Problems Occurring in De-Salter plant Of Crude oil and its solution.

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***Abstract*—Abstract- This work is about the solving of problems occurring in desalter plant of crude oil. One of the major causes of desalter upsets is grid over-load. This is can be solved by detecting the presence of emulsions building upwards before they enter the grids. Another major causes of desalter upsets is high water content crude being delivered to the desalter from the tank farm. The primary function of the desalting system is the removal of inorganic chlorides and other water-soluble compounds from crude oil. Also averaged total hydrocarbon releases to refinery sewers range from 0.5% to 0.4% of the total crude charge. Unfortunately, refiners are losing valuable feedstock to the sewer and must spend nearly $10bbl to recover and reprocess lost hydrocarbons. The desalting system is the largest contributor to wastewater; improving operating methods on this unit can reduce shutdowns and maintenance expenses. Equally important, better operating practices can decrease organic loading on the wastewater treating unit. Several case histories illustrate various source reduction methods to minimize hydrocarbon emulsion losses to sewer. The possible outcomes of these problems are very necessary for De-Salter plant.**

***Index Terms*—De-Salter plant, Refinery, Crude oil desalting** *(key words)*

I. INTRODUCTION (HEADING 1)

A paper contains process description of desalter plant, different problem occurring in plant due to some unfavorable condition and their solutions. There many methods to solve the engineering problems occurring in desalter plant. In this we will focus on AGAR SYSTEM to increase efficiency of desalter plant of crude oil.

In these systems (AGAR SYSTEM), multiple probes are used to control the desalter and warn the operators of possible problems by giving operations time to take corrective actions before upsets occur. Desalter upsets if grid is over-load. The first indications of Emulsion Build-Up in the desalter are the decrease in Volts and increase in Amps on the Grids. By detecting the presence of emulsions building upwards before they enter the grid will allow operators to take corrections before the grid begin to overload.

If high water content crude being delivered to the desalter from the tank farm then also desalter upsets. The detection of high water content crude before it arrives at the desalter allows operations to make adjustments to minimize the adverse effects of the wet crude.

The desalting system is the largest contributor to wastewater; improving operating methods on this unit can reduce shutdowns and maintenance expenses. Equally important, better operating practices can decrease organic loading on the wastewater treating unit. Several case histories illustrate various source reduction methods to minimize hydrocarbon emulsion losses sewer.

Due to a mature and more competitive marketplace, operating companies are re-evaluating fundamental manufacturing strategies. Consequently, the incentive to apply new technologies and improve operations is more compelling than ever before. New measurement technologies, such as energy absorption, have steadily entered the marketplace to meet this need.

Source reduction is an area where innovative technology is being evaluated and used by many major oil and petrochemical companies. The most effective way of reducing the hydrocarbon content in final effluent is to avoid contaminant losses at their source. Energy absorption (EA) technology has proven to be a useful tool when controlling the amount of hydrocarbons sent to wastewater treatment plants (WWTPs). EA can be applied for monitoring and controlling many separation processes. Additionally, these new control systems help to relieve the pressure from tighter environmental restrictions by reducing the quantity of hydrocarbons released to wastewater pretreatment systems.

Introduction of ONGC Desalter Plant:

The crude oil produced from north Gujarat has high salinity and high BS&W which is detrimental for refinery operation. In order to reduce the salinity and BS & W of the crude to meet the refinery specifications, ONGC had set up a desalter plant at Nawagam.

With the increasing regulations on effluent water and the ever increasing cost of producing a barrel of oil, the use of emulsion-treatment plants has become an important practice in crude oil processing. Treatment of emulsions has always ranged from simple methods such as gravity settlement to highly sophisticated methods such as tri-volted desalting and dehydration systems. The development of desalting systems has always been evaluated in terms of quantities of salt and water being removed. In a desalting unit, when crude oil is heated as part of various desalting, dehydration or refining processes, the water may be driven off as steam.

The salts in the water, however, do not leave with the steam. They crystallize and may either remain suspended in oil or form scale within heat-exchange equipment. Entrained salt crystals may deactivate catalyst beds and plug processing equipment. Because of these potential problems, refineries usually reduce crude oil salt content to very low levels prior to processing. To reduce the amount of desalting required at the refinery, some oil purchasing contracts specify maximum salt content as well as maximum water content. A typical salt specification would be 10 Pounds per Thousand Barrels (10.0 PTB).

To satisfy such purchase specifications, producers may be required to perform some oil desalting. Among the many reasons desalting, dehydration units are installed to avoid transporting high viscosity liquids, ''water-in-oil'' emulsions, which require more pumping energy. Furthermore, salts and water are removed in day-to-day operation for three reasons: corrosion, scale accumulation, and lowering of activity of catalysts.

Desalter plant, Nawagam was commissioned in Jan 1995 to process highly saline crude to meet the refinery requirement of 15 PTB of salinity and 1% of BS& W. Desalting means removing salt from crude oil by adding less salty water. The less salty water is relatively fresh than the highly salty formation water produced with the crude. Adding of this, so called fresh water dilutes and lowers the salt concentration of the formation water remaining in the crude to an acceptable level. The less salty water added into crude is known as wash water or dilution water. The desalter Complex consists of existing Desalter units, floating roof, storage tanks and proposed desalter units. There are three desalter trains available at Nawagam for processing of 12000-13000 m3/day of crude oil. The desalter plant has been designed to reduce water content from 5% to 1%. Presently the water content of the crude at inlet varies from 6-13% and after processing the water content of the crude oil in the outlet of desalter vessel varies from 0.58% to 1.5%.

After the dismantling of the administrative prince mechanism the water content in the dispatch crude oil should not exceed 0.2%. Hence the project, up gradation of facilities at Nawagam envisages additional processing facilities to limit water content and salinity in the crude oil to comply with the requirement of post APM scenario. In addition, the setup gradation of firefighting facilities and DCS control system for the total plant are also envisaged in the project.

Materials & Methods

Electrical treatment (Electrostatic coalescing):

It is the most effective method that provides a strong driving force for removing salt water from Crude oil.

The natural composition of the water droplet itself is the basis of this theory. The water droplet is made up of many polar molecules. Each water molecule has one part oxygen and two parts of Hydrogen. Oxygen has a negative end and hydrogen a positive end. These polar forces are arranging a shape very much like a bar magnet and easily responds to an applied electrical force field.

Method of dehydration

When the producer water in crude is very salty as in our case then, straight dehydration is not the only solution and so the crude has also to be desalted.

Dehydration: means removing of salt water from crude oil to at least 0.1%. This accomplished by gravitational method through 3 phases' separators, well tanks and desalter vessels.

Desalting: means removal of salt from crude oil by adding less salty water. The less salty water is relatively fresh than the highly salty formation water produced with the crude. Adding of this, so called fresh water dilutes and lowers the salt concentration of the formation water remaining in the crude to an acceptable level. The less salty water added into crude is known as wash water or dilution water. The formation water produced with the Kuwaiti crudes normally contains salts in range of 150,000 to 200,000 ppm.

The main objective of install dehydration/-desalting plant……

To maintain field production potential

Clean up drilled and worked over wells

To provide an effective controlling method that will allow a better reservoir production distribution.

Allow produce wet wells caused by injection of help recovery.

To increase the final recoverable receives.

Types of emulsion normally, there are two types of water in oil emulsion

Tight emulsion:

Small water droplets spread in the crude oil, this violent mixing of water in oil can be caused by submersible pumps big differential pressure drop at well head or at mixing valve in the desalter plant. Tight emulsion is very easy to make but difficult to break one because it requires higher operating temperature, higher chemical injection rates and higher efforts.

Loose emulsion:

Formed of large water droplets and it caused by moderate and sufficient mixing and it is not difficult to treat.

Main Function of desalter:

The main function of the desalter plant is to separate emulsified water and oil. For this, following steps are taken in order:

Chemical dosing:

To separate oil and water from each other different chemicals are added to break emulsifications. These chemicals are called demulsifier and the process is known as demulsification. Demulsifier are added before the feed pump which is actually a centrifugal pump. So whatever amounts of demulsifier is added in the crude oil are well mixed. After feed pump process water (0.5%) is added

Heat Exchangers:

Feed is heated by heat exchanger heat with the hot product from the desalter vessel to temperature 63 deg C. Demulsifiers work better at higher temperatures. So the treated crude which is very hot is used as shell side and the untreated crude at the tube side is used in shell and tube heat exchanger. The exchanger very effectively heats up the crude oil and raises its temperature from 30 C to 63 C.

Heater:

This temperature of 650C is not enough for effective for demulsification of oil and water. For raising the temperature further it is sent to heater where it is fired by fuel gas. The feed heaters are flue gas recycle type. Its temperature rises from 650C to 900C

Economizer:

From heater heat is recovered in economizers. And again this energy or heat is used to fire the fire-tube in heat exchanger.

Desalter Vessel:

The hot feed oil is mixed with wash water in mixing valve to ensure thorough mixing and sent to desalter. Oil & salty water in the incoming feed are separated by electrostatic means in the desalter. It contains a system of electrostatics grid which is very effective in removing water from oil. On application of high voltage electric field, the water droplets in the oil coalesces and settle down due to density difference, taking along with them other solid particles present in the feed. It has two outlets for draining. The product crude is taken out from the top of the desalter and is cooled to 50 deg C by exchanging heat with the feed in feed head exchangers.

Product water is taken out and sent to the waste water treatment plant. The water is drained through outlets contains 100ppm of oil. This small amount of oil is further recovered when it is sent to ETP (Effluent Treatment Plant) or WWTP (Waste Water Treatment Plant).

Variables affecting the performance of desalting:

Desalter process is achieved by various combination of treatment such as:

Gravity separation

Chemical treatment

Heating

Washing with water (dilution)

Mixing wash water (agitation)

Electrical treatment (electrostatic coalescing)

Gravity separation:

Most desalting-dehydration equipment relies on gravity to separate water droplets from the continuous oil phase. Gravity difference is the active element in this process; the produced=formation water droplets are heavier than the volume of oil they displace. The produced water usually carries some salts and solids coated predominantly with a thin film of oil or just freely flowing along the emulsion stream (Lohne, 1994).

The removal of free water or unemulsified water from crude oil, the free water when given opportunity i.e. residence time and enough space, It readily separates by gravitational method. The gravity settling out of this free water is mainly accomplished in separators, wet tanks and desalter vessels.

Chemical Treatment:

Emulsions can be further treated by the addition of chemical stabilizers. These surface-active chemicals adsorb to the water-oil interface, rupture the film surrounding water drops, and displace the emulsifying agents back into the oil. Breaking the film allows water drops to collide by the natural force of molecular attraction, forming a large droplet which is easily separates from oil and settles down faster. Time and turbulence aid diffusion of Demulsifiers through the oil to the interface. Experience has shown that the mechanism of the chemical process is not explicable by any simple theory. Nevertheless, there is a rule of thumb learned in the field that states that the lower the water percentage in an emulsion the more difficult it is to treat.

Chemicals:-There are 4 types of chemicals mainly using desalter plant.

a. Demulsifier chemical
b. Oxygen scavenger
c. Scale inhibitor
d. Coagulant chemical

a. Demulsifier

Demulsifier chemical is injected into water-in-oil emulsion to break and remove a thick film of emulsifying agents around water droplets. The dosage ppm of Demulsifier is 20ppm.

b. Oxygen scavenger:

It is injected into wash water system to remove free oxygen to prevent oxygen corrosion. The dosage ppm of oxygen scavenges is 64ppm.

c. Scale inhibitor:

It is injected into both wash water system and wet oil system in order to prevent formation of scale deposits. The dosage ppm of scale inhibitor is 20-30ppm.

d. Coagulant chemical:

It is infected into wash water treatment unit at the floatation inlet line. Its purpose is to break oil in water emulsion.

Heating:

Heat causes a decrease in viscosity, thickness, and cohesion of the film surrounding water drops. Heat also reduces the continuous phase (oil) viscosity, helping water drops to move freely and faster for coalescing. Controlling the temperature during operations is a very delicate job. Any excessive heat might lead to evaporation, which results not only in a loss of oil volume, but also in a reduction in price

Washing with water (Dilution water):

Salts in emulsion sometimes come in solid crystalline form. So, the need for freshwater to dissolve these crystal salts arises and dilution with freshwater has become a necessity in desalting equal to dehydration processes. Freshwater is usually injected before heat exchangers to increase the mixing efficiency and to prevent scaling inside pipes and heating tubes. Freshwater is injected so that water drops in emulsions can be washed out and then drained off, hence the term ‘‘wash water.’’ The addition of less salt water into wet crude is very important and helps to dilute its highly salt water content. When wash water is well distributed in crude, it helps to join together smaller droplets and speedup this separation from the crude. The quantity equal to ratio of freshwater injected depends on the API gravity of the crude, but, generally, the injection rate is 3_10% of the total crude flow, (al-Kandari, 1997).

Mixing wash water (Agitation):

High shear actions form emulsions. Similarly, when dilution water (freshwater) is added to an emulsion, one needs to mix them in order to dissolve the salt crystalline and to aid in coalescing finely distributed droplets. Mixing works in three steps: (1) helps smaller drops to join together, (2) mixes chemical equal to demulsifier with the emulsion, and (3) breaks the free injected volume of wash water into emulsion-sized drops and evenly distributes it. So wash water must be distributed in every direction inside the wet crude in order to let wash water do.

Results & Discussion

Effect of Wash Water Dilution Ratio:

At the beginning of water injection, the W=C efficiency was higher than S=R efficiency. This can be explained by the presence of some salt in the crystalline form. The free water was being washed out, hence increasing the W=C efficiency, but leaving salt crystalline flowing out with the product crude. As the dilution water injection increased, more salt dissolved in the water. The efficiency of S=R improved, crossing the water cut efficiency at 3% water injection rate and then stepped up as the water rate was increased. The W=C efficiency, however, started to deteriorate as the water injection rate increased. This is due to a phenomenon known in the petroleum field as the ‘‘reverse emulsion’’ incident. It appears that as the continuous phase, being oil here, gets more diluted, a higher dissolving rate of salt crystalline is reached, thus improving salt removal efficiency but increasing the water phase.

To improve the efficiency of W=C, the wash water injection must be operated at the optimum point. Beyond that point, experience has shown that excessive water may lead to deterioration in the pH range of the water volume as a whole. Ranges of pH above or below 7.0 may cause severe problems in emulsion breaking and precipitation of hydrocarbon solids (e.g., naphthalene) into the water continuous phase (Agar, 2000). Eligibly et al. (1999) stated that at lower values of pH (3-10) of emulsion, surfactants dissolve readily in the oil phase forming stable water-in-oil emulsions. In contrast, at pH values 11-13, they noted that surfactants dissolve in the aqueous phase, creating stable oil-in-water emulsions. Furthermore, dilution maximizes the density difference between water drops and the oil phase. The dilution mechanism is also used to minimize the viscosity of the oil, thus improving the overall efficiency of a desalting-dehydration process

Effect of Chemical Dosage:

The second parameter investigated was the effect of the dosage of the demulsifier (Servo CC 3408) in ppm on the overall efficiency of the desalting-dehydration process. As the demulsifier was added, both the S=R and W=C efficiencies increased, reached a maximum, and then decreased at higher chemical dosage. The demulsifier acts to neutralize the effect of the emulsifying agents, freeing more water drops from the surrounding interfacial film. The excessive use of this demulsifier can decrease the surface tension of water droplets and actually create a more stable emulsion, which is difficult to treat. It is worth noting here that chemical injection is usually applied in practice on a trial and error basis. The operator injects a certain quantity of chemical, sees the effect on efficiencies, and then adjusts the quantity injected accordingly.

Effect of Heating:

Heating is another important factor used in the desalting-dehydration process. When an emulsion is subjected to heating, the rise of temperature will increase thermal motions to enhance the collision rate. As the temperature increases the viscosity (including interfacial viscosity) will be reduced, thus increasing the likelihood of water drop coalescence. It should be noted that the reported results are based on experiments conducted in an open vessel. Currently most desalting in refineries is done in closed electrostatic desalter at 100 to 500 C, No dehydration due to evaporation occurs in these units.

Effect of Mixing Time:

Mixing is used in a desalting-dehydration process to promote further dispersion of dilution water and demulsifier-chemical with the emulsion. It is also used to help smaller water droplets coalesce, enhancing the S=R efficiency and, in particular, affects the W=C efficiency. Initially, the W=C efficiency increased slightly above the S=R efficiency with increasing mixing time. Both efficiencies increased up to the point of 5 min, when W=C efficiency began to deteriorate. The reason for such deterioration is due to the phenomenon of emulsion type inversion when an emulsion suddenly changes type, from water-in-oil to water-in-oil-in-water. This process was almost invariably observed in the beaker tests after emulsions had been stirred for a sufficiently long time. The time required for a stable emulsion to invert depends on the stirring speed, temperature, the surfactant species, and its concentration (Sun and Shook 1996). Although many papers and studies have explored this subject, the exact mechanism of inversion remains unclear.

It can also be observed that at a long mixing time, as more salt quantities melt and are collected at the bottom of the test beaker, the S=R efficiency improves. Eligibly et al. (1999) also reported similar observations. TPL (1992) also reported that too low pressure drops (short mixing time) across the mixing valve of a desalting-dehydration process will cause a decrease in S=R efficiency. That is due to a less intimate contact between dilution water and crude.

Effect of Settling Time:

The settling time factor was experimentally investigated using a centrifuge at a fixed speed of 1000 rpm. The relative centrifugation force (g force) was 223.6. The time was varied from 1 to 5 min. Figure 6 shows a dramatic increase of S=R and W=C efficiencies. The settling time factor was varied here from 1.0 min to 5.0 min. basically, the two efficiencies follow the same pattern when settling time is applied. The S=R efficiency shows a sharp increase at the first three levels (1.0_3.0 min) and then a leveling off towards the end points (4.0_5.0 min). The W=C efficiency increases as a result of the increase of gravity difference between oil and water. It can also be observed from Figure 6 that at higher settling times (4.0_5.0 min), the efficiency reached a maximum value of 65.0%. The asymptotic behavior in W=C efficiency is due to reaching a point at which the water droplets are too small to settle out. This can be attributed to their relatively high specific surface. A specific concentration of chemical-Demulsifier or more mixing times is required for further settling. This is due to the type of emulsion that is being tested; more than 40.0% of the water droplets are considered too small to release from the thin films surrounding them. Those thin films create what is known as a tight emulsion: an emulsion that contains very small droplets (less than 10.0 microns) that are hard to settle out.

Combined Effects:

Mixing times in the range of 12.0_15.0 min at 55_C give a W=C less than 3.0%. The figure clearly shows that increasing the temperature while fixing the mixing time would not improve the W=C final value for the oil and demulsifier studied. This is true because at higher temperatures, the decrease in viscosity is counterbalanced by the effect of chemical=demulsifier on the type of emulsion.

When the W=C value is plotted against chemical dosage (ppm), Figure 8 shows the reverse situation at the same two values of temperature, 55 and 70_C. The mixing time is fixed here at 1 min but the final values of W=C behaved in an opposite way. If an excess of chemical-demulsifier is used under the lower temperature, 55_C, the W=C value becomes independent of chemical dosage. In the opinion of many researchers (e.g., Schramm, 1992) this independent behavior is due to the development of multilayer's of emulsions that are not affected by any change of chemical dosage.

Conclusion

By using AGAR SYSTEM in desalter plant, ONGC can save $ 89,044,170.21 which spent to separate crude from waste water in WWTP and again sent separated crude oil to desalter plant. Also refinery spent $10 bbl to recover & reprocess lost hydrocarbon. So AGAR SYSTEM helps to save $ 890441702.1. And installation cost of AGAR SYSTEM is $ 1,722,200. Hence after 10 year ONGC can get profit of $ 87,321,970.21.

Therefore, project is feasible. AGAR SYSTEM can be used in desalter plant to get high profit.

Table of Content

Character	Value
Specific gravity ($60^o/60^o$)	0.864
Reid vapour pressure (Psia)	10.5
Pour point (^{o}F)	Less than-30
Average API gravity at 60_F	31.7
Viscosity (Cs) at 70_F	17.4
100_F	10.5
130 F	6.79
160 F	4.8
Average sulphur content (% by wt)	2.7
Asphaltenes (wt %)	2.23

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