Corrosion Mitigation in Crude Oil Process by Implementation of Desalting Unit in Erbil Refinery

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Abstract

The aim of this study is to reduce the percentage of salt and water in the Khurmele crude oil which is chosen for this study in order to mitigate the corrosion of the equipment's involved in the refining process. The produced oil in Khurmele oil field, received by a refinery, usually contains water, mineral salts, and sediments, which should be treated before starting the refining process. In addition, this water normally contains dissolved mineral salts which are usually soluble in the water phase such as chlorides of sodium, calcium, and magnesium. If crude oil is left untreated, it can cause various operating problems such as scaling, corrosion and inorganic fouling of the equipment, and catalyst poisoning of the hydrotreating unit. This study focuses on the optimization of the salt removal and dehydration efficiency of the desalter unit, which currently is a single-stage desalter. Five parameters which are affecting the efficiency of the desalter unit are; temperature, demulsifier injection rates, wash-water injection rates, differential pressure, and electrical current. A systematic study was carried out by variation of one parameter while keeping the other four parameters constant at each time. Basic Sediments & Water (BS&W) will be measured to evaluate the effect of each parameter. Samples were taken with every changed factor and analyzed.., For multiple tests, the extent of the changes and the difference between the results of the first sample with the results of other samples, on the basis of the analysis of the percentage removal of salts and separation of water, were determined in order to get the best results at the end. This leads to the improvement of the operational conditions to good working conditions. It was found that at a crude oil flow rate of 70 -200m3/hr.

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The optimum result of salt and water removal was at the temperature 125 °C. The optimum injected concentration of Embreak 2W157D was 20ppm for salt and water removal. The highest efficiency for salt and water removal was reached at 1.3bar differential pressure (ΔP = 1.3bar). The best ratio of wash water injection to desalter unit for optimum salt and impurities removal from the crude oil was found to be 6m3/hr. Also, It was found that the electrical voltage value of 23 Kv. gave the optimum collection of water drops. Finally, the overhead system corrosion was due to the hydrogen chloride dissolved in crude oil passed through bad desalting process to downstream of the desalter unit.

Keywords: Corrosion; desalting process; refinery.

1. Introduction

A desalting study was chosen and done in KAR refinery. To avoid equipment failures and reduce the corrosion problems by the desalting process, because that oil was processed in this refinery is Khurmele oil field, this crude has a high amount of inorganic salt contents, which amounts for up to 35 PTB when receiving in refinery and must be lowered down to approximately 1 PTB. Inorganic salts that hydrolyze at high temperatures making acids, which develop high corrosion in heat exchangers in the crude, preheat system and the overhead system in an atmospheric distillation tower.

The produced crude oil which is received by refinery contains small quantities of mineral salts most of which are dissolved in the water, the remainder found as very fine crystals. This amount of the salt creates acids at high temperature, which are corrosive that attack the material of the different equipment which decreased their work live. To scale down the corrosion effect on those types of equipment, the inorganic salt substance in crude oil is reduced through desalting system. Corrosion is related to metallic material however others nonmetallic substances like ceramics and polymers can also be damaged when they are attacked by chemicals. In this record goes to increase the chemical corrosion due to acid attack and the desalting system to cut the acid corrosion influence within the distinctive forms of equipment used in Oil Refinery industry [1].

The presence of alkaline magnesium, calcium, etc... Chloride impurities in the petroleum abounding to refineries introduce hydrochloric acid in the tops of crude columns. In a characteristic crude column, due to the attendance of stripping steam in the column, or wash water in an upstream desalter unit, or due to the presence of water in the abounding petroleum, hydrolysis of these alkaline earth chlorides happens and issues hydrochloric acid HCl While magnesium and calcium chloride salts incline to hydrolyze in the feed heater and bottommost section of the crude column, the sodium chloride salt attacks hydrolysis and is stable. The hydrochloric acid vapors are unstable and move through crude column beside with the column overhead vapor. If untreated, the hydrochloric acid gas will condense in the neighborhood of the aqueous dew point in the crude column overhead system, which is causing active acid corrosion [2].

The Sources of corrosion obstruction credited to components presents in the crude oil are mostly for hydrogen chloride, natural, and organic and inorganic chlorides, That brine is crude oil contamination, and the separation of crude from brine is difficult, all crudes include a salt of NaCl and MgCl2 that dissolved in water and then

type HCl through hydrolysis at 149°C. to 205 °C. After forming HCl it passes through preheat exchanger, furnace and entered to the distillation column. On the prime of distillation column where the temperature is low, near about 135ºC and turns into reducing in overhead strains that sooner or later reason corrosion as it gets contact with water at 100 ºC. HCl makes reaction with iron (Fe). To decrease this corrosion NH3, NaOH, natural and organic corrosion inhibitors are directly dosed in an overhead system and keeping the PH of water at a value of 6. The prime temperature of the crude distillation column should be more than the water dew point (100°C) [3].

Salts of chlorides in the oil could also be hydrolyzed into HCl to corrode the devices, scale down the effectivity of energy replacing, and broaden the oil float resistance and even impede the pipes. Furthermore, over quantity of salts and water in the crude oil would poison the catalysts in refining. In order to mitigate the corrosion, it is advantageous to lower the salt concentration to under 5 mg/L and water content material to under 0.3% (v.) of the crude oil before refining. The crude oils are critical to desalting and dewatering before distillation [4].

Crude oil comes from the field, which contains a mixture of elements like inorganic metal, water, mud. Pretreatment of the crude oil is important if the crude oil is to be carried effectively and to be processed without causing fouling and corrosion in the succeeding operation starting from distillation [5].

2. Operating Variables in Desalter

The variables in the desalter operation are crude flow rate, temperature, and pressure, mixing valve pressure drop and wash water rate, quality, desalting voltage. Crude oil temperature charged to the desalter is very importance for the good operation of desalter. Lower temperature reduces desalting efficiency because of increased viscosity of oil while higher temperature reduces desalting efficiency due to the major electrical conductivity of the crude. The pressure in the vessel must be continued at a high value to avoid loss of crude oil pressure, which result in risky condition, undependable operation, and a loss of desalting efficiency. The addition of diluents water, heating, and applying electricity can enhance gravity separation. The main objective of a desalting plant is to break the films surrounding the small water droplets, coalescing droplets to form larger drops, and allowing water drops to settle out during or after coalescing. The most important variables affecting desalting performance that have been identified and studied include: [6].

(1) Temperature (°C).

(2) Mixing, Delta p (kg/cm2).

(3) Adding freshwater (m3/hr.).

(4) Chemical/demulsifier injection (ppm).

(5) Electricity, voltage (kV).

3. Desalting Process

Crude oil passes through the cold preheat train and is then pumped to the desalters by crude booster pumps. The recycled water from the desalters is injected in the crude oil containing sediments and produced salty water. This liquid enters in the static mixer which is a crude, water disperser; maximize the interfacial surface area for optimal contact between both liquids. The wash water shall be injected as near as possible emulsifying device to avoid the first separation with crude oil. Wash water can come from various sources including comparatively high salt water, stripping water, etc. The still mixers are installed upstream the emulsifying devices to improve the contact between the salt in the crude oil and the wash water injected in the line. The oil/water mixture is homogeneously emulsified in the emulsifying device. The emulsifying device is used to emulsify the dilution water injected upstream in the oil. The emulsification is important for contact between the salt production water contained in the oil and the wash water. Then the emulsion enters the desalters where it separates into two phases by electrostatic coalescence [7].

4. Corrosion due to Chlorides Salts

Corrosion is the critical attack that has a material due to, chemical reaction with its environmental. Normally, corrosion is connected with a metal material, but nonmetallic materials like ceramics and polymers can be destroyed by chemical attacks. The Chemical reaction that produce corrosion depend on the situation where the material is and its rate depend on the concentration of the corrosive material The corrosion affects the material properties or cause material losses in it, salt content in crude oil its main cause of pitting corrosion equipment's, the most frequent problem that salts and water cause is corrosion in pipelines, vessels, valves and instrument parts in the processing plants. Chloride salts melt in heaters, where the temperature could reach as high as 300°C. As a result, and in the attendance of water, HCl forms, which could cause serious corrosion problems with equipment and instrumentation that, are made of iron.
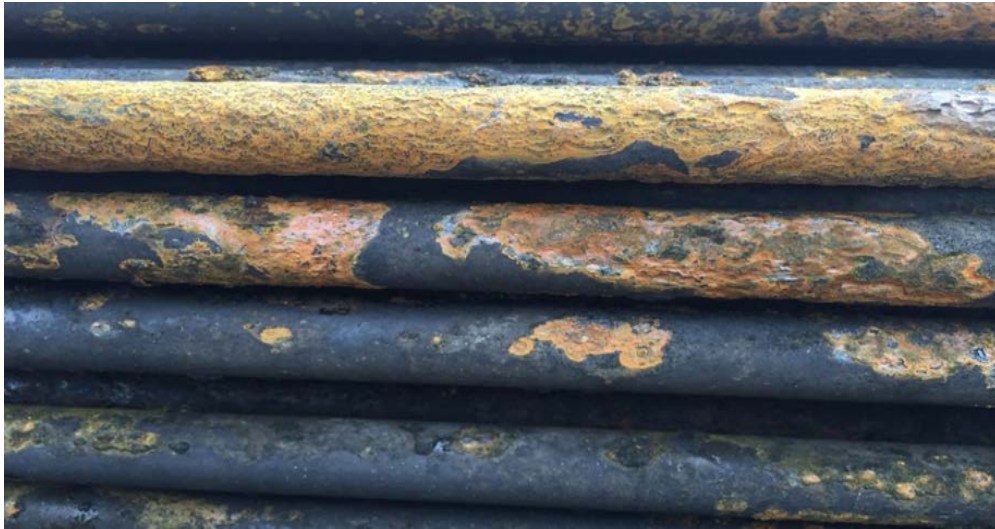
4.1 Uniform Corrosion

It is commonly called rusting over iron and other metals. As sometimes called, is defined as a type of corrosion attack that is more or less uniformly distributed over the entire exposed surface of a metal. Uniform corrosion also refers to the corrosion that proceeds at approximately the same rate over the exposed metal surface (fig.1a). The uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction which proceeds regularly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. Cast irons and steels corrode uniformly when exposed to open atmospheres, soils, and natural waters, leading to the corroded look [8].

4.2 Pitting corrosion

Pitting Corrosion is the localized corrosion of a metal surface limited to a point or minor area (as shown in fig.1b), which takes the form of cavities. Pitting is one of the most negative forms of corrosion. Commonly pitting enters from the horizontal surface deeply almost perpendicular direction. It is a very crafty type of corrosion because it is often undetectable, with very little loss of material until a failure occurs. Pitting requires

an inactive external surface that can provide a high potential to cause the current to flow into the pit; if the external surface is active, this driving force is not available. It is assumed that gravity is the cause of growth below the pitting; the dissolution is concentrated in the pitting a sit progresses down [9].

Figure 1a: Uniform Corrosion (Erbil refinery, Heat Exchanger)

Figure 1b: Pitting Corrosion (Erbil refinery, Heat Exchanger)

Experimental Work

5. Materials used

5.1 Crude oil

Crude oil collected for the kar refinery is from khurmala oilfield-Erbil- Kurdistan, Iraq. Supplied by the ministry

of natural resources (MNR). The experimental work was selected from KAR Oil Company Laboratory. The test results were supplied by (MNR). The characteristics of the Khurmala crude oil are illustrated in Table 1.

5.2 Mud wash water

Mud wash water used in the experiment sample was collected from site operation of the Kar refinery. Table 2 gives its characteristics.

5.3 Demulsifier

An oil soluble demulsifier with commercial name Embreak 2W157D was used.

Table 1: The characteristics of the Khurmala crude oil.

TEST	METHOD	UNIT	VALUE
Density at actual temperature	ASTM D 1298	Temperature °C	0.8557
			15
Density at 15°C (ASTM-table)			0.8557
API Gravity at 60°F		Temperature °C	33.8
Kinematic Viscosity @ 37.8 C° c St, ASTM D 445	ASTM D 445	Viscosity Mm²/sec	7.1
Total Acid Number	ASTM D 664	Mg/kg	0.31
Total Sulfur wt%,	ASTM D 4294	Mass %	2.35
Mercaptan sulphur	UOP 163	Mg/kg	219
Total Nitrogen^Q	ASTM D 5762	Mg/kg	1040
Acid Value (black oils)	ASTM D 664	mgKOH/g	0.195
Pour point (max)	ASTM D 6749	°C	-41
Micro Carbon Residue (MCRT)	ASTM D 4530	Mass %	4.09
Salt as NaCl in crude	ASTM D 3230	PTB	40
Reid Vapor Pressure	ASTM D 323	Pressure, psi	7
Sediment	ASTM D96	Vol.%	0.4
Water	ASTM D96	Vol.%	0.1

Table 2: Chemical analysis of the used mud washes water.

TEST	UNIT	VALUE
Specific gravity (60F°)	Temperature, F°	1.009
PH		8.6
Electrical conductivity	(µS/cm)	659
Total dissolved solids TDS	ppm	422
Sulphate as SO-24	ppm	10
Chloride as Cl⁻	ppm	55
Calcium as Ca H.	ppm	670
Phosphate as PO4	ppm	6.7
Total alkalinity as CaCo3	ppm	260
Sodium as Na	ppm	782
Total iron Fe	ppm	0.17

6. Testing methods

Samples were analyzed and tested for salt content (PTB) and water cut as a percentage of the crude (%). The tests were carried out as the following:
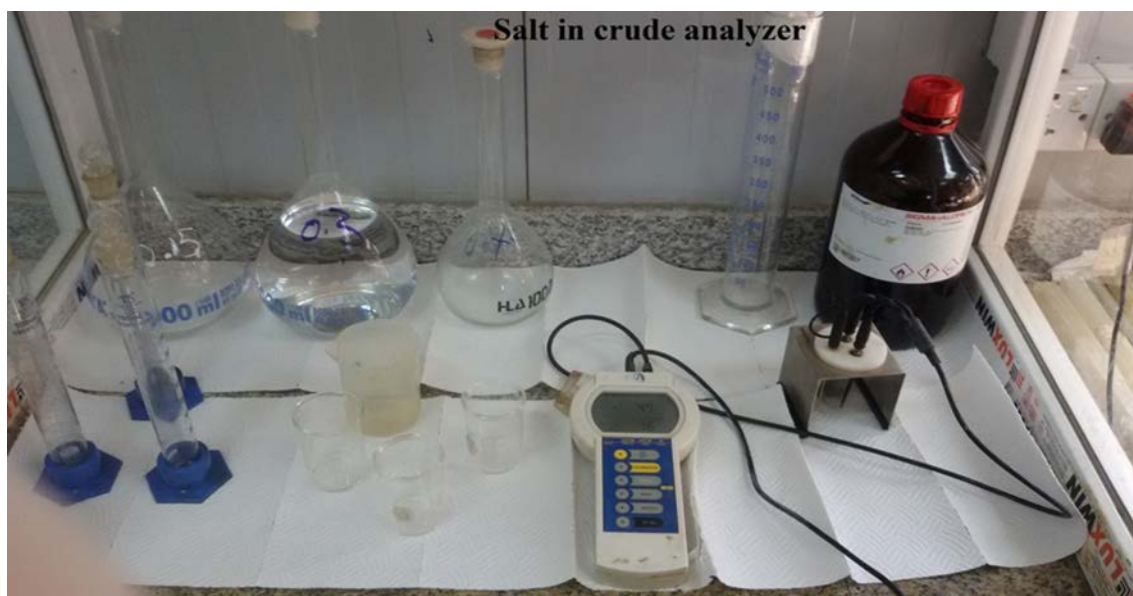
6.1 Salt in the crude test

Using the method described earlier, and after the standardization and calibration of the equipment, the initial and final samples were tested in a polar type solvent consist of 1-Butanol, anhydrous methanol, and xylene in ratios of (60:30:10) respectively. Unit: PTB (lbs. /1000bbl) = pounds per Thousand barrels.

The procedure of measuring the salt content consists of the following steps (2a):

a. 10 ml of crude were mixed with 15 mL of xylene in a dry 100 ml graduated glass-stoppered mixing cylinder, mixed and made up to 50 mL with xylene. A well-mixed fluid is obtained by shaking the cylinder for 60 seconds.

b. The above solution was made up to 100 ml with mixed alcohol solvent.

c. The cylinder was shaken vigorously for 30 seconds and then allowed to settle for 5 minutes.

d. The metal part of the sensor assembly was cleaned with xylene then wiped to remove all traces of the cleaning solvent.

e. The solution was poured into a dry test beaker and electrodes were placed into the solution

immediately then   the salt content was recorded in (PTB).

f.   The sensor assembly was cleaned and dried to be ready for the next measurement.

Figure 2a: Salt in the crude analyzer (Refinery laboratory).

6.2 Water cut testing method

Samples were tested for water cut in every single experiment. The basic principle here is to rotate sample tubes in a circular motion at a very rapid rate. A force of the gravity is exerted on the particles and then the heavier constituents of the tube, such as water and sediment, which have higher mass, have greater tendency to break away from the axis of rotation than the lighter oil particles. Therefore, the heavier particles become concentrated at the bottom of the tubes.

Unit: Volume %.

To measure water cut, the following procedure was followed:

a.   100 mL centrifuge test tubes (fig.2b) were filled with exactly 50 mL sample taken directly from the sampling bottle and made up to 100 mL with toluene.

b.   Stopper test tubes were tightened and inverted for minimum 10 times to mix the crude with a solvent to obtain a well-mixed flued.

c.   Tubes were placed in a preheated water bath at 60 C and then centrifuged for 10 minutes.

d.   Immediately after the centrifuge comes to rest, record the combined volume of sediments and water in the bottom of each centrifuge tubes.

Figure 2b: Water & sediment analyzer (Refinery laboratory).

6.3 Chloride ion testing method: Titration method

This method determines the chloride ion concentration of a solution by titration with silver nitrate. As the silver nitrate solution is slowly added, a precipitate of silver chloride is formed. The end point of the titration occurs when all the chloride ions are precipitated. Then additional silver ions react with the chromate ions of the indicator, potassium chromate, to from a red-brown precipitate of silver chromate.

Reagents used were: Titrant which was a standard solution of AgNO3 0.0141 N from HACH, potassium Chromate K2CrO4 indicator 5% and distilled water.

Apparatus:

Automatic burette, conical flask, dropped and pipette

To measure chloride ions, 5 mL of the sample were pipetted in a conical flask, 10 drops of distilled water and 3 drops of the indicator were added and shaken well. The solution was then titrated against the standard solution of AgNO3 until the end point, which is the first excess of titrant results in the formation of red silver chromate precipitation.

6.4 Conductivity

This method determines the conductivity.

Apparatus: conductivity meter (WTW) (fig.2c), Reagent used was: Water wash cut, Unit: microsiemens / cm, milisiemens / cm

Procedure:

   1. Put the conductivity electrode in the distill water for 30 minute.

   2. Put the sample in the beaker and insert the cond. Electrode in.

   3. Switch the conductivity meter on.

   4. Read the result shows in the display.

Figure 2c: Conductivity meter (Refinery laboratory)

## 7. Results and Discussions

7. 1 Effect of the temperature

The efficiency of desalting in each experiment is determined the percentage of salt removal and the percentage of water cut. Figure 3 & 4 the effect of the temperature for five values: 110 °C, 115°C, 120°C, 125°C and 130 °C shows the crude oil properties, inlet, and outlet of the desalter, also the water characteristics inlet an outlet of the desalter. The higher salt and solids removal of 98% and 80% of water removed respectively were reached when the temperature was 125°C. It has been confirmed that the higher temperature in the desalter benefit the desalting and solids removal efficiency. The highest temperature was 130 °C due to the limitation on the preheating train of the crude distillation unit, but at temperature 125°C the results were good. As technical literature mentioned "the purpose for this is ruled by stokes law which says that the higher temperature the higher density difference between oil and water and the earlier the molecules will settle. In addition with higher temperature, the viscosity will lessen resulting in earlier settling. With all this increased settling velocity and measure it is possible for water molecules to combine earlier and form bigger molecules that can settle much

quicker.

Operational Conditions:

Flow rate (70 - 200) m3/hr.; Temperature °C: variable; Demulsifier: 5 ppm; ΔP thru mixing valve: 1kg/cm2.

Water Flow: 2m3/hr.; Voltage: 12 KV.
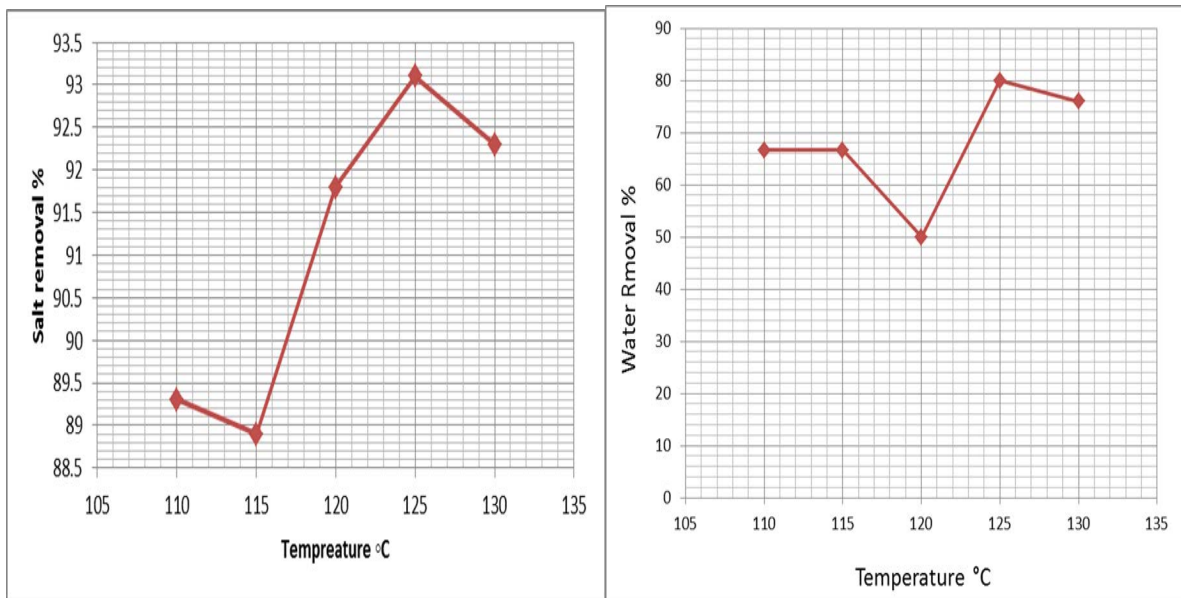
Figure 3: Effect of Temperature on desalting, salt removal   water removal   (%) vs. temperature (°C)

**Figure 4:** Effect of temperature on desalting,   (%) vs temperature (°C)

7.2 Effect of the demulsifier

In principle, demulsifier dosage for desalter should be set with the assistance of a chemical vendor but at no time should be assumed suitable for an extended period of time. At least once a year a short study should be undertaken to verify that the dosage is still suitable. In our present analysis, we optimize the dosage without a chemical vendor, and we have found that the best chemical dosage was 20ppm, reaching high efficiency on salt, solids and water removal in the desalter. As shown in figure 5 & 6. The desalting does not necessarily increase with chemical dosage increase; it will be depending on the characteristics of the crude oil. According to other refinery experiences, and also a lesson learned in Erbil refinery, which should be shared within the operational people, is that: when you have been running crude oil for long period and a new crude oil parcel desalts less efficiently. The chemical injection rates are the same, the desalter is tested out and looks to be functioning as expected, and the crude oil looks the same from its physical properties. But this material is hard to desalt. It has been found upstream exploration companies use chemicals as stabilizers and carry through in the crude oil and have been known to affect the desalting process. Usually on the demulsifier dosage of 20ppm, we continue with the analysis of the third variable (ΔP) deferential pressure through mixing valve.
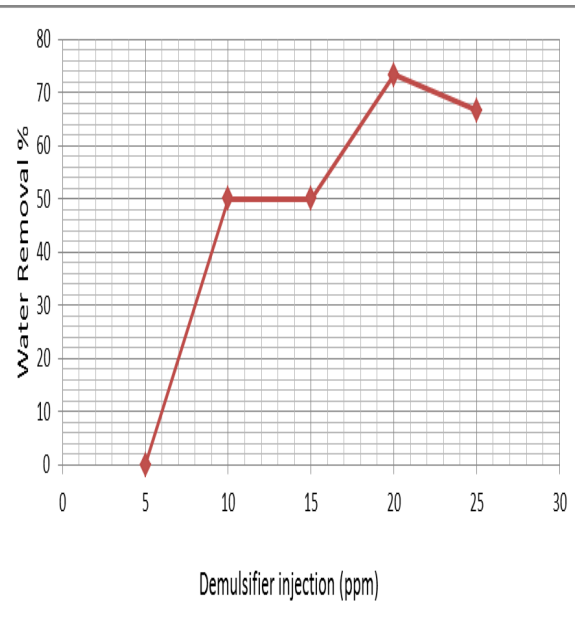
Operational Conditions:

Flow rate (70 to 200) m3/hr.; Temperature: 125°C; Demulsifier: variable; ΔP thru mixing valve: 1kg/cm2

Water Flow: 2m3/hr.; Voltage: 12 KV.
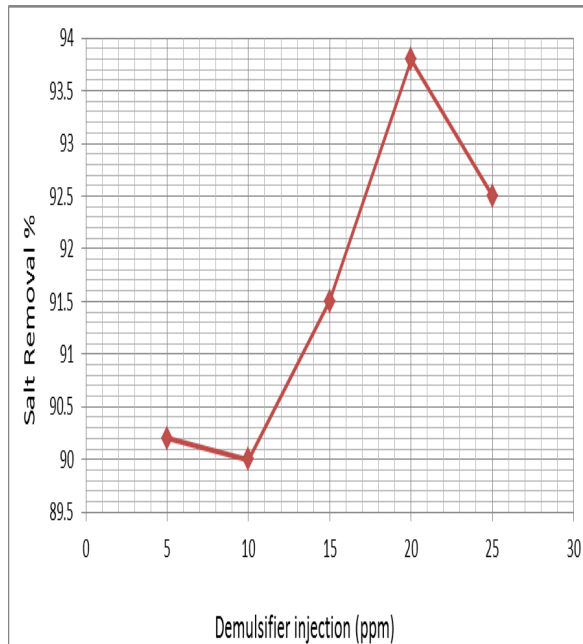
| **Figure 5:** Effect of chemical injection on desalting, salt water removed | **Figure 6:** Effect of chemical injection on desalting, removed |

7.3 Effect of ΔP thru mixing valve

The pressure drop across the mixing valve should be monitored and controlled closely. Too high pressure makes an emulsion that is durable to break, particularly if there are any solids present. It is important to only use abundant pressure drops to get good mixing; the increase or decreasing the pressure drop it's done by close and open the mixing valve to pass crude oil through this valve. Though that draws more current from the grid and requires adjustments to keep from over amperage. In figure 7 & 8 show the effect of differential pressure through mixing valve at five values: 1.0, 1.2, 1.3, 1.4 and 1.5 bars. The highest efficiency for salt and solids removal was reached at differential pressure = 1.3 bars.

Operational Conditions: Flow rate (70 to 200) m3/hr.; Temperature: 125°C; Demulsifier: 20 ppm; ΔP thru mixing valve: variable; Water Flow: 2m3/hr.; Voltage: 12 KV.

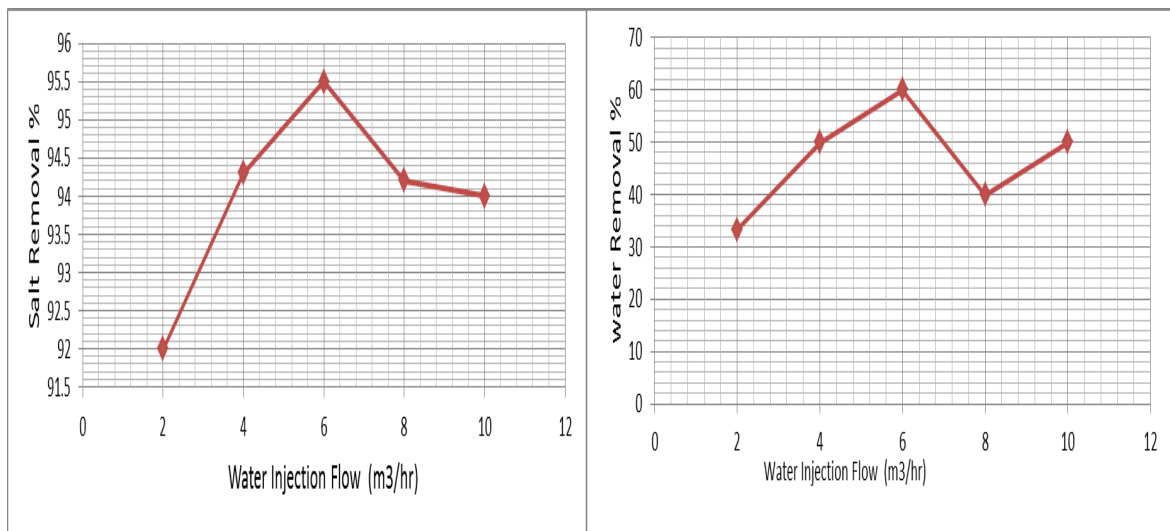### 7.4 Effect of the water dilution

Water-related with crude oil can cause huge operational problems. The removal of this water can be readily able by using a desalting/dehydration unit. Wash water rate should be increased to improve the contacting of the oil and water streams. We tried to use different water flow rate to desalter that water flow increased up step-by-step start from 2m3/hr. to 10m3/hr. at the 100m3/hr. crude flow rate, the best efficiency of desalter was at 6m3/hr.

water flow rate by depending on the laboratory results. In figure 9 & 10 shows the result. The quality of the wash water is important. Wash water with a high pH can cause stable emulsions. This is normally and an indication of caustic in the system, which can cause the attendance of sodium naphthenates (soaps). These soaps can also be formed with a naphthenic acid containing in crude oil with acid numbers more than 1.0. Five values of wash water were added to desalter were analyzed: (2, 4, 6, 8, and 10) m3/hr. it was confirmed that water injected equal 6% of crude oil flow rate was the best condition.
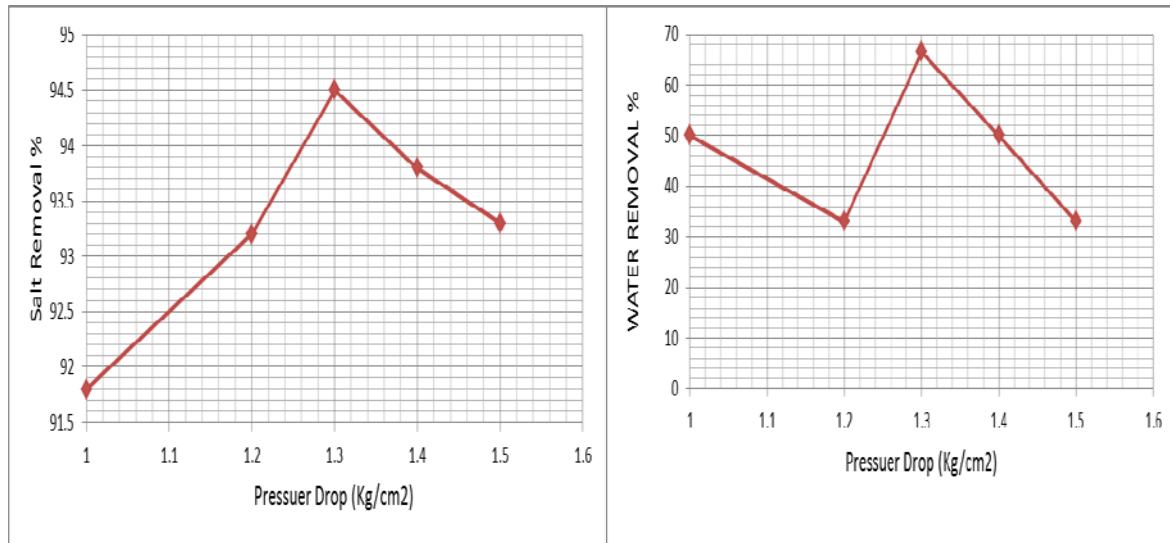
Figure 7: Effect of ΔP through mixing valve on salt removed   **Figure 8:** Effect of ΔP through mixing valve on water removed

Operational Conditions: Flow rate (70 to 200) m3/hr.; Temperature: 125°C; Demulsifier: 20 ppm; ΔP thru mixing valve: 1.3kg/cm2 Water Flow: variable; Voltage: 12 KV.


Figure 9: Effect of water dilution on salt removed   **Figure 10:** Effect of water dilution on water   removed

7.5 Effect of the voltage

Electrical current helps water droplets to collect at a short time to drop dawn, the voltage was changed from 12 KV to 16 KV, 20 KV, 23 KV, and 25 KV the best result was 23 KV. Figure 11 & 12 shows the results.

Operational Conditions: Flow rate (70 to 200) m3/hr.; Temperature: 125°C; Demulsifier: 20 ppm; ΔP thru mixing valve: 1.3kg/cm^2; Water Flow: 6m3/hr.; Voltage: variable.
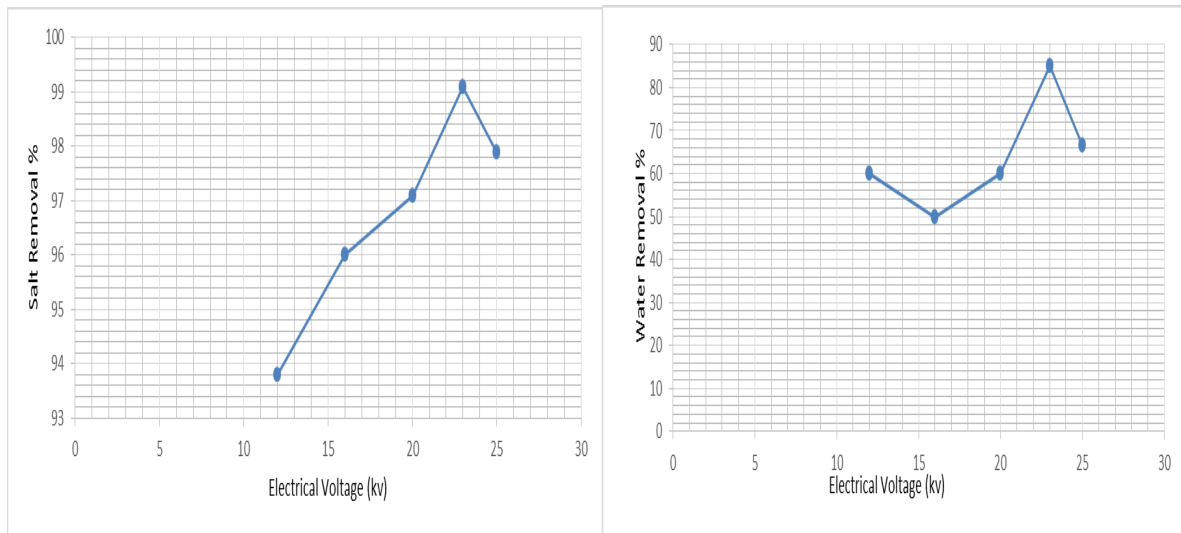
Figure 11: Effect of electrical voltage on salt removed **Figure 12:** Effect of electrical voltage on water removed

7.6 Effects of the five factors at the stable status

Determine the best performance of the desalter as a key equipment of desalting, salt and water removal of crude oil. Founded the professional performance a desalter efficiency, it has been concluding that desalting helps reducing corrosion, water removal help in avoiding fouling of downstream preheat exchangers. For these reasons, our targets in this study are the following: desalting efficiency should be more than 98 %. In Table 11 the effect of those five factors at the best conditions and all of the factors in the stable status. Fifteen samples are taken during fifteen days to prove the desalter efficiency for remove salt and water.

Operational Conditions:

Flow rate (70 to 200) m3/hr.; Temperature: 125°C; Demulsifier: 20 ppm; ΔP thru mixing valve: 1.3kg/cm2.

Water Flow: 6m3/hr.; Voltage: 23 kv.

Table 11: The best performance efficiency of the desalter unit was reached after following variables of the operation condition.

	OPERATION CONDITION					CRUDE PROPERTIES						
DESALTER OPERATION CONDITIONS AND PERFORMANCE												
Date	Temoreatuer °C	Demulsifer (pmm)	ΔP Thruogh Mixing Valve Kg/cm2	Water flow (m3/hr.)	Voltage (kv)	Water inlet %	Water outlet %	Sediment inlet %	Sediment outlet %	salt inlet (PTB)	Salt Outlet (PTB)	Salt removal %
Aug/1/2016	126	20	1.3	6	23	0.25	0.01	0.7	0.1	41.2	0.4	99
Aug/2/2016	125	20	1.3	6	23	0.3	0.03	0.6	0.1	32.3	0.35	98.9
Aug/3/2016	124	20	1.3	6	23	0.35	0.04	0.8	0.1	50.2	0.5	99
Aug/4/2016	125	20	1.3	6	23	0.5	0.1	1.2	0.06	46.8	0.35	99.2
Aug/5/2016	126	20	1.3	6	23	0.3	0.01	0.6	0.1	39.2	0.25	99.3
Aug/6/2016	124.5	20	1.3	6	23	0.4	0.02	0.8	0.1	37.8	0.2	99.4
Aug/7/2016	125	20	1.3	6	23	0.2	0.01	1	0.03	44.1	0.4	99
Aug/8/2016	125.5	20	1.3	6	23	0.4	0.05	1.1	0.05	38.6	0.3	99.2
Aug/9/2016	124	20	1.3	6	23	0.35	0.05	0.7	0.05	36.4	0.3	99.1
Aug/10/2016	126	20	1.3	6	23	0.45	0.08	0.7	0.1	43.4	0.5	98.8
Aug/11/2016	125	20	1.3	6	23	0.35	0.1	0.45	0.1	37.5	0.25	99.3
Aug/12/2016	126	20	1.3	6	23	0.5	0.1	0.5	0.06	45.9	0.3	99.3
Aug/13/2016	124	20	1.3	6	23	0.25	0.08	0.8	0.02	49.6	0.45	99
Aug/14/2016	125	20	1.3	6	23	0.6	0.06	1.1	0.02	50	0.3	99.4
Aug/15/2016	125	20	1.3	6	23	0.5	0.02	0.8	0.05	39.7	0.35	99.1
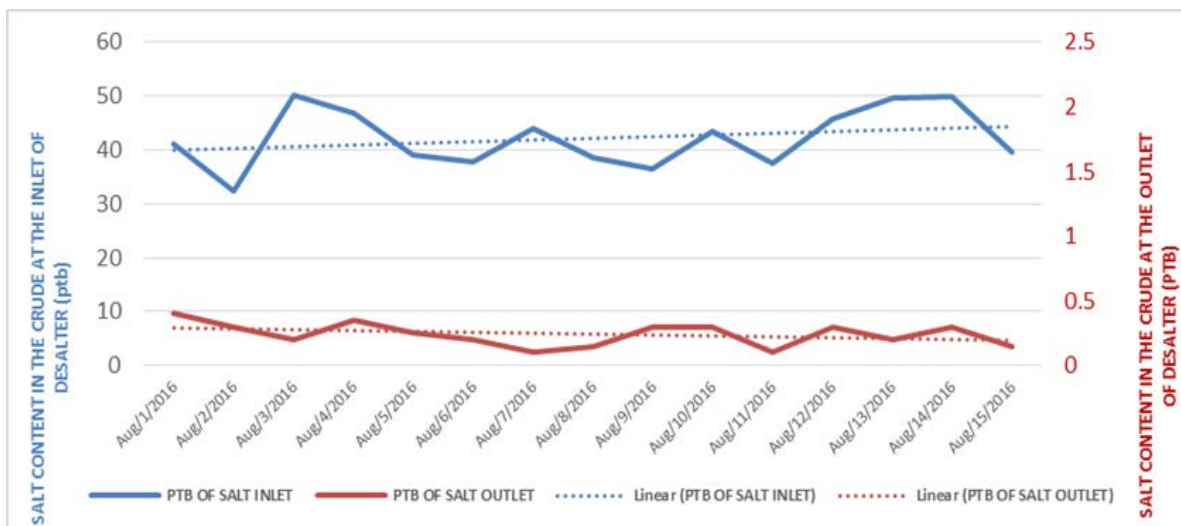
Figure 13: Salt content in the crude oil at inlet and outlet of desalter.
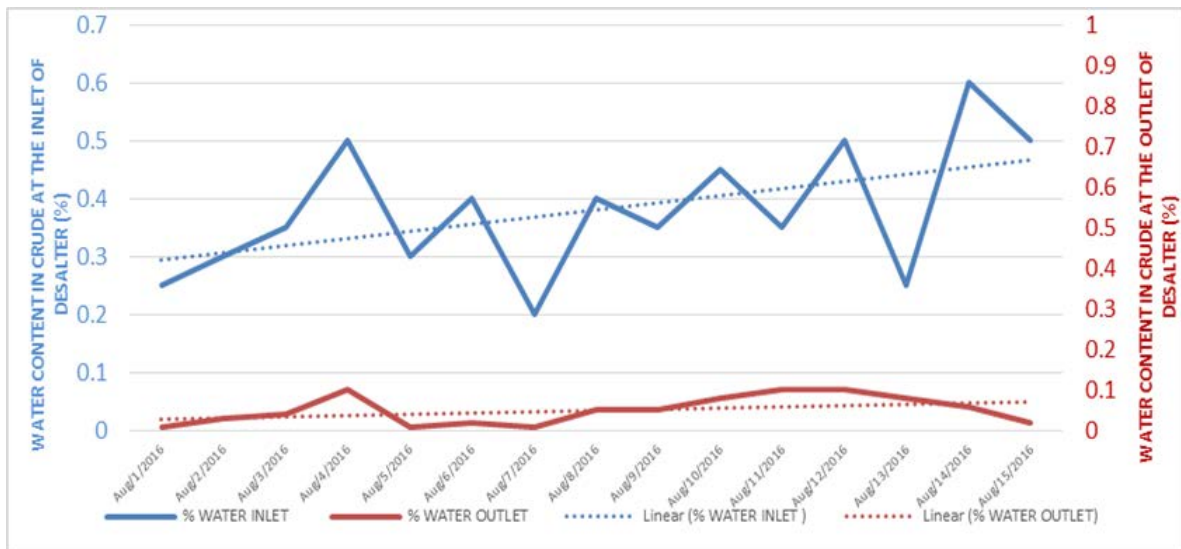
Figure 14: Water in crude oil at the inlet and outlet of desalter.

Figure 15: Sediments content in the crude oil at inlet and outlet of desalter.

8. Conclusions

1. The following conclusions are found on the basis of best desalter efficiency at a crude oil flow rate of

   70 -200m3/hr.:

   a. The optimum result of salt and water removal was at the temperature 125 °C.

   b. It was found that the optimum injected concentration of Embreak 2W157D was 20ppm for salt and water removal.

   c. The highest efficiency for salt and water removal was reached at 1.3bar differential pressure (ΔP =

1.3bar).

d. The best ratio of wash water injection to desalter unit for optimum salt and impurities removal from the crude oil was found to be 6m3/hr.

e. It was found that the electrical voltage value of 23 Kv. gave the optimum collection of water drops.

2. The overhead system corrosion was due to the hydrogen chloride dissolved in crude oil passed through bad desalting process to downstream of the desalter unit.

9. Recommendations

The followings are recommended for future work:

1. Adjust the desalter operational conditions of KAR refinery according to the conclusions of this research. General recommendations to improve the operation of the desalter are the following:

• Increase the operating temperature of the desalter up to the temperature limit.

• Increase the pressure drop across the mixing valve to increase atomization of the feed and water and increase mixing.

2. Study the effect of differential temperature on water separation process.

3. Using different kinds of chemical agents to improve the performance of demulsifiers.

4. Apply another method of treatment to corrosion mitigation, such as naphthenic acids,

metal, salt removal.

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