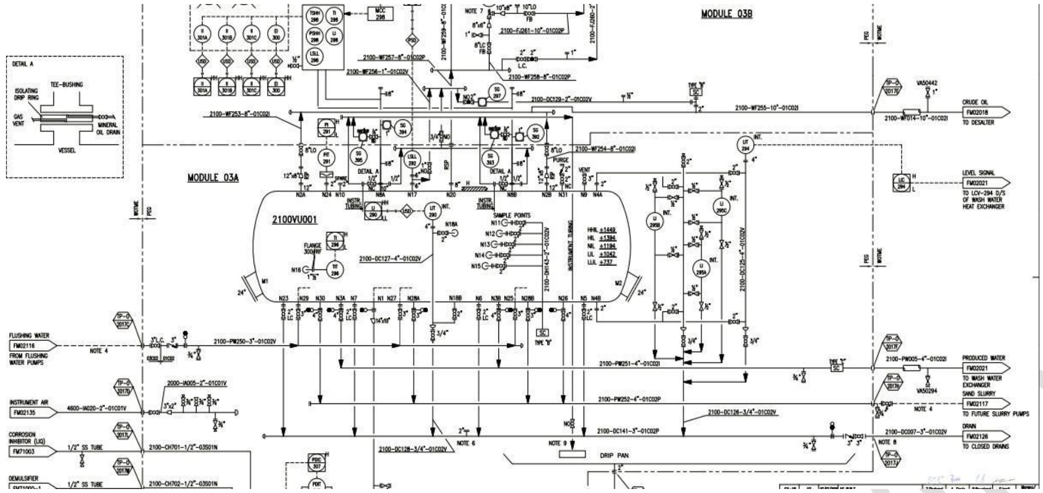

Figure 3: Process and instrumentation diagram for desalter unit in X-field

Figure 4 is a pictorial view of how Figure 3 is represented in the Distributive control system (DCS), for control of process variables. Looking at it closely, shows the process set points and process parameters (Temperature, Pressure, Level and Flow rate etc.).

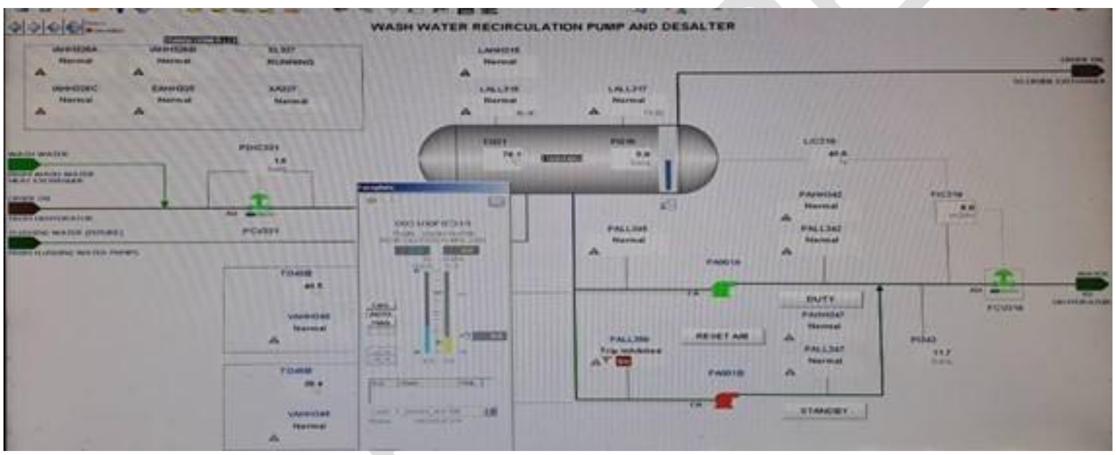

Figure 4 is a typical process flow scheme diagram of a desalting unit in X-field.

The crude oil feed to the desalter is commingled with re-circulation water from the Wash Water System before entering at the bottom of the desalter. The desalted crude oil exits the top of the vessel and is routed to the Crude/Crude Ex-changer. The produced water interface level shall, under normal operating conditions, operate and below the electrostatic grid. To ensure that the level of the desalter is closely monitored and controlled, the desalter vessel is designed with sampling points (N11, N12, N13, N14, and N15). The lower sample points, N15 and N14 indicates water, N13 indicates oily water emulsion while N12 and N11 indicates oil. Hence, whenever the water interface level increases beyond N15, N14 (Above electrostatic grid), the salinity in the crude oil will be high. At this point, tricock operation is carried out to ascertain the water interface level and to effect the appropriate control.

2.1 Equipment and Materials

The following equipment was used in the crude oil separation, dehydration and desalting system. These equipment are integrated in the Figure 2

Table 1: List of equipment description and tag number for the system

EQUIPMENT DESCRIPTION	EQUIPMENT TAG NO.
1st Stage separator	SP-001
Crude/crude Exchanger	A-001
Crude oil exchanger	F-001
2nd stage separator	SP-002
Charge Pumps	A-001A/B
Dehydrator	D-001
Desalter	D-002

Crude oil rundown cooler	C-001
Re-circulation pumps	R-001

Produced fluids are directed to the X-field from an X-field Flow Station via the offsite interconnecting pipeline to the crude oil 1st stage separator. The inlet pipeline includes an offsite Motor Operated Valve (MOV) and a Shutdown Valve (SDV) upstream of the 1st stage separator. Well fluids are initially directed through the three-phase high pressure 1st stage separator, which separates the majority of hydrocarbon gas and produced water from the wet crude oil. Wet crude oil is directed to the crude/crude ex-changer, produced water is directed to the Produced Water System, gas is compressed using the HP export compressors and/or piped to the export pipeline. The 1st stage separator is capable of handling 45,000 bpd of crude oil, 40,000 bpd of produced water and 35.4 MMscfd of produced gas. Crude oil from the 1st stage separator is preheated in the crude/crude ex-changer, before entering the crude oil heater where crude oil is further heated using fuel gas burnt in a combustion chamber. This is carried out to assist further water and gas removal in the downstream low pressure 2nd stage separator. The 2nd stage separator is a three-phase low pressure separator, which directs water to the Produced Water System, separated gas to the LP compressors and crude oil to the dehydrator/desalter for further processing. The 2nd stage separator is capable of handling 40,000 bpd of crude oil, 5,300 bpd of produced water and 15MMscfd of produced gas. As the separated, hot crude oil is now at significantly lower pressure than the produced fluid from the X-field Flow Station, two 100% duty centrifugal charge pumps are provided in parallel to pump oil through downstream dehydrator and desalter, which facilitate the removal of inorganic chlorides (salts) and water-soluble contaminants from the crude oil. This is achieved by injecting wash water into the oil, emulsifying and coagulating droplets for removal using an electrostatic charge. As further cooling is required before the hot crude oil can be directed to the storage tank, the oil is passed through the crude/crude ex-changer in counter-current flow with the wet crude oil preheated from the 1st stage separator. This pre-cools the dry oil before flowing to the crude oil rundown cooler to a temperature of between 50°C (winter) and 60°C (summer), acceptable for storage. To enhance the performance of the dehydrator and desalter, Wash Water Heat Exchanger and Wash Water Pumps (A/B) is used. Water separated in the desalter is pumped back to the dehydrator using Wash Water Re-circulation Pumps (A/B), while the desalted crude oil is cooled using the crude/crude ex-changer and routed, through crude oil rundown cooler, directing crude oil to either the crude oil on-spec or off-spec storage tank, where sample could also be collected from the storage tank for analysis.

2.2 Design parameters

The wash water pump are electric motor driven, horizontal, single stage centrifuged pumps with the following specifications:

Table 2: Wash Water pump operating conditions

ITEM	DESCRIPTION
Operating temperature	-5 °C to 55 °C
Suction Pressure	0.1 barg (1.45psi)
Discharge pressure	10.1 barg (146.5psi)
Differential pressure	10 barg (145psi)
Differential head	102m
Designed temperature	85 °C
Designed pressure	12.3 (178.4psi)
Casing	Carbon steel
Impeller	Standard steel (12% chrome)
Flow rate	19.1m³/hr (normal), 21m³/hr (rate) 7m³/hr (turndown)
Power (motor)	18.5 kw

The wash water heat ex-changer is a plate and fin type heat ex-changer with the following specifications as shown in Table3

Table 3: Wash Water Heat Ex-Changer Operating conditions

Equipment	Wash water heat exchanger			
	Wash water stream (Cold)		Produced water stream (Hot)	
	Summer	Winter	Summer	Winter
Inlet Temperature	40.0 °C	60.0 °C	90.0 °C	90.0 °C
Outlet Temperature	80.0 °C	80.0 °C	68.4°C	49.1 °C
Operating Pressure	7.0 barg (101.5psi)		6.0 barg (87psi)	
Pressure Drop (Allowable)	1.0 barg (14.5psi)		1.0 barg (14.5psi)	
Design Temperature	125 °C		125 °C	
Design Pressure	14.0 barg (203psi)		14.0 barg (203psi)	
Design Flow Rate	19.50 kg/hour		36.50 kg/hour	

Dimension –HE	1216mm length: 1596mm height: 540mm width
Internal Arrangement	45 titanium plates

Wash Water Streams

In a desalter of crude oil, injected wash water is used to reduce the concentration of salts in the crude oil. This is done by mixing the wash water with the crude oil in a mixing valve. The mixing valve is designed to create a turbulent flow that promotes the mixing of the wash water and crude oil.

Nature and Source of Data

The nature and source of data used for this study were all primary data obtained from the process plant at X-field. This sampling exercise was carried out for a period of 70 days.

Method of Data Collection

Crude oil samples were collected with the aid of a sampling bottle under operating conditions from the downstream of the desalting unit, in the treatment plant to analyse the samples for data generation.

Sample and Sampling Techniques

Samples are taken from the process streams to verify system and equipment efficiency daily.
The Desalter is provided with a series of sample points equally spaced across the vessel at varying heights (Nozzle N11 N12, N13, N14 and N15). These sample points are referred to as “Tricocks” and are provided for sampling and monitoring the actual level of the water, oily water emulsion, and oil within the vessel. The lower sample points, N15 and N14 may indicate water, N13 may indicate oily water emulsion and N12 and N11 may indicate Oil. The Tricocks can also be used to verify the interface level as indicated by instrumentation.

To take samples, the valves that controls the respective nozzles are turned on and sampling is done using sampling bottles or by visual observation. This procedure which was used in this study, is applicable to the X-field in Iraq.

3. RESULTS AND DISCUSSION

Measurements of salinity in ppm after treatment of the crude oil from the downstream of the desalter over a period of time are shown in Figure 5 through Figure 10. Information on the process variables (flowrate, temperature, pressure and level) are obtained from the process history (trend) in the Distributive Control System (DCS). From the results shown in Figure 5 through Figure 10, it can be observed that, there are cases where the measurements of salinity in morning and evening varies. This was caused by the changes in the process variables such as the flowrate, temperature, pressure, water-oil interface level and the de-emulsifying agents.

Optimal flow rates ensures adequate contact between the crude oil and water, allowing for efficient salt removal and separation [11]. Higher temperatures improve the solubility of salts and aids their removal and also promotes emulsion resolution [12]. Proper interface level control system ensures that water and oil phases are adequately separated, avoiding emulsion formation and improving the quality of the desalted crude oil [13]. Use of optimal pressure is key to effective separation to prevent blowby or carryover during separation. High pressure-drop operations results in a good mixing between wash water and the emulsion leading to a decrease in the salt content in the bulk of the oil phase; facilitating effective salt removal and water-oil separation [14]. The use of demulsifying agents or chemical additives can aid in separating water and oil phases during desalting. Proper selection and dosage of demulsifiers are crucial to enhance the efficiency of the separation process. The oil salinity decreases remarkably with the increasing of chemical demulsifier rate [11]; although, effectiveness of demulsifiers can be influenced by temperature, pressure, and the specific characteristics of the crude oil.

Therefore, to ensure efficient desalting operation, the crude oil flow rate, temperature, and pressure, along with the pressure drop in the mixing valve and the quality and rate of wash water should be at optimum during operations. All these parameters play vital roles and are significant and are the major causes of the variations in the measurements during the morning and evening periods.

Figure 5 shows the behaviour of the crude oil salinity at a wash water flow rate of15 m3/hr. At this flow rate, the salinity of the crude oil meets the requirement for export; however, the wash water pump is not flowing at the maximum rate of 19.7 m3/hr, rather above the turndown rate.

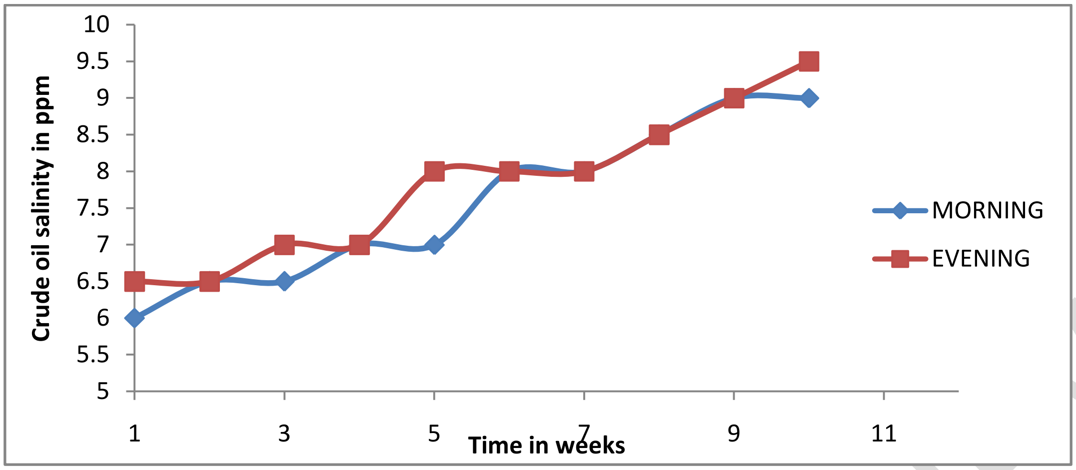

Figure 5; Crude oil salinity when wash water is flown at 15 m3 /hr maximum efficiency.

Figure 6 shows the behaviour of the crude oil salinity at a wash water flow rate of10 m3/hr. Again, at this flow rate, the salinity of the crude oil meets the requirement for export but the wash water pump is not flows above the maximum turndown rate of19.7 m3/hr.

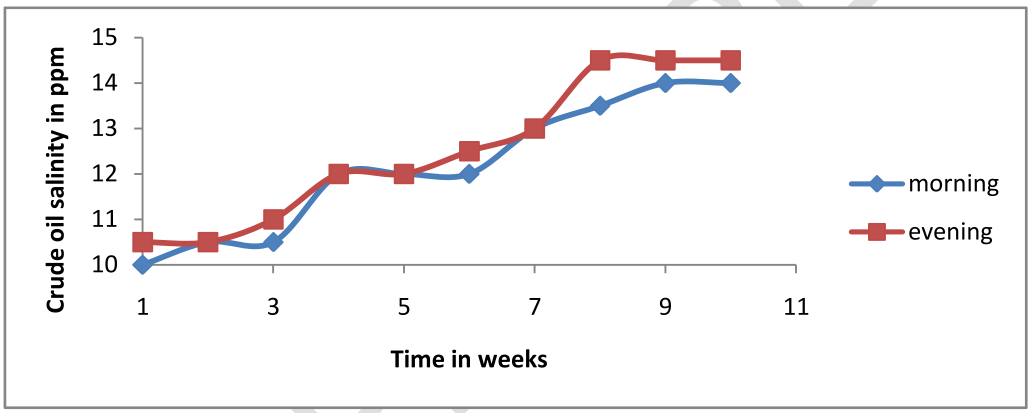

Figure 6: Crude oil salinity when wash water flow rate is set at 10 m3 /hr maximum efficiency.

Figure 7 shows the measurements of the crude oil salinity when the wash water flow rate is 8m3/hr. It was also observed that the salinity at this flow rate meets export specifications. However, there is an increase in the salinity that caused a concern due to the wash water pump working above it maximum capacity and turndown rate.

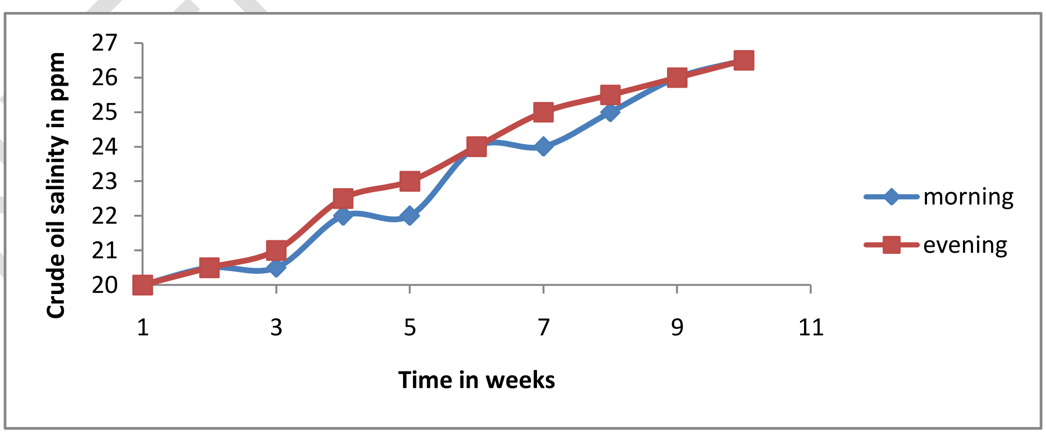

Figure 7: Crude oil salinity when wash water flow rate is set at 8 m3 /hr maximum efficiency

Figure 8 shows the measurements of the crude oil salinity at a wash water flow rate of 7m3/hr. At this flow rate, the salinity of the crude oil is almost at the benchmark requirement for export. There is a considerable increase in the salinity so much that caused a major concern. The wash water pump is far below its maximum rate, but slightly above the turndown rate. Again, the major variations in the salinity measurements experienced in the morning and evening is due to a new well that was opened to the treatment facility with high flow rate. This activity took place on week 3, 5 – 7 and on 12 hours bases.

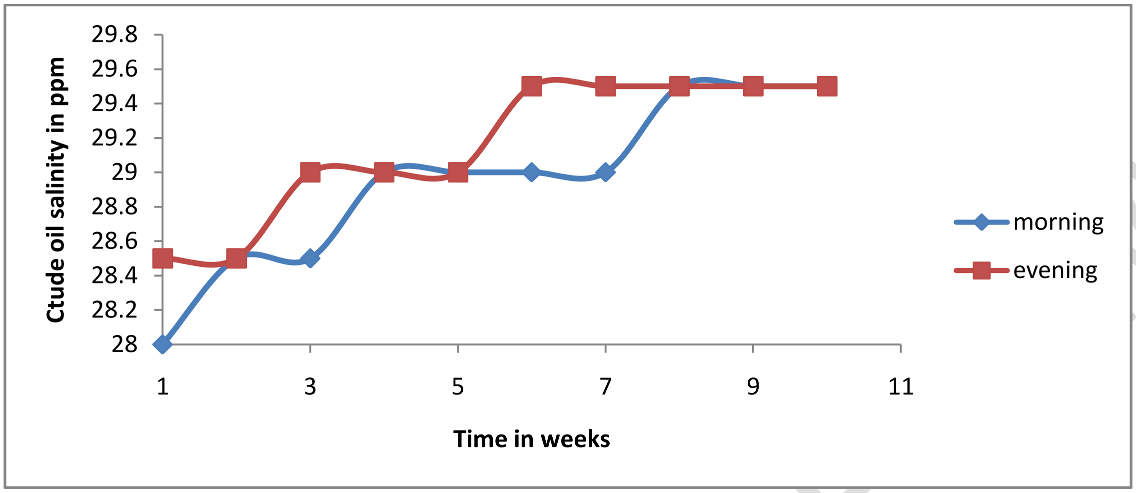

Figure 8; Crude oil salinity when wash water flow rate is set at 7 m3 /hr maximum efficiency.

Figure 9: shows the behaviour of the crude oil salinity at a wash water flow rate of 6m3/hr. At this flow rate, the salinity of the crude oil is above the bench mark of 30ppm required for export. The increase in salinity also caused a great concern to the operator as the wash water pump could not give a flow rate above the turndown rate.

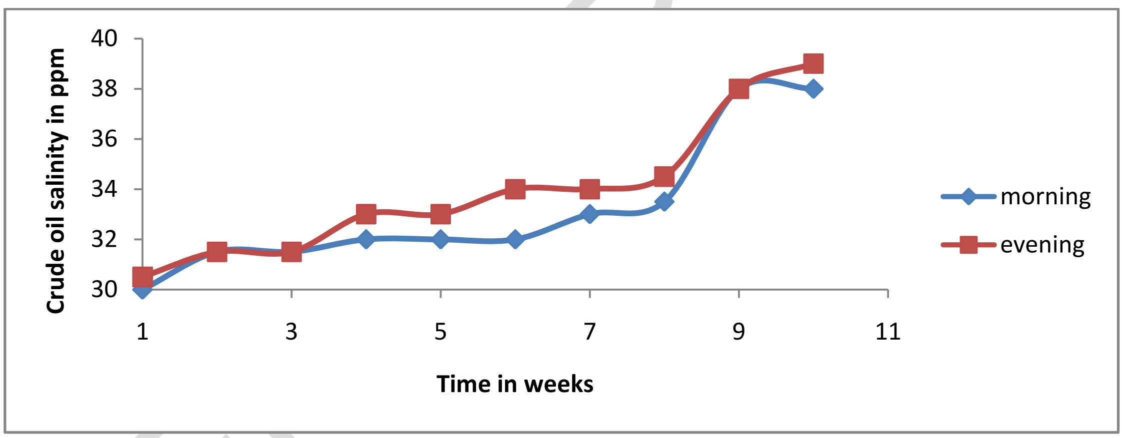

Figure 9: Crude oil salinity when wash water flow rate is set at 6 m3 /hr maximum efficiency.

Measurements of the crude oil salinity at a wash water rate of 5m3/hr is shown in Figure 10 At this flow rate, the salinity of the crude oil exceeds the benchmark export specification of 30ppm.

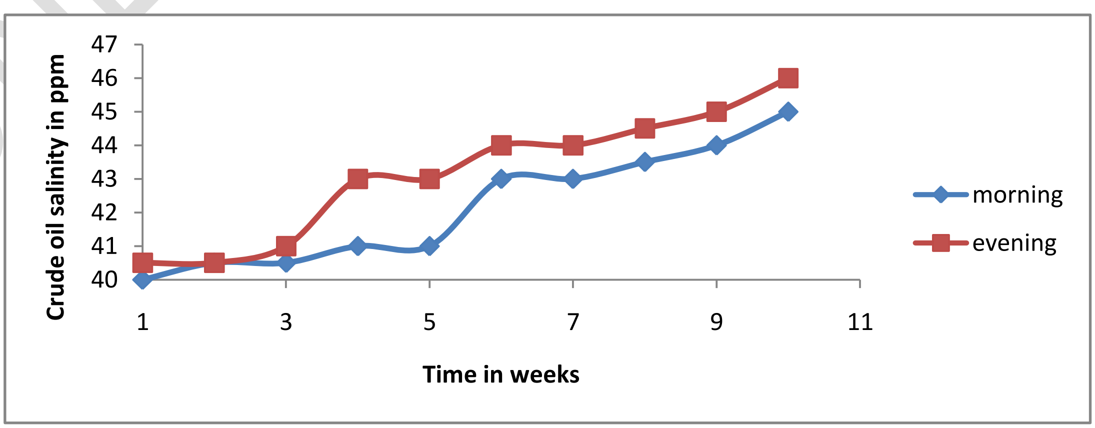

Figure 10: Crude oil salinity when wash water flow rate is set at 5 m3 /hr maximum efficiency

Figure 11 shows the crude oil salinity at the various wash water pump rate for eleven weeks in the mornings. As can be seen in Figure 11, the higher the wash water pump rate the lower the salinity and vice versa. Hence, the least crude oil salinity in the mornings was observed when the flow rate is 15m3 /hr while the maximum was observed at a flow rate of 5 m3 /hr. Also, as can be seen in Figure 11, except for the flow rate of 7m3 /hr, the crude oil salinity for at other flow rates changes as the week progresses. A similar trend was also observed for measurements taken in the evenings as shown in Figure 12 for the 11 weeks under which this study was carried with the minimum and maximum crude oil salinity occurring at 15m3 /hr and 5 m^3 /hr respectively.

Figure 13 shows an average performance of the wash water pump at various flow rates for the mornings and the evenings. It could be observed that at 15m3/hr down to a rate of 7m3/hr, the salinity of the crude oil was within the requirement and, or close to the benchmark specifications. As time progresses, the wash water pump flow rate started declining below the turndown rate as shown in the Figure 9 and Figure 10, at flow rates of 6m3/hr to 5m3/hr. At this set point, the crude oil can no longer be pumped out for export because; it has fallen below the acceptable salinity requirement of 30ppm in the industry.

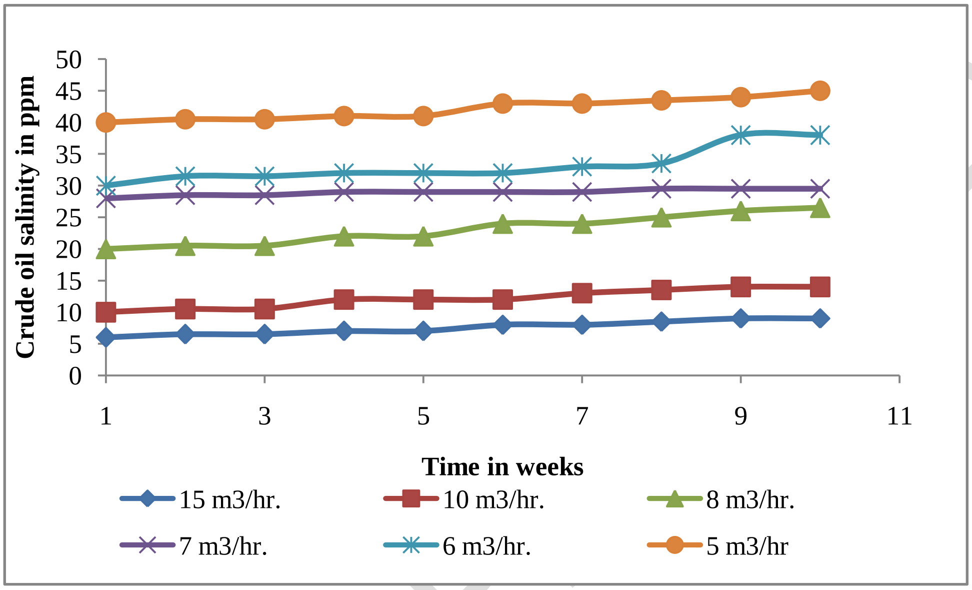

Figure 11: Measurements of crude oil salinity in the mornings at different flow rates for 11 weeks

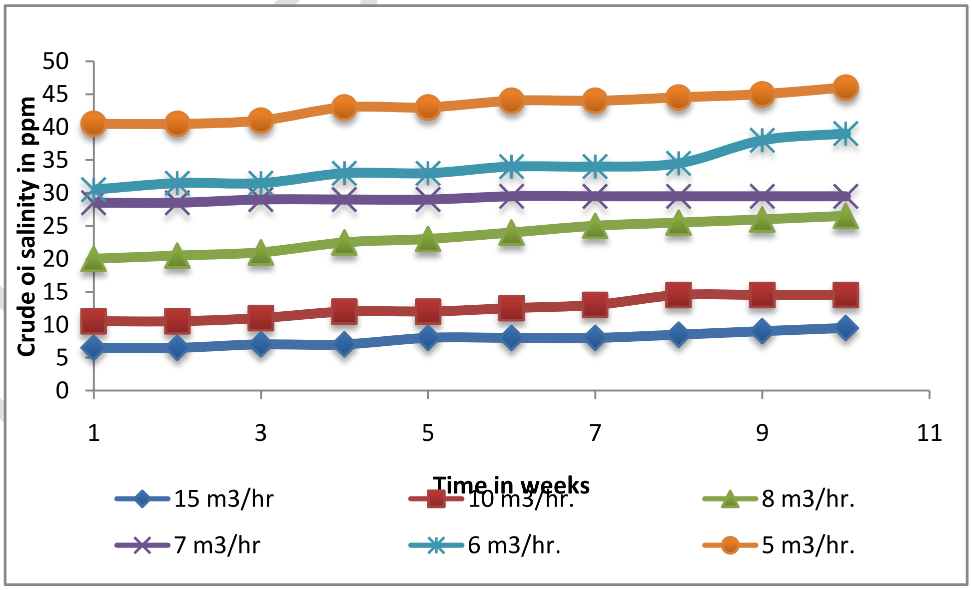

Figure 12: Measurements of crude oil salinity in the evenings at different flow rates for 11 weeks

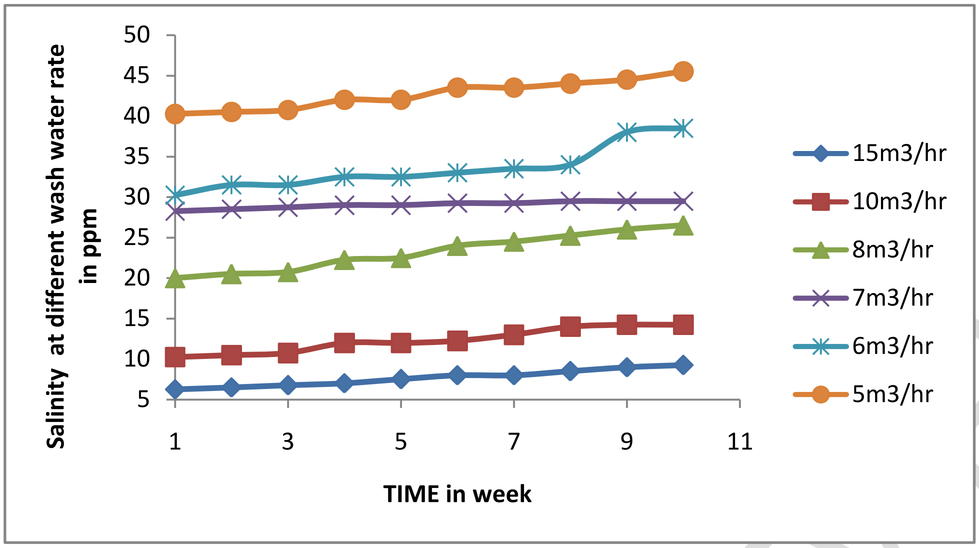

Figure 13: Average of mornings and evenings crude oil salinity at the various wash water pump flow rates

The Proposed Method of Optimizing the Wash Water Pump Rate

The flowchart for the proposed method developed in this study for optimizing the wash water pump rate during a desalting process is shown in Figure 14. The recommended minimum operating flow rate of the pump is $7m^3/hr$ and maximum flow rate of $19.1m^3/hr$. It is also recommended that wash water control valve be operated in a cascaded mode to observe the volume of crude oil produced at a given wash water flow rate. Once the optimization is completed in line with the procedure shown in Figure 14, the process could be put into a cascade mode to enhance the plant efficiency. This would lead to increase in production, reduced maintenance cost, reduced downtime and meeting of the target market specification of the crude oil.

4. CONCLUSION

The research work focused on evaluating an existing crude oil desalting plant in X field located in Iraq. The study considered the wash water pump flow rate as the single parameter while keeping other parameters constant. A comprehensive case study was conducted, where crude oil samples were collected weekly for ten months. The crude oil was commingled with re-circulation water before entering the desalter. Tricock operations were performed to monitor the water-oil interface and, to ensure effective control. The average salinity of the crude oil after treatment in the desalter at various wash water flow rates were determined at the end of each test.

The analysis of the crude oil samples over the ten-month periods also revealed variations in salinity content, which were influenced by water-oil interface level, flowrate, pressure, de-emulsifying agents and temperature in the desalting operation. The study also examined the performance of the wash water pump and its impact on crude oil salinity. It was observed that as the wash water pump flow rate decreased, the salinity of the crude oil increased. At a flow rate of $6m^3/hr$, the salinity exceededthe benchmark of 30ppm, which is above the export specification. Thus, at this flow rate, the wash water pump could not provide a flow rate above the turndown rate.

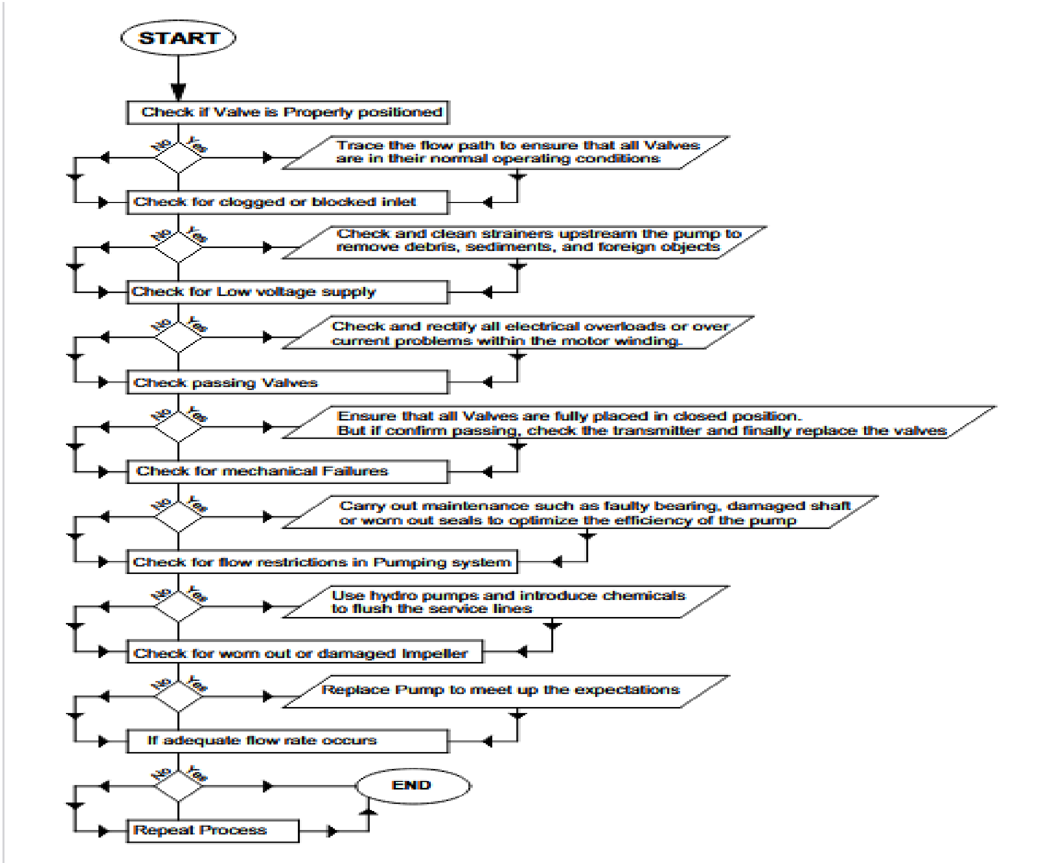

Figure 14: Proposed Method of Optimizing the Wash Water Pump Rate

The causes and consequences of inadequate wash water pump rate were identified as clogged or blocked inlet/outlet, insufficient power supply, passing valve, worn-out or damaged impeller, mechanical failure, piping issues, poor desalting performance, fouling, sealing, and increased operational costs. Finally, a method for optimizing the wash water pump rate was proposed, aiming to improve desalting performance and reduce operational issues.

REFERENCES

[1]. Hanoon .H, Ali N, HuwaidahIA,Maryam JJ. Experimental study of desalting crude oil, Periodicals of Engineering and Natural Sciences. 2020; 8(2):727-735

[2]. Gary JH, Handwerk GE. Petroleum Refining: Technology and Economics (4th Ed.). CRC Press 2001.

[3]. Alqaheem DY, Alomair A. Hydrogen recovery from ARDS unit by membranes: A simulation and economic study, Results in Engineering. 2022;:15,100559

[4] Ibrahim. DS, Sami NA. Experimental Study of Desalting and Dehydration of Two Samples of Iraqi Crude Oils, Petroleum Science and Technology. 2015;33(15-16):1533-1539

[5] Abdel-Aal HK, Aggour M, Fahim MA.Petroleum and gas field processing. New York: Marcel 2003.

[6] Al-Otaibi M, Elkamel. A, AL-sahhaf T, Ahmed AS. experimental investigation of crude oil desalting and dehydration chemical engineering. communication, 2003:190: 65- 82,

[7] Fortuny M, Silva EB, Filho AC, Melo RLFV, Nele M, Coutinho RCC, Santos AF. Measuring Salinity in crude oils: Evaluation of methods and an improved procedure. *Fuel.*2008;.87: 1241–1248

[8] Hasan SW, Ghannam MT, Esmail N. Heavy crude oil viscosity reduction and rheology for pipeline transportation.

Fuel.2010; 89: 1095–1100

[9] Abdul-Wahab S, Elkamel A, Madhuranthakam CR., Al-Otaibi MB. Building inferential estimators for modeling product quality in a crude oil desalting and dehydration process, Chemical Engineering Process. 2006;45: 568–577

[10] Bai ZS, Wang.HL Crude Oil Desalting using hydrocyclones ChemicalEngineering Research and Design. 2007; 85 (A12) 1586–1590

[11] Sellami MH, Naam R, TemmarM.Optimization of Operating Parameters of Oil Desalting in Southern Treatment Unit (HMD/Algeria). Journal of Petroleum and Environmental Biotechnology, 2016; 7(2): 1-6

[12] Pruneda E, Garfias J, EscobedoE.Optimum Temperature in the Electrostatic Desalting of Maya Crude Oil. Revista de la Sociedad Química de México. 2005

[13] Behin J Aghajari M. Influence of water level on oil–water separation by residence time distribution curves investigations. Separation and Purification Technology. 2008; 64. 48-55.

[14] Axens S, Kurita C, SUEZ W. Our desalting rate drops away quickly when we use heavier feeds. What is the problem here? Digital Refining. 2021