ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 1, July 2014

Extraction and Chromatographic Analysis of Gases Dissolved in Water Base Mud

Ashraf Yehia El Naggar
Chemistry department, Faculty of Science, Taif University, Kingdom of Saudi Arabia.
Egyptian Petroleum Research Institute, Nasr City, Cairo, Egypt.

Abstract:- Three water base mud samples (HW-1, HW-2 and HW-3) were collected from Hellenic Egyptian Petroleum Company in Al-Keram-1x at different Reservoir depths 3666 m, 3393 m and 3304 m respectively. The gases dissolved in theses water samples were extracted through lowering the Reservoir Pressures for each water sample. The gas water ratio was determined by counting the volumes of water and extracted gas using gas meter. The extracted three gas samples were analyzed using gas chromatography for complete composition of gas samples. The calculation of molecular weight and relative density were achieved depending on the gas composition analysis. In addition to the calculation of gross and net Calorific heat Values for each gas samples according to the standard method ASTM.

Key words:-**Water base mud, Reservoir Pressures, Gas water ratio, Gas chromatography, Net Calorific Heat Values**

I. INTRODUCTION

In water-based mud (WBM) most basic water-based mud systems begin with water, and then clays and other chemicals as hydrocarbons are incorporated into the water to create a homogeneous blend [1, 2]. The clay is usually a combination of native clays that are suspended in the fluid while drilling, or specific types of clay that are processed and sold as additives for the WBM system. The most common of these is bentonite, frequently referred to in the oilfield as "gel" [3, 4]. The extracted natural gases from water base mud play, nowadays, an important role in human life. A principal reason is the abundant supply of natural gases, as a clean source of energy and for the production of high value chemicals. Recently, natural gas supply chain was investigated using concepts related to natural gas industry [5. The characteristics of natural gases are dependent on the hydrocarbons distribution in the gases. Thus, the calculation of calorific value, hydrocarbon dew point, specific gravity and other physical properties requires detailed analysis of the gases as can be provided by gas chromatography [6]. Also, the gas compression flow rates through pipes, and therefore shape of flames, design of gas holders and the most other gas handling equipments [7, 8]. The correct decision about the most profitable petrochemical products to be made from natural gases is essentially dependent on the hydrocarbons distribution in the gases [9]. On the other hand, the hydrocarbons ratios pattern could be used to predict the productive potential of a reservoir and the formation evaluation. Thus, the relationship of methane to the heavier hydrocarbon components ethane to nonanes is indicative of gas, oil and water productive potential and in some cases reservoir permeability [10]. This study aims to extract, analyze and evaluate the natural gases from different reservoir deeps from Hellenic Egyptian Petroleum Company in view of the hydrocarbons distribution. In addition the physicochemical properties of the extracted gases can be calculated from gas composition and discussed on the bases of hydrocarbons ratios in these gases.

II. METHOD OF EXTRACTION

1. First, three cylinders was washed and used carefully with a proper solvent followed by deionized water and then dry them.
2. The cylinders were evacuated by connecting them to the vacuum pump.
3. The cylinders were filled with three water base mud HW-1, HW-2 and HW-3 under pressures 6088 psi, 4753 psi and 4595 psi respectively, the volumes of waters in each cylinder are nearly the same and then closed the valves.
4. The valve of each cylinder was opened then the dissolved gases were released and swept through chromatographic micro litter syringe and then injected into the injector of gas chromatography.
5. The releases gases were injected at least three times and all of them were injected into GC, then the average weight percent of the dissolved gases was obtained.

III. PHYSICAL PROPERTIES

1. The three water base mud HW-1, HW-2 and HW-3 and the reservoir conditions were given in Table 1. The water volume was counted to be nearly 400 ml.
2. Their density was measured at 60 oF , the volume of gas dissolved in water was measured using gas meter.
3. The gas water ratio was calculated for the three studied samples.

IV. GAS CHROMATOGRAPHY

Hydrocarbons from C_1 to C_9, carbon dioxide, and nitrogen were analyzed using Agilent model 6890 plus HP gas chromatograph equipped with thermal conductivity detector "TCD" and flame ionization detector "FID". The packed column Porapack-Q, 40 ft in length and 1/8 inch in internal diameter was used to analyze light hydrocarbons and capillary column 15 m in

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 1, July 2014

length and 0.53 inch in internal diameter and packed with molecular sieve was used for the analysis of nitrogen. DB-1 capillary column, 60 m in length and 0.32 mm in internal diameter were also used in attachment with TCD and FID respectively. Helium gas was used as carrier gas at flow rate of 4ml min^{-1}. The elution of the studied gas mixture was achieved with temperature programming from 50ºC to 200ºC at a rate of 10ºC min^{-1}. The quantitative analysis of the gas mixture was achieved using a standard natural gas sample of known composition and according to the standard [ASTM: D 1945–03]. The injector and detector temperatures were 200ºC and 250ºC, respectively. The data was estimated by integration of the area under the resolved chromatographic profiles, using the HP computer of software chemstation.

IV. RESULTS AND DISCUSSION

Three water base muds HW-1, HW-2 and HW-3 were collected from different reservoir depths 3666, 3393 m and 3304 m respectively. The reservoir temperatures and pressures were given in Table 1. Also, the density and pH of water samples and the volumes of water and dissolved gases were given in Table 1.

Table 1. The reservoir conditions and the physicochemical properties of the selected water base mud samples

Property	HW-1	HW-2	HW-3
Depth , m:	3666.2	3393	3304
Reservoir Pressure: , psi	6088.14	4753.96	4595.1
Reservoir Temperature: ^{0}F	129.3	122.75	123.08
Opening Pressure, bar @ 22 ^{0}C	44	10	26
Phase:	Water base mud	Water base mud	Water base mud
Volume of Gas Dissolved/Water	1057.613	472.1	424.934
Weight of Water	470.956	467.028	476.190
Density of Water @ 60 ^{o}F	1.17739	1.16757	1.16144
Volume of Water	400.000	400.000	410.000
Gas Water Ratio :	2.644	1.180	1.036
Gas Water Ratio :	14.845	6.625	5.817
pH :	7.73	7.8	7.1

V. GAS CHROMATOGRAPHIC ANALYSIS OF THE EXTRACTED GASES

The summary of the major hydrocarbons in the natural gases from the three extracted gas samples collected from Hellenic Egyptian Petroleum Company in Al-Keram-1x at different Reservoir depths was given in Table (1). Considerable variations in the hydrocarbons distributions can be found in gases extracted from water base mud at different depths. The extracted gases contain hydrocarbons and non hydrocarbons, the hydrocarbons are methane, ethane, propane, butanes, pentanes, hexanes, heptanes, octanes and nonanes. The non hydrocarbons include nitrogen and carbon dioxide. There is no one chromatographic column and one detector can separate the all components present in natural gases, so, we use three different columns and two detectors in order to obtain complete analysis of the extracted natural gases. The first column used is capillary column packed with silicon oil stationary phase coated on the surface of chromosorb WAW for separating the heavy hydrocarbons in natural gas, the second is molecular sieve capillary column for separating nitrogen and oxygen and the third packed column is Porapack-Q for separating methane, ethane and propane in addition to carbon dioxide. The first detector used is thermal conductivity detector for light paraffines and non hydrocarbons and the second one is flame ionization detector for heavy hydrocarbons. From these columns and detectors we can achieve complete analysis of natural gas. The mean percentage of methane in extracted gases from Hellenic Egyptian Petroleum Company given in Table 2 represents the highest value, the methane percentage increase in the order HW-1> HW-2> Hw-3. This order is matched with the reservoir deeps, the deepest gas sample accompanied with high percentage of methane. The complete compositions of extracted gases given in Table 2 include low percentage of nitrogen and considerable amounts of carbon dioxide ranged from 3.896 to 6.695 mol %. Each gas contains paraffines up to nonanes. The extracted gases contain light aromatics hydrocarbons such as benzene, toluene, ethyl benzene, o-xylene, m-xylene and p-xylene as given in Table 2. Ethane represents the second high percentages in natural gas samples after methane. These variations are reflected on the physical properties of the gases such as specific gravity, molecular weight and calorific values. For example, the highest methane value in HW-1, is accompanied by the lowest values of density, gas gravity, molecular weight and gross heating value. The physical properties of the extracted natural gases from water base mud are given in Table 3. It has been found that the relative density, average molecular weight and both gross and net calorific values of the extracted gases increase with lowering reservoir deeps, this may be due to the increase of heavy hydrocarbons in the studied natural gas. Generally, the composition of all extracted gases can be used as good gas fuels exhibiting high heat values as given in Table 3.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 1, July 2014

The main observation on the hydrocarbons distributions may be that a considerable amount of non methane hydrocarbons are present in the majority of the studied gases. These are promising indications for these gases as primary materials for petrochemical processes, as well as, a valuable source for energy. From another point of view, the hydrocarbons distributions in the gases may contribute in elucidation of the geochemistry of the studied gases. Thus, in the source rocks, there has been considerable time for gas generation and accumulation, so that these deposits represent the integration of generation, migration and trapping processes operating over a very long period.

Table 2 the composition of the extracted natural gas samples by gas chromatography

Composition	HW-1		HW-2		HW-3	
	Mol %	Wt. %	Mol %	Wt. %	Mol %	Wt. %
Nitrogen	0.477	0.367	0.447	0.325	0.409	0.293
Methane	45.614	20.080	44.047	18.331	42.485	17.432
Carbon Dioxide	4.254	5.137	3.896	4.448	6.596	7.424
Ethane	18.012	14.862	17.822	13.902	16.453	12.653
Propane	12.019	14.543	11.112	12.711	10.851	12.238
i-Butane	1.895	3.022	1.983	2.990	2.474	3.677
n-Butane	3.854	6.147	3.892	5.869	4.045	6.013
i-pentane	1.322	2.617	1.459	2.731	1.679	3.098
n-Pentane	1.291	2.556	1.385	2.592	1.360	2.509
Hexanes	2.550	6.030	3.178	7.105	3.221	7.099
Benzene	0.735	1.575	0.827	1.676	0.843	1.684
Heptanes	3.312	9.106	3.604	9.369	3.615	9.264
Toluene	1.327	3.355	1.831	4.377	1.726	4.067
Octanes	2.326	7.291	3.120	9.246	2.858	8.349
Ethyl-benzene	0.141	0.411	0.172	0.474	0.164	0.445
p,m-xylene	0.182	0.530	0.254	0.700	0.290	0.787
o-xylene	0.089	0.259	0.133	0.366	0.151	0.410
Nonanes	0.600	2.112	0.838	2.788	0.780	2.558
Total	100.000	100.000	100.000	100.000	100.000	100.000

Table 3 the physical properties of the extracted gas samples calculated from the composition

Physical property	HW-1	HW-2	HW-3
Relative Density (Air= 1.0000)	1.2583	1.3309	1.3501
Average Molecular Weight	36.444	38.548	39.102
Gross Calorific Value, Btu/ft^3	1998.435	2085.538	2123.272
Net Calorific Value, Btu/ft^3	1833.146	1915.123	1949.462

Conclusion

- The methane percentage is the main amount in the extracted natural gases and increase in the order HW-1> HW-2> HW-3 with the same order of decreasing reservoir deeps, followed by ethane percentage.
- The physical properties of the extracted gases, specific gravity, average molecular weight and calorific values decrease in the order HW-1> HW-2> HW-3 with the same order of decreasing reservoir deeps due to the increase of heavy hydrocarbons.
- The hydrocarbon distribution in each extracted gas sample from water base mud can be used as good gas fuels exhibiting high heat values.

REFERENCES

[1] ASME Shale Shaker Committee (2005) The Drilling Fluids Processing Handbook ISBN 0-7506-7775-9

[2] Kate Van Dyke (1998) Drilling Fluids, Mud Pumps, and Conditioning Equipment

[3] G. V. Chilingarian & P. Vorabutr (1983) Drilling and Drilling Fluids

[4] G. R. Gray, H. C. H. Darley, & W. F. Rogers (1980) The Composition and Properties of Oil Well Drilling Fluids

[5] Hamedi M., Farahani R. Z., Husseini M. M. and Esmaeilian G. R., Energy Policy, 37, 799-812 (2009).

[6] Cramers, C.A., "Trends in the analysis of natural gas by capillary gas chromatography" publ. by El sever, Amesterdam, Neth. And New York, NY, USA, p. 445-457 (1986).

[7] American Gas Association, "Gas Engineer, Hand book" Industrial Press Inc., New York (1969).

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 1, July 2014
[8] British Gas Corporation, British Gas Data Book, vol. 1 (1974).

[9] Barker, J. F., Pollock, S. J. Bull. Canadian Petroleum Geology 32 (3), 313 (1984).

[10] Tissot, B., B. Durand, j. Espitalie and A. Combay, 1974 Influence of nature and diagnosis of Organic matter in formation of petroleum: Bull. Of the American Association of Geologists, V. 58, P. 499-506.