MC-20 Separator Gas

Oil Sheen Analysis Test and Gas Compositional Analysis

Document #: COUV-MC 20-O&M-RPT-00014-Rev. 0

6/30/2019

Revision	Date	By	Check	Approve	Remarks
Rev. 0	6/30/2019	Hoffmann	Kennelley	Couvillion	Initial Document

Executive Summary

Since April 12, 2019 the Rapid Response Solution has been successfully collecting oil subsea to stop the sheen at MC 20. There are days where a slight sheen is observed on the surface of the water in and around the MC 20 site. Whilst the sheen observed is significantly smaller than sheens observed before the Rapid Response Solution was deployed the question was asked: Could the gas being vented from the subsea separator contain enough lighter-end hydrocarbons to cause a sheen on the surface of the water? To address this issue two gas samples were collected at the gas separator outlet subsea at a water depth of 404 ft and temperature of approximately 65F using two 80 cubic ft scuba tanks that had been modified for gas collection. One sample was placed on the bottom of a 1,000 gallon tank filled with fresh water. The valves were then opened slowly to allow the gas to be vented to the surface. A very slight sheen was observed.

The second sample of gas was sent to Core Labs for chemical analysis. From the gas composition obtained a GPM (gallons per 1,000 scf gas) value is 1.457 gallons of plant products per 1,000 cubic feet of gas at standard conditions of 15.025 psia and 60 °F. This GPM is calculated based on molar contributions from ethane out to what was defined as $C10^{+}$. Eliminating the very volatile components from the GPM calculation and starting the GPM calculation at iso-pentane, the laboratory results indicate a GPM value of 0.061 gallons per 1,000 scf. For the quantity of gas contained within one of the scuba tanks this would equate to one liquid hydrocarbon droplet of 1.47 ml in diameter which would explain the very slight sheen observed in the 1,000 gallon tank test.

Site Test at Couvillion Yard in Belle Chasse

Goal of Test

The goal of the test conducted was to determine if a pressurized sample of gas collected on-site at MC-20 from the subsea separator on April 27, 2019 will create an oil sheen when released into a tank containing 1,000 gallons of fresh water.

Sample Collection Device and Capture of Gas Sample under Pressure

Two 80 cubic foot scuba tanks were modified to collect two samples of the gas from the separator outlet discharge. A photograph of a collection device is shown below:

Figure 1: Scuba Tank with Gas Sample

On April 27 with the Rapid Response System collecting oil, two samples were taken at the Separator outlet in approximately 404 ft of water at an ambient temperature of 65F and pressure of 2 with an ambient pressure of 180 psi. Both the upper and lower valves were left open as the scuba tank descended to depth using an ROV. The ROV held the scuba tank with the funnel placed directly above at the separator gas outlet to collect the gas. As gas filled the scuba tank water exited through the tygon tubing. Once gas was observed exiting the end of the tygon tubing the gas was continued to be collected for 2 minutes to ensure all liquids had exited the tank. Both valves were then closed and the scuba tank was retrieved. Two samples were collected using this process. One was for the tank test and the other was for chemical analysis at Core Labs.

Experimental Test Methodology:

An 81" high by 64" diameter plastic tank was filled with water to the 5ft level in the tank.

Figure 2&3 : Tank used on site in Belle Chasse Yard and Type of Tank used for Test

- The funnel was removed from the 80 cubic foot scuba tank and the scuba tank was then lowed to the bottom of the tank and held in place vertically with nylon rope (same orientation as shown above in Figure 1)
- The top valve was slowly opened and most of the gas was vented over a two minute period in which the surface of water was observed for any signs of an oil sheen.
- After two minutes the bottom valve was opened, and the surface of the water was observed for signs of an oil sheen.
- The tank valves were left open overnight and the following morning water in the tank was observed for any signs of an oil sheen to conclude the test.

Date and Time Test Started: 5-20-19 @ 15:53 hrs
Date and Time Test Finished: 5-21-19 @ 10:00 hrs
Location: Couvillion Group Yard Belle Chasse, LA

Attendees:

TJ Broussard – BSEE GOMR
Mike Prendergast – BSEE GOMR
Dillon Hoffmann- Couvillion
Kevin Kennelley – Couvillion
John Leblanc – Couvillion
Michael Carroll – Couvillion
Timmy Couvillion – Couvillion

Experimental Observations:

5/20/19

- 14:53 hrs– Initial pictures of water tank with gas tank suspended showing clean water and placement of gas tank. (See Figure 4)
- 14:54 hrs– Top valve opened, bubbles of gas flowing and continued for 2 minutes and no oil sheen was observed on the surface of the water.
- 14:56 hrs– Bottom valve opened and gas tank filled with water. Almost immediately after opening the bottom valve a very slight sheen was observed on the surface of the water. (Figure 5)
- 14:57 – No increase in sheen severity or intensity was observed.

5/21/19

- 10:00 – No increase in sheen severity was noted although the presence of a very slight sheen could still be observed. (Figure 6)

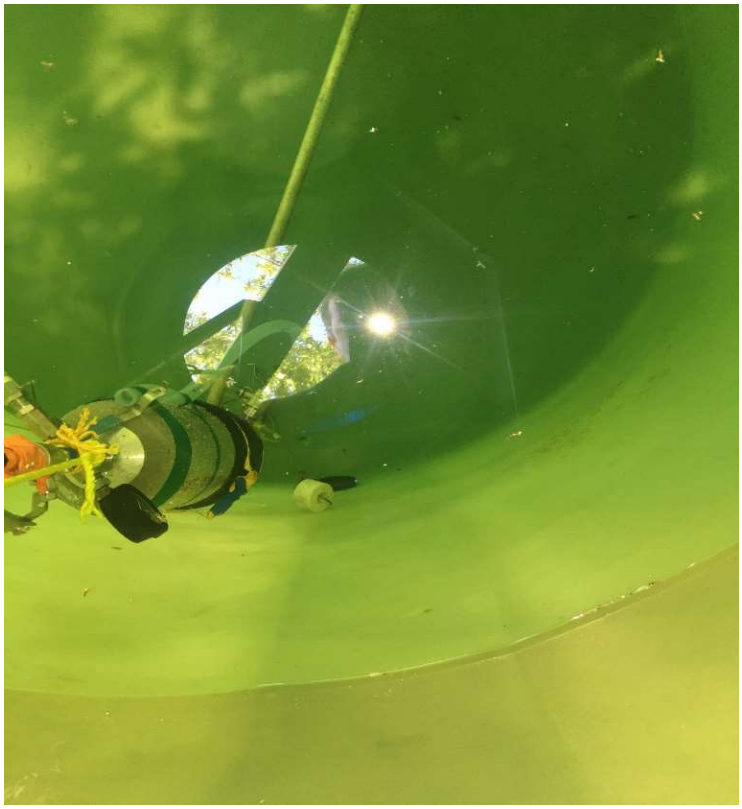

Figure 3: Tank Suspended in water tank

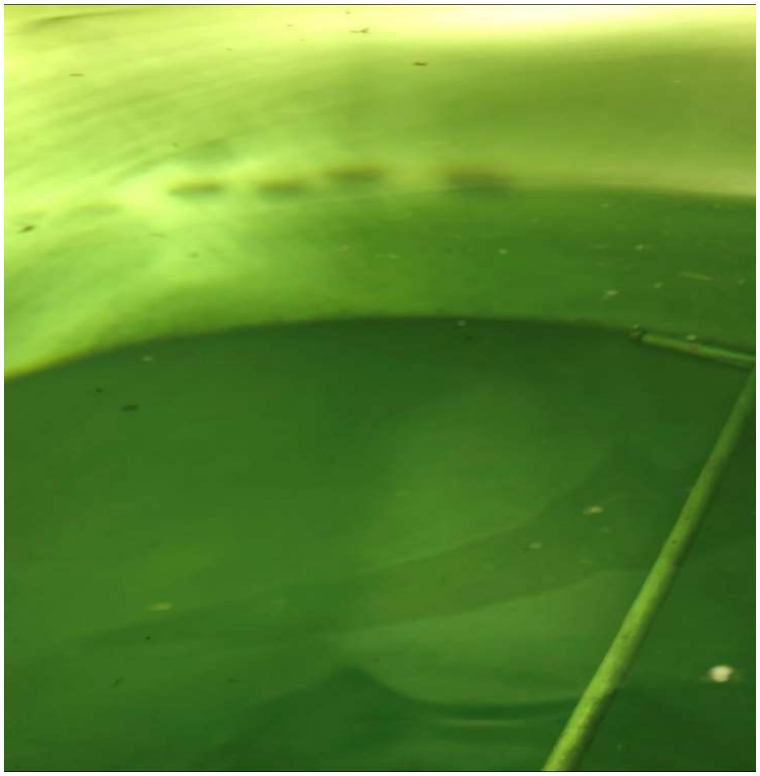

Figure 4: Sheen recorded 5/20/19 @ 14:56

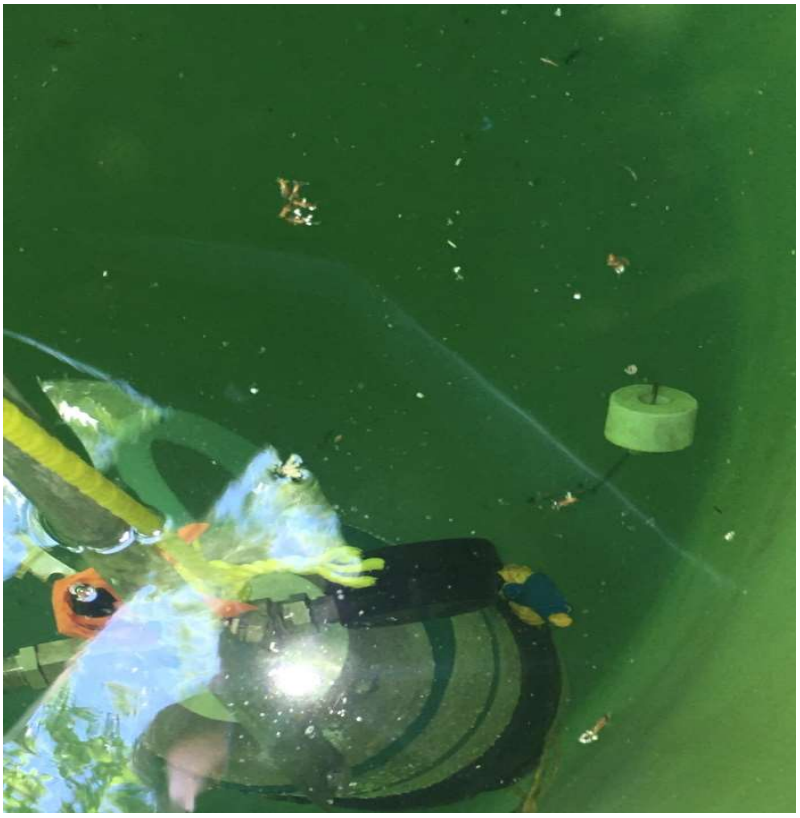

Figure 5: Slight Sheen stil Observed on 5/21/19 @ 10:00

Findings and Further Analysis:

After observing a slight sheen in the water after the sampling device valves were open it would appear that a sufficient trace amount of the lighter-end hydrocarbons may be contained in the gas that are sufficient to create an oil sheen.

The second scuba tank sample of gas was sent to Core Labs for chemical analysis to further confirm this hypothesis.

Core Lab Analysis of Gas Sample

The sample arrived at Core Labs on May 21, 2019. They were requested to perform a $C10^{+}$ compositional analysis of the gas as well as an isotope gas analysis. The results of these tests are shown in the Appendix 1.

The chemical analysis for the gas sample is shown below.

Compositional Analysis of Separator Gas

RFS ID No. 201801803-01-02
Sample date and time: Not Provided
Opening Conditions: 91 psig at 127 °F
Sample Source: Scuba Tank P175906

	Component	Mole %	GPM at 15.025 psia	Weight %	Molecular Weight
N_2	Nitrogen	1.514	0.000	2.446	28.013
CO_2	Carbon Dioxide	0.033	0.000	0.083	44.010
H_2S	Hydrogen Sulfide	0.000	0.000	0.000	34.082
C1	Methane	93.312	0.000	86.338	16.043
C2	Ethane	3.274	0.891	5.676	30.070
C3	Propane	1.214	0.341	3.086	44.097
iC4	Iso-Butane	0.242	0.081	0.811	58.123
nC4	N-Butane	0.258	0.083	0.865	58.123
iC5	Iso-Pentane	0.069	0.026	0.286	72.150
nC5	N-Pentane	0.034	0.013	0.143	72.150
C6	Hexanes	0.028	0.012	0.138	86.177
C7	Heptanes	0.013	0.006	0.071	93.604
C8	Octanes	0.005	0.002	0.029	107.130
C9	Nonanes	0.002	0.001	0.012	119.050
C10+	Decanes Plus	0.002	0.001	0.016	162.645
	Total	100.000	1.457	100.000	

Calculated Properties of Gas

			Data at 15.025 psia	
Gas Specific Gravity (Air = 1.00)		=	0.5999	
Net Heat of Combustion (Btu/Cu.Ft. at 60 °F)	Dry	=	974.5	Real
Gross Heat of Combustion (Btu/Cu.Ft. at 60 °F)	Dry	=	1,080.1	Real
Gross Heat of Combustion (Btu/Cu.Ft. at 60 °F)	Wet	=	1,061.2	Water Sat.
Gas Compressibility (1 Atm. at 60 °F)	Z	=	0.9976	

From the above gas composition, the resulting calculated GPM (gallons per 1,000 sft/day gas) value is 1.457 gallons of plant products per 1,000 cubic feet of gas at standard conditions of 15.025 psia and 60 °F. This GPM is calculated based on molar contributions from ethane out to what we are defining as C10+. Eliminating the very volatile components from the GPM calculation and starting the GPM

calculation at iso-pentane, **the resulting GPM value would be 0.061 gallons per 1,000 scf. So for every 1,000 scf of gas produced, we could potentially generate about 0.061 gallons of hydrocarbon liquid.**

In order to calculate the theoretical liquid at surface per day, you would need to know the gas rate. For the scuba tank sample used in the site test you would need know the volume of gas released in the tank. This can be calculated using PVT equations. The gas compressibility value for the sample gas is listed above as 0.9976 so for simplicity you can calculate the values assuming ideal gas laws. For an 80 cubic foot scuba tank the internal volume of the tank is 0.39 ft^2. Using this volume at a depth 404 ft which equates to 12.24 atm above atmospheric pressure and a temperature of 65F the volume of gas at atmospheric pressure can be calculated at a temperature of 90F. Using $(P_1V_1)/T_1 = (P_2V_2)/T_2$ yields a volume of gas released in the scuba tank during the test at Belle Chasse of 7.15ft^3. Using this value times 0.061 gallons of hydrocarbon liquid per 1,000 scf yield a volume of 0.056 oz or 1.66 ml which is equivalent to a drop the size of 1.47 ml diameter which would explain the slight sheen observed in the test.

It does need to be pointed out that GPM is a theoretical number based on 100% efficiency, ie, if you could convert all of the components to liquid NGLs. In the real world we only realize a fraction of the theoretical potential liquids.

Conclusion

From both experimental observation and theoretical calculations, it is possible that the gas being vented from the subsea separator can contain enough lighter-end hydrocarbons to cause a sheen on the surface of the water.

Appendix I

Core Labs Compositional Analysis in the Separator Gas Sample (File embedded with attached images below)

Petroleum Services Division

Reservoir Fluid Services

5820 Highway 90 East

Broussard, Louisiana 70518

Tel: (337) 839-9060

June 19, 2019

Couvillion Group, LLC

P.O. Box 344

Belle Chasse, Louisiana 70037

Attention: Mr. Kevin Kennelley

Subject: Compositional Analyses

Scuba Tank Sample

Report No.: 201901803-5019068385

Dear Mr. Kennelley:

RFS received the subject sample on May 21, 2019, at our Broussard, Louisiana facility. At your request, we have performed a C10+ compositional analysis of the gas as well as an isotope gas analysis. The isotope analysis of the gas indicates that the gas is of a thermogenic origin. The results of the aforementioned anlayses are presented in this report.

RFS is very pleased to have been of service to you in this work. Should any questions arise concerning the data presented in this report, or if we may be of assistance in any other matter, please do not hesitate to contact us.

Yours sincerely,

Terry W. Daigle

Project Manager

Compositional Analysis of Separator Gas

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Opening Conditions: 91 psig at 127 °F
Sample Source: Scuba Tank P175906

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Gas Compressibility (1 Atm. at 60 °F)	Z	=	0.9976	

- ☐ Heat of combustion is the quantity of heat produced when gas is burned completely to carbon dioxide and water.
- ☐ Wet and dry refer to the condition of the gas prior to combustion.
- ☐ Wet refers to a gas that is saturated with water vapor, and dry refers to a gas that contains no water vapor prior to combustion.
- ☐ Net and gross refer to the condition of the water resulting from combustion.
- ☐ Gross heat is the heat produced in complete combustion under constant pressure with the combustion products cooled to standard conditions, and the water of the combustion products condensed to the liquid state.
- ☐ Net heat is the heat produced in complete combustion under constant pressure with the combustion products cooled to standard conditions and the water of combustion products remains in the vapor phase.

Company: **Couvillion Group**
Well : **Not provided**
Location: **Not provided**
RFS ID No: **201901803-01**

SAMPLE INFORMATION						STABLE ISOTOPE ANALYSIS				VRo-Eq	
RFS ID	*Sample Formation*	*Sample Type*	*Top Depth*	*Bottom Depth*	*Sample Depth*	*$\delta^{13}C$ Methane*	*$\delta^{13}C$ Ethane*	*$\delta^{13}C$ CO2*	*$\delta^{2}H$ Methane*	**VRo-Eq Methane*	**VRo-Eq Ethane*
201901803-01-03	Not provided	Scuba Tank P175906	NA		NA	-54.10	-28.04	-13.91	-194.93	0.15	1.53

*Vro-equivalent values calculated after Berner & Faber 1996

*Two Point Calibration is used for Methane and C2+

*Precision is better than 0.5‰ for δ13C and 5 ‰ for δ2H

Stable isotopes
Thermogenic vs Biogenic gas