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## APPENDICES

### Appendix A Amount of Water in Crude by Toluene Separation

5 ml of crude oil in centrifuge tube and add up another 5 ml with toluene. Place the tube in the water bath at 60 °C for 0.5 hours. After it was centrifuged at the 2000 rpm for 10 minute. Repeat this sequence until the amount of free water reach the constant volume. The procedure followed ASTM D4007. The phases separation consist of free water (W), crude, and emulsion (E). Calculation of the actual volume of free water separated was multiplied by two since the volume of crude oil was 50% and toluene 50%.

| Name of well / Centrifugal time | NMM C 10T | | NMM F 10T | | NMM F 09T | | LKU W 05T | | LKU A 07T | | LKU D 12T | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W (ml) | E (ml) | W (ml) | E (ml) | W (mi) | E (ml) | W (ml) | E (ml) | W (ml) | E (ml) | W (ml) | E (ml) |
| 1 time | 0.5 | 0.8 | 1.2 | 0.2 | Nil | | Nil | | 3.5 | 0 | 1.8 | 0.2 |
| 2 time | 0.7 | 0.8 | 1.5 | 0.2 | Nil | | Nil | | 3.5 | 0 | 2 | 0.1 |
| 3 time | 0.7 | 0.7 | 1.7 | 0.2 | Nil | | Nil | | 3.5 | 0 | 2 | 0.1 |
| % Water & emulsion | 14 | 14 | 34 | 4 | Nil | | Nil | | 70 | 0 | 40 | 2 |

## Appendix B Original Water in Crude Oil by Using KF Method

For the KF method, we also used toluene (50 w %) to dissolve the crude oil and make them easier to measure the water content in the sample.

| Wells | Amount of water (%) | | | | |
|---|---|---|---|---|---|
| | 1st sampling | 2nd Sampling | 3rd Sampling | Average | Multiply by 2 |
| D 12T | 20.24 | 19.38 | 19.92 | 19.85 | 39.70 |
| W 05T | 4.00 | 4.00 | 4.01 | 4.00 | 8.00 |
| F 10T | 12.99 | 13.07 | 10.48 | 12.18 | 24.36 |
| C 10T | 9.20 | 8.68 | 9.01 | 8.96 | 17.92 |
| F 09T | 0.80 | 1.55 | 0.95 | 1.10 | 2.20 |
| A 07T | 34.46 | 36.06 | 37.21 | 35.91 | 71.82 |

## Appendix C Viscosity and Amount of Asphaltene

| Viscosity | | | |
|---|---|---|---|
| Wells | Viscosity (cP) | Torque (%) | RPM |
| D 12T | 157 | 97.3 | 62 |
| W 05T | 53.2 | 97.3 | 183 |
| F 10T | 58 | 97.3 | 165 |
| C 10T | 69.5 | 97.5 | 138 |
| F 09T | 53.8 | 97.3 | 180 |
| A 07T | 284 | 97.4 | 34 |

| Amount of Asphaltene | | |
|---|---|---|
| Wells | Amount of Asphaltene (g) | % |
| D 12T | 0.1169 | 2.34 |
| W 05T | 0.0693 | 1.39 |
| F 10T | 0.1413 | 2.83 |
| C 10T | 0.2338 | 4.68 |
| F 09T | 0.3679 | 7.36 |
| A 07T | 0.1105 | 2.21 |

**Appendix D Water Remaining (%) in Crude Oil Phase by KF Method**

In addition to measure free water separated by reading at a graduated scale of centrifuge tube, the water remaining in crude after separation was determined for more accurate determination of water and material balance for later calculation.

**The Method to Calculate KF Equation**

Find the $H_2O$ titer for determine the water content in KF solution reagent by waiting for the drift value reach or below 20 μl/min then injected the 10 microliters of distilled water by microsyringe. Input the volume of water sample(10 microliters) then the water content in the reagent is obtained.

Formula for titer determination.

RS1=C00*C01/EP1 .....1)

Where: RS1= titer (It should be less than 5mg/ml if less than 3 mg/ml change KF solution)

EP1= volume of the KF solution at the end point

C00= sample size (10 micoliters)

C01= factor (see appendix 5, in this case we use 1 because density of water [g/ml] is 1. The factor depends on type and water content of standard

The factor used to calculate in titer equation are,

| Standard | Sample size in | Factor |
|---|---|---|
| Water | g | 1000 |
| Water | μl | Density of $H_2O$[g/ml]=1 |
| Methanol | ml | Water content in methanol in [mg/ml] |
| Methanol | μl | 0.001*water content of methanol in [mg/ml] |
| $Na_2Tart*2H_2O$ | g | 156.6 |
| $Na_2Tart*2H_2O$ | mg | 0.1566 |

Finding the water content in the crude oil sample after blend oil with toluene 50%(v/v) by recalling method KF, then enter the sample size(g). Allow the instrument memorize formula.

RS1=(EP1-C01)*C02*C03/(C00*C04) .....2)

Where: RS1= water content

EP1= volume of the KF solution at the end point

C00=sample size (g)

C01= initial water (0.00)

C02= titer

C03= factor (0.1) see also appendix 6

C04= divisor

Enter all the parameter and wait for conditioning the instrument. When it shows "drift OK", the sample is withdrawn into a syringe and placed on the 5 digits balance and tared. The sample is injected into KF solution then the syringe is weighed again. The weight of the injected sample is determined. Allow the instrument titrate until the end point. The amount of water content is shown.

The factors used to calculate in KF equation are,

| Unit | Sample size | Factor | divisor |
|---|---|---|---|
| % | g | 0.1 | 1 |
| % | mg | 100 | 1 |
| % | ml | 0.1 | Density of sample[g/ml] |
| ppm | g | 1000 | 1 |
| ppm | ml | 1000 | Density of sample[g/ml] |
| ppm | µl | 1000000 | Density of sample[g/ml] |
| mg/ml | g | Density of sample[g/ml] | 1 |
| mg/ml | ml | 1 | 1 |
| g/l | g | Density of sample[g/ml] | 1 |
| g/l | ml | 1 | 1 |
| mg | 1 | 1 | 1 |
| ml | 1 | 1 | 1000 |
| mg/pc | pc | 1 | 1 |

**Appendix E Results from KF Method**

| Water remaining (%) in crude oil by Terric 61 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 0.22 | 0.24 | 0.09 | 0.11 | 0.45 | 0.25 |
| | 0.23 | 0.25 | 0.10 | 0.16 | 0.37 | 0.28 |
| | 0.25 | 0.26 | 0.11 | 0.12 | 0.51 | 0.35 |
| average (%) | 0.23 | 0.25 | 0.10 | 0.13 | 0.44 | 0.29 |
| multiply by 2 | 0.47 | 0.50 | 0.20 | 0.25 | 0.89 | 0.59 |

a

| Water remaining (%)in crude oil by Terric 62 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 0.25 | 0.18 | 0.21 | 0.16 | 0.07 | 0.21 |
| | 0.19 | 0.15 | 0.20 | 0.21 | 0.10 | 0.23 |
| | 0.20 | 0.18 | 0.24 | 0.19 | 0.08 | 0.19 |
| average (%) | 0.21 | 0.17 | 0.22 | 0.18 | 0.08 | 0.21 |
| multiply by 2 | 0.42 | 0.34 | 0.44 | 0.37 | 0.17 | 0.41 |

b

| Water remaining (%)in crude oil by Terric 64 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 0.85 | 0.27 | 0.33 | 0.29 | 0.64 | 0.28 |
| | 0.83 | 0.29 | 0.29 | 0.24 | 0.60 | 0.29 |
| | 0.88 | 0.27 | 0.31 | 0.28 | 0.65 | 0.23 |
| average (%) | 0.85 | 0.28 | 0.31 | 0.27 | 0.63 | 0.27 |
| multiply by 2 | 1.71 | 0.55 | 0.62 | 0.54 | 1.26 | 0.53 |

c

| Water remaining (%)in crude oil by Terric 87 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 0.36 | 0.20 | 0.28 | 0.29 | 0.40 | 0.21 |
| | 0.37 | 0.22 | 0.34 | 0.30 | 0.41 | 0.23 |
| | 0.44 | 0.26 | 0.25 | 0.29 | 0.39 | 0.19 |
| average (%) | 0.39 | 0.23 | 0.29 | 0.30 | 0.40 | 0.21 |
| multiply by 2 | 0.78 | 0.45 | 0.57 | 0.59 | 0.80 | 0.42 |

d

| Water remaining (%)in crude oil by Terric 305 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 0.42 | 0.43 | 0.32 | 0.41 | 0.90 | 0.47 |
| | 0.27 | 0.49 | 0.30 | 0.43 | 0.90 | 0.41 |
| | 0.35 | 0.37 | 0.32 | 0.36 | 0.89 | 0.39 |
| average (%) | 0.35 | 0.43 | 0.31 | 0.40 | 0.90 | 0.42 |
| multiply by 2 | 0.70 | 0.86 | 0.62 | 0.80 | 1.79 | 0.84 |

e

| Water remaining (%)in crude oil by Pluronic PE 4300 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 1.36 | 12.56 | 2.06 | 5.63 | 0.52 | 23.54 |
| | 1.47 | 13.78 | 2.26 | 5.02 | 0.38 | 21.45 |
| | 1.78 | 14.52 | 2.26 | 4.26 | 0.76 | 26.22 |
| average (%) | 1.54 | 13.62 | 2.19 | 4.97 | 0.55 | 23.74 |
| multiply by 2 | 3.08 | 27.24 | 4.39 | 9.94 | 1.11 | 47.47 |

f

| Water remaining (%)in crude oil by Pluronic PE6100 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 1.26 | 11.03 | 0.15 | 6.25 | 0.52 | 21.59 |
| | 1.58 | 12.15 | 0.24 | 4.26 | 0.21 | 27.65 |
| | 1.62 | 14.37 | 0.33 | 4.21 | 0.83 | 20.16 |
| average (%) | 1.49 | 12.51 | 0.24 | 4.91 | 0.52 | 23.13 |
| multiply by 2 | 2.98 | 25.03 | 0.47 | 9.81 | 1.05 | 46.27 |

g

| Water remaining (%)in crude oil by Pluronic PE 6120 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 2.21 | 10.26 | 2.57 | 5.27 | 0.54 | 25.69 |
| | 3.26 | 9.25 | 2.34 | 3.26 | 0.33 | 21.35 |
| | 1.25 | 11.63 | 3.21 | 3.25 | 0.66 | 26.13 |
| average (%) | 2.24 | 10.38 | 2.71 | 3.93 | 0.51 | 24.39 |
| multiply by 2 | 4.48 | 20.76 | 5.42 | 7.86 | 1.02 | 48.78 |

h

| Water remaining (%)in crude oil by Pluronic PE 6200 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 1.36 | 9.97 | 3.22 | 2.59 | 0.65 | 5.24 |
| | 2.66 | 9.66 | 2.21 | 6.21 | 0.53 | 6.22 |
| | 2.59 | 9.23 | 2.11 | 4.22 | 0.39 | 4.27 |
| average (%) | 2.20 | 9.62 | 2.51 | 4.34 | 0.52 | 5.24 |
| multiply by 2 | 4.40 | 19.24 | 5.03 | 8.68 | 1.05 | 10.48 |

i

| Water remaining (%)in crude oil by Pluronic PE 6400 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 2.35 | 8.66 | 3.26 | 5.24 | 0.90 | 26.55 |
| | 2.62 | 9.20 | 4.22 | 4.22 | 0.89 | 28.22 |
| | 2.54 | 9.25 | 3.20 | 8.13 | 0.88 | 29.59 |
| average (%) | 2.50 | 9.04 | 3.56 | 5.86 | 0.89 | 28.12 |
| multiply by 2 | 5.01 | 18.08 | 7.12 | 11.72 | 1.78 | 56.24 |

j

| Water remaining (%)in crude oil by Pluronic PE 6800 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 2.85 | 7.52 | 4.99 | 9.21 | 0.25 | 28.59 |
| | 2.96 | 6.24 | 5.20 | 6.26 | 0.69 | 26.25 |
| | 2.71 | 5.29 | 4.21 | 8.13 | 0.59 | 27.21 |
| average (%) | 2.84 | 6.35 | 4.80 | 7.87 | 0.51 | 27.35 |
| multiply by 2 | 5.69 | 12.70 | 9.60 | 15.73 | 1.02 | 54.70 |

k

| Water remaining (%)in crude oil by Pluronic PE 10500 KF method | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 1.29 | 9.26 | 5.23 | 5.22 | 0.63 | 9.52 |
| | 4.97 | 10.25 | 4.90 | 3.06 | 1.25 | 7.51 |
| | 2.26 | 11.26 | 3.53 | 9.52 | 0.63 | 8.02 |
| average (%) | 2.84 | 10.26 | 4.55 | 5.93 | 0.84 | 8.35 |
| multiply by 2 | 5.67 | 20.52 | 9.10 | 11.86 | 1.67 | 16.70 |

l

| Water remaining (%)in crude oil by Pluronic RPE 2520 KF method | | | | | | |
|---|---|---|---|---|---|---|
| well | W 05T | D 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 3.20 | 10.26 | 4.21 | 4.25 | 0.63 | 29.10 |
| | 3.29 | 10.26 | 7.26 | 4.24 | 0.75 | 24.87 |
| | 2.15 | 12.49 | 9.25 | 6.81 | 0.33 | 19.59 |
| average (%) | 2.88 | 11.00 | 6.91 | 5.10 | 0.57 | 24.52 |
| multiply by 2 | 5.76 | 22.00 | 13.81 | 10.20 | 1.14 | 49.04 |

m

| Water remaining (%)in crude oil by Pluronic RPE 3110 KF method | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 12T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 5.21 | 1.12 | 0.05 | 6.26 | 0.22 | 21.37 |
| | 7.72 | 1.26 | 0.09 | 3.26 | 0.32 | 27.26 |
| | 6.26 | 1.94 | 0.06 | 4.02 | 0.21 | 24.98 |
| average (%) | 6.40 | 1.44 | 0.07 | 4.51 | 0.25 | 24.54 |
| multiply by 2 | 12.79 | 2.88 | 0.13 | 9.02 | 0.50 | 49.08 |

n

| Water remaining (%)in crude oil by adding NP 6 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 15.45 | 3.65 | 2.66 | 5.49 | 0.96 | 0.63 |
| | 15.87 | 4.29 | 2.59 | 5.71 | 1.10 | 0.66 |
| | 15.61 | 3.33 | 2.74 | 5.67 | 0.80 | 0.59 |
| average (%) | 15.64 | 3.76 | 2.66 | 5.62 | 0.95 | 0.63 |
| multiply by 2 | 31.29 | 7.52 | 5.33 | 11.25 | 1.91 | 1.26 |

o

| Water remaining (%)in crude oil by adding NP 15 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 15.96 | 2.88 | 1.42 | 4.50 | 0.56 | 0.21 |
| | 16.87 | 2.80 | 0.86 | 4.18 | 0.46 | 0.16 |
| | 16.30 | 2.79 | 1.27 | 4.30 | 0.44 | 0.17 |
| average (%) | 16.37 | 2.82 | 1.19 | 4.33 | 0.49 | 0.18 |
| multiply by 2 | 32.75 | 5.65 | 2.37 | 8.65 | 0.98 | 0.36 |

p

| Water remaining (%)in crude oil by adding NP 30 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 13.95 | 4.30 | 3.36 | 3.70 | 1.16 | 1.05 |
| | 14.41 | 3.67 | 3.28 | 3.91 | 1.05 | 0.94 |
| | 14.18 | 3.87 | 3.46 | 4.14 | 1.11 | 0.90 |
| average (%) | 14.18 | 3.95 | 3.36 | 3.92 | 1.11 | 0.96 |
| multiply by 2 | 28.35 | 7.90 | 6.73 | 7.83 | 2.22 | 1.93 |

q

| Water remaining (%)in crude oil by FES 32 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 20.33 | 5.84 | 6.02 | 9.93 | 0.93 | 4.74 |
| | 21.78 | 4.59 | 6.01 | 9.96 | 1.01 | 5.59 |
| | 18.99 | 4.13 | 5.25 | 8.84 | 0.68 | 4.22 |
| average (%) | 20.37 | 4.86 | 5.76 | 9.58 | 0.87 | 4.85 |
| multiply by 2 | 40.73 | 9.71 | 11.52 | 19.15 | 1.75 | 9.70 |

r

| Water remaining (%)in crude oil by FES 61 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 21.64 | 4.59 | 2.27 | 7.44 | 6.07 | 10.35 |
| | 15.87 | 4.06 | 1.45 | 7.89 | 5.05 | 10.04 |
| | 19.24 | 4.05 | 1.38 | 7.81 | 5.08 | 9.33 |
| average (%) | 18.92 | 4.24 | 1.70 | 7.71 | 5.40 | 9.91 |
| multiply by 2 | 37.83 | 8.47 | 3.40 | 15.43 | 10.80 | 19.81 |

s

| Water remaining (%)in crude oil by FES 77 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 18.35 | 5.53 | 5.74 | 8.92 | 1.24 | 11.12 |
| | 16.39 | 4.99 | 4.69 | 8.07 | 1.01 | 9.43 |
| | 15.63 | 4.55 | 4.34 | 6.82 | 1.29 | 9.36 |
| average (%) | 16.79 | 5.03 | 4.92 | 7.94 | 1.18 | 9.97 |
| multiply by 2 | 33.58 | 10.05 | 9.84 | 15.87 | 2.37 | 19.95 |

t

| Water remaining (%)in crude oil by FES 993 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 16.41 | 5.19 | 3.39 | 6.18 | 1.04 | 7.09 |
| | 15.82 | 4.37 | 3.74 | 5.60 | 0.92 | 6.98 |
| | 16.14 | 4.66 | 3.60 | 6.30 | 0.95 | 6.78 |
| average (%) | 16.12 | 4.74 | 3.58 | 6.03 | 0.97 | 6.95 |
| multiply by 2 | 32.24 | 9.48 | 7.15 | 12.05 | 1.94 | 13.90 |

u

| Water remaining (%)in crude oil by AFX 780 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 7.02 | 2.80 | 3.21 | 5.18 | 1.24 | 0.56 |
| | 7.89 | 2.39 | 2.46 | 4.74 | 1.34 | 0.55 |
| | 7.84 | 3.36 | 1.49 | 5.29 | 1.86 | 0.70 |
| average (%) | 7.58 | 2.85 | 2.39 | 5.07 | 1.48 | 0.60 |
| multiply by 2 | 15.16 | 5.70 | 4.78 | 10.14 | 2.96 | 1.21 |

v

| Water remaining (%)in crude oil by AFX 1080 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 12.64 | 4.22 | 2.93 | 5.45 | 0.97 | 0.42 |
| | 13.42 | 3.85 | 2.02 | 4.57 | 1.12 | 0.30 |
| | 12.50 | 3.85 | 2.90 | 4.64 | 1.42 | 0.37 |
| average (%) | 12.85 | 3.97 | 2.62 | 4.88 | 1.17 | 0.36 |
| multiply by 2 | 25.70 | 7.95 | 5.23 | 9.77 | 2.34 | 0.73 |

w

| Water remaining (%)in crude oil by AFX 4060 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 19.74 | 3.05 | 1.03 | 4.15 | 0.84 | 0.45 |
| | 15.40 | 3.33 | 1.15 | 3.84 | 1.12 | 0.51 |
| | 19.63 | 3.82 | 1.02 | 3.93 | 0.93 | 0.47 |
| average (%) | 18.26 | 3.40 | 1.07 | 3.97 | 0.96 | 0.48 |
| multiply by 2 | 36.51 | 6.80 | 2.13 | 7.94 | 1.93 | 0.96 |

x

| Water remaining (%)in crude oil by AFX 1575 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 12.16 | 4.40 | 1.19 | 5.54 | 1.48 | 0.60 |
| | 10.20 | 4.36 | 1.23 | 5.90 | 1.32 | 0.50 |
| | 11.49 | 4.52 | 1.53 | 4.98 | 1.55 | 0.42 |
| average (%) | 11.28 | 4.43 | 1.32 | 5.47 | 1.45 | 0.50 |
| multiply by 2 | 22.57 | 8.86 | 2.64 | 10.95 | 2.89 | 1.01 |

y

| Water remaining (%)in crude oil by AFX 2075 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 19.58 | 3.49 | 1.38 | 6.47 | 1.59 | 0.47 |
| | 20.23 | 3.31 | 1.51 | 6.84 | 1.05 | 0.52 |
| | 18.92 | 3.09 | 0.99 | 5.90 | 1.21 | 0.43 |
| average (%) | 19.58 | 3.30 | 1.29 | 6.40 | 1.28 | 0.47 |
| multiply by 2 | 39.15 | 6.59 | 2.59 | 12.81 | 2.57 | 0.94 |

z

| Water remaining (%)in crude oil by AFX 3070 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 21.24 | 3.11 | 0.65 | 6.11 | 0.72 | 0.46 |
| | 21.10 | 3.06 | 0.56 | 5.82 | 1.04 | 0.39 |
| | 21.43 | 2.86 | 0.41 | 6.02 | 1.32 | 0.45 |
| average (%) | 21.26 | 3.01 | 0.54 | 5.99 | 1.03 | 0.43 |
| multiply by 2 | 42.51 | 6.02 | 1.08 | 11.97 | 2.05 | 0.87 |

aa

| Water remaining (%)in crude oil by SUS 87 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 18.23 | 3.76 | 3.31 | 3.33 | 0.54 | 7.30 |
| | 18.16 | 3.36 | 3.56 | 3.65 | 0.81 | 7.41 |
| | 17.90 | 3.98 | 3.43 | 3.83 | 0.53 | 7.22 |
| average (%) | 18.10 | 3.70 | 3.43 | 3.60 | 0.63 | 7.31 |
| multiply by 2 | 36.19 | 7.40 | 6.87 | 7.21 | 1.25 | 14.62 |

ab

| Water remaining (%)in crude oil by SUS IC 640 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 9.61 | 2.86 | 5.99 | 5.23 | 0.48 | 12.85 |
| | 9.38 | 3.28 | 5.08 | 4.85 | 0.54 | 10.76 |
| | 9.11 | 3.31 | 5.24 | 4.98 | 0.36 | 10.94 |
| average (%) | 9.37 | 3.15 | 5.44 | 5.02 | 0.46 | 11.52 |
| multiply by 2 | 18.74 | 6.30 | 10.87 | 10.04 | 0.92 | 23.03 |

ac

| Water remaining (%)in crude oil by SUS IC 680 (KF method) | | | | | | |
|---|---|---|---|---|---|---|
| well | D 12T | W 05T | F 10T | C 10T | F 09T | A 07T |
| water remaining (%) | 4.76 | 2.81 | 3.15 | 4.29 | 0.87 | 10.47 |
| | 4.83 | 2.77 | 2.65 | 3.90 | 0.51 | 9.19 |
| | 4.53 | 2.91 | 2.85 | 3.80 | 0.61 | 9.87 |
| average (%) | 4.71 | 2.83 | 2.88 | 3.99 | 0.66 | 9.84 |
| multiply by 2 | 9.41 | 5.66 | 5.77 | 7.99 | 1.33 | 19.68 |

ad

**Appendix F The Salinity Concentration of Each Well and Summary of Finding The Optimum Condition for Teric 61 and AFX 780 by Varying The Salinity Solution**

| wells | Na (mg/L) | Ca (mg/L) | K (mg/L) | Mg (mg/L) | Li (mg/L) | Fe (mg/L) |
|---|---|---|---|---|---|---|
| D 12T | 10261.54 | 330.77 | 50 | 2.88 | 0 | 0 |
| W 05T | 1428.57 | 400 | 85.71 | 7.86 | 0 | 0 |
| F 10T | 1666.67 | 60 | 0.83 | 4.67 | 0 | 0 |
| C 10T | 5000 | 1425 | 137.5 | 12.5 | 0 | 0 |
| F 09T | 2500 | 475 | 62.5 | 13.75 | 0 | 0 |
| A 07T | 2142.86 | 773.81 | 65.48 | 11.9 | 0 | 0 |

| Teric 61 (Could point 16-18 °C) | | | | | |
|---|---|---|---|---|---|
| %Free water | | | | | |
| Well | Original crude | Add 1ml H2O in 10 ml Crude | Teric 61 (liq) | Teric 61 in aqeous solution | Teric 61 in 1.0 NaCl |
| F 09T | 2.2 | 11.09 | 0 (no $H_2O$ sep) | 11.82(complete sep) | 9.09(80% $H_2O$ sep) |
| W 05T | 8 | 16.36 | 0(no $H_2O$ sep) | 0(no $H_2O$ sep, $H_2O$ increase emulsion phase) | 9.09(80% $H_2O$ sep) |
| C 10T | 17.92 | 25.38 | 18(complete sep) | 14.56 (57.37% removed) | 15.45(57% $H_2O$ sep) |
| F 10T | 24.36 | 31.24 | 11(46% $H_2O$ sep) | 31.82(complete sep) | 31.82(95% $H_2O$ sep) |
| D 12T | 39.7 | 45.18 | 20(50% $H_2O$ sep) | 0(no $H_2O$ sep, $H_2O$ increase emulsion phase) | 0 (no $H_2O$ sep) |
| A 07T | 71.82 | 74.38 | 61(85% $H_2O$ sep) | 45.45(61.11% $H_2O$ sep) | 0 (no $H_2O$ sep) |

| AFX 780 | | | | | |
|---|---|---|---|---|---|
| %Free water | | | | | |
| Well | Original crude | Add 1ml $H_2O$ in 10 ml Crude | AFX 780 (liq) | AFX 780 in aqeous solution | AFX 780 in 1.0 NaCl |
| F 09T | 2.2 | 11.09 | 0 (no $H_2O$ sep) | 0.91(8.2% $H_2O$ sep) | 5.45 (49.18% $H_2O$ sep) |
| W 05T | 8 | 16.36 | 0(no $H_2O$ sep) | 0.09(0.56% $H_2O$ sep) | 6.36 (38.9% $H_2O$ sep) |
| C 10T | 17.92 | 25.38 | 0(no $H_2O$ sep) | 2.27(8.95% $H_2O$ sep) | 12.73 (50.15% $H_2O$ sep) |
| F 10T | 24.36 | 31.24 | 1(41% $H_2O$ sep) | 6.36(20.37% $H_2O$ sep) | 9.09 (29.1% $H_2O$ sep) |
| D 12T | 39.7 | 45.18 | 0(no $H_2O$ sep) | 0(no $H_2O$ sep) | 0(no $H_2O$ sep) |
| A 07T | 71.82 | 74.38 | 40(55.7% $H_2O$ sep) | 14.55(19.56% $H_2O$ sep) | 23.64 (31.78% $H_2O$ sep) |

## Appendix G Initial and Final pH of pH Effect on Demulsification Efficiency

pH of aqueous phase of teric 61

| Wells | Initial pH | Final pH (buffer 4.01) | Final pH (buffer 7.00) | Final pH (buffer 10.01) |
|---|---|---|---|---|
| D 12T | 9 | 7 | 8 | 9 |
| W 05T | 8 | 7 | 7 | 9 |
| F 10T | 9 | 7 | 8 | 10 |
| C 10T | 9 | 8 | 8 | 9 |
| F 09T | 8 | 7 | 7 | 9 |
| A 07T | 9 | 7 | 8 | 9 |

pH of aqueous phase of teric 62

| Wells | Initial pH | Final pH (buffer 4.01) | Final pH (buffer 7.00) | Final pH (buffer 10.01) |
|---|---|---|---|---|
| D 12T | 9 | 7 | 8 | 10 |
| W 05T | 8 | 7 | 8 | 9 |
| F 10T | 9 | 7 | 8 | 10 |
| C 10T | 9 | 8 | 8 | 9 |
| F 09T | 8 | 7 | 7 | 10 |
| A 07T | 9 | 8 | 8 | 9 |

pH of aqueous phase of Pluronic PE6100

| Wells | Initial pH | Final pH (buffer 4.01) | Final pH (buffer 7.00) | Final pH (buffer 10.01) |
|---|---|---|---|---|
| D 12T | 9 | 8 | 8 | 10 |
| W 05T | 8 | 8 | 7 | 9 |
| F 10T | 9 | 8 | 7 | 10 |
| C 10T | 9 | 8 | 8 | 9 |
| F 09T | 8 | 7 | 7 | 10 |
| A 07T | 9 | 8 | 9 | 10 |

pH of aqueous phase of AFX 780

| Wells | Initial pH | Final pH (buffer 4.01) | Final pH (buffer 7.00) | Final pH (buffer 10.01) |
|---|---|---|---|---|
| D 12T | 9 | 7 | 7 | 10 |
| W 05T | 8 | 7 | 7 | 10 |
| F 10T | 9 | 7 | 8 | 10 |
| C 10T | 9 | 8 | 8 | 9 |
| F 09T | 8 | 7 | 7 | 11 |
| A 07T | 9 | 7 | 8 | 9 |

**Appendix H Effect of Mixed Surfactant**

Most of the demulsifiers that using in the real plant is coming from mixture of chemical in order to achieve the synergistic effect from the demulsifiers so that it can be solved the emulsion problem. The results of mixed surfactant are shown below.

| Effectiveness of mixed surfactant on D 12T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 0 | 0 | 0 | 0 |
| 10:90 | 0 | 0 | 0 | 0 |
| 30:70 | 0 | 0 | 0 | 0 |
| 50:50 | 0 | 0 | 0 | 0 |
| 70:30 | 0 | 0 | 0 | 0 |
| 90:10 | 0 | 0 | 0 | 0 |
| 100:0 | 20 | 20 | 6 | 6 |

| Effectiveness of mixed surfactant on W 05T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 0 | 0 | 0 | 0 |
| 10:90 | 0 | 0 | 0 | 0 |
| 30:70 | 0 | 0 | 0 | 0 |
| 50:50 | 0 | 0 | 0 | 0 |
| 70:30 | 0 | 0 | 0 | 0 |
| 90:10 | 0 | 0 | 0 | 0 |
| 100:0 | 0 | 0 | 0 | 0 |

| Effectiveness of mixed surfactant on F 10T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 22 | 10 | 22 | 10 |
| 10:90 | 23 | 12 | 24 | 7 |
| 30:70 | 24 | 12 | 24 | 7 |
| 50:50 | 24 | 15 | 23 | 7 |
| 70:30 | 23 | 23 | 22 | 9 |
| 90:10 | 22 | 23 | 20 | 10 |
| 100:0 | 20 | 20 | 6 | 6 |

| Effectiveness of mixed surfactant on C 10T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 0 | 0 | 0 | 0 |
| 10:90 | 0 | 0 | 0 | 0 |
| 30:70 | 0 | 0 | 0 | 0 |
| 50:50 | 0 | 0 | 0 | 0 |
| 70:30 | 0 | 0 | 0 | 0 |
| 90:10 | 0 | 0 | 0 | 0 |
| 100:0 | 17 | 17 | 8 | 8 |

| Effectiveness of mixed surfactant on F 09T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 0 | 0 | 0 | 0 |
| 10:90 | 1 | 0 | 0 | 1 |
| 30:70 | 0 | 0 | 0 | 1 |
| 50:50 | 0 | 0 | 0 | 0 |
| 70:30 | 0 | 0 | 0 | 0 |
| 90:10 | 0 | 0 | 0 | 0 |
| 100:0 | 0 | 0 | 0 | 0 |

| Effectiveness of mixed surfactant on A 07T (%) | | | | |
|---|---|---|---|---|
| A:B | Teric 61: Pluronic PE 6100 | Teric 61:AFX 780 | Teric 62:Pluronic PE 6100 | Teric 62:AFX 780 |
| 0:100 | 13 | 40 | 13 | 40 |
| 10:90 | 6 | 13 | 7 | 14 |
| 30:70 | 7 | 13 | 7 | 16 |
| 50:50 | 8 | 17 | 7 | 17 |
| 70:30 | 10 | 20 | 9 | 24 |
| 90:10 | 12 | 24 | 10 | 23 |
| 100:0 | 61 | 61 | 67 | 67 |

The results from the mixed surfactant were exhibited less effect compare with single surfactant that opposite with our assumption. It probably explained by matching with the wrong pairs of surfactant. Further study for these experiments is need to identify the right surfactants.

**Appendix I Proportional of Mixed Crude Oil and The Water Remaining of Mixed Crude**

The initial data from PTTEP was used as a guide for preparing the crude mixture. PTTEP suggested the proportion of each clued to be 1:1:1:1:1:1 which gave the water content of the blended clued oil 37%. Water content in each crude was determined by KF method. Trial of crude oil ratio of 1:1:1:1:1:1 gave water content in the blened crude 34%.

| Wells | %Original water (Tested by PTTEP)* | %Original water by KF method (Tested by PPC) | Crude proportion |
|---|---|---|---|
| D 12T | 38 | 45 | 1 |
| W 05T | 12 | 25 | 1 |
| F 10T | 70 | 44 | 1 |
| C 10T | 80 | 38 | 1 |
| F 09T | 10 | 4.2 | 1 |
| A 07T | 12 | 48 | 1 |
| Total | 222 | 204.2 | 6 |
| %Water after blended | 222/6 = 37 | 204.2/6 = 34 = acceptable | |

* Example given by PTTEP

Water remaining had been examined with KF method after removal in order to check the percentage of water content since the criteria of good demulsifiers should reduced the water content less than 0.5% and the results were shown below:

| well | mixed crude |
|---|---|
| amount of water remaining (%) | 0.21 |
| | 0.27 |
| | 0.23 |
| average (%) | 0.24 |
| multiply by 2 | 0.47 |

| Water remaining after separated by adding Pluronic PE6100 on mixed crude oil | |
|---|---|
| well | mixed crude |
| amount of water remaining (%) | 9.15 |
| | 7.26 |
| | 8.22 |
| average (%) | 8.21 |
| multiply by 2 | 16.42 |

| Water remaining after separated by adding AFX 780 on mixed crude oil | |
|---|---|
| well | mixed crude |
| amount of water remaining (%) | 8.01 |
| | 7.25 |
| | 7.59 |
| average (%) | 7.62 |
| multiply by 2 | 15.24 |

| Water remaining after separated by adding Teric 61:Pluronic PE6100 on mixed crude oil | |
|---|---|
| well | mixed crude |
| amount of water remaining (%) | 0.13 |
| | 0.17 |
| | 0.15 |
| average (%) | 0.15 |
| multiply by 2 | 0.3 |

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