MUD GAS ANALYSIS FOR PETROLEUM RESERVOIRS EVALUATION OF TASBULAT FIELD, WESTERN KAZAKHSTAN

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Abstract: *the paper includes real-time mud gas analyzing procedures while drilling process with using mud gas data from reservoir fluid for its evaluation. The mud gas detection was carried out while drilling in the drill hole of 328 in the Tasbulat oil and gas condensate field. In the work was used 53 gas samples of the drill well, which were determined by gas chromatography "Agilent" (3000 A) for identifying gas contact with fluid zones and gas quality with indicating more productive hydrocarbon zones using mud gas analyzing method.*
Keywords: *Tasbulat, reservoirs, mudlogging.*

АНАЛИЗ БУРОВОГО ГАЗА ДЛЯ ОЦЕНКИ НЕФТЯНЫХ КОЛЛЕКТОРОВ МЕСТОРОЖДЕНИЯ ТАСБУЛАТ, ЗАПАДНЫЙ КАЗАХСТАН

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Аннотация*: в работе представлены процедуры анализа бурового газа в режиме реального времени в процессе бурения с использованием данных бурового газа из пластовой жидкости для его оценки. Обнаружение бурового газа осуществлялось при бурении скважины 328 на Тасбулатском нефтегазоконденсатном месторождении. В работе было использовано 53 пробы газа буровой скважины, которые определялись методом газовой хроматографии "Агилент" (3000 а) для выявления контакта газа с флюидными зонами и качества газа с указанием более продуктивных углеводородных зон методом анализа бурового газа.*
Ключевые Слова: *Тасбулат, водохранилища, заболачивание.*

The scope of this paper comprises real time drilling mud gas description for identification of reservoir evaluation in its quality of productiveness, using gas ratio analyzing methods, which probably have reliable abilities to indicate hydrocarbon potential in the well.

The purpose of the study is to determine more productive horizons with indicating gas quality and gas-fluids contacts in the well 328 for demonstrating

high possibility of mud gas ratio analyses with obtaining immediate evaluation and recognition of reservoir characterization in real time which is possible effective method during while the drilling.

The relevance of the study is to react fast in search a detection of productive gas zones, gas quality and gas-fluid contact zones while drilling according to the mud gas ratio analyses. The drill hole of 328 is a good sample to demonstrate a detection rate of mud gas ratio analysis in this work. Because, the drill hole has comparatively good gas shows with light gas and heavy gas components (in total gas 175%) [1].

The use of gas ratio analysis is one of the many tools that have been used effectively for real time gas evaluation. These ratios generally compare the relative quantities of the heavier components with the lighter fractions of reservoir fluid [2]. The gas ratio analyses are used gas shows from mud-gas separation while a drilling, which all mud logging operations use some sort of "gas trap" to release hydrocarbons from the drilling fluid. The extracted gases are then transported, via some type of tubing, to the logging unit for total gas and chromatograph components [3]. Total gas and chromatograph components readings are synchronized with depth and corresponding lithology in special mud logging programs [4]. And then gas detections are calculated real-time immediate evaluation and recognition of reservoir changes and plotted on a depth-based log for comparison with other mud logging and wireline data for effective reservoir evaluation [5].

The Tasbulat oil and gas field is located in South Mangyshlak sub-basin which is part of a Middle Caspian Basin. The field is located 85km to the southeast of the town of Ózen. The Tasbulat structure was delineated by the seismic exploration work in 1965 and the field was discovered via prospecting drilling in 1967. Exploration drilling in the Tasbulat field started in 1974. The productive horizons are of Middle Jurassic formation and lithologically composed of alternating sandstone, siltstone and shale beds [1].

The drill hole of 328 in the Tasbulat, focusing gas shows from 1800 m to 2500 m (bottom hole) in productive horizons (J1, J2a1, J2a2, J9a1 and J10b listed in Table 1) of sandstone reservoir with thinly interbedding of coal and claystones, which are related to Middle Jurassic formation. The main focus of the Tasbulat-328 well is Jurassic-1, J-2a2, 10a and 10b reservoirs in the work.

Table 1. Productive sandstone reservoirs description [1]

Formation:	**Middle Jurassic**			
Sandstone reservoir labels:	J-1	J-2a2	J-10a	J-10b
Depth (meter):	1813	1893	2404	2440

The gas sampling was carried by Chromatograph Agilent (3000 A) with indicating gas components and their concentrations from the drill hole. The total

hydrocarbon gas level is monitored and a chromatographic analysis is made automatically every 60 sec. Among gas detections were selected 53 gas specimens which are related to gas-bearing intervals of the reservoirs between 1800-2500 meters and focusing on one reservoir J10b in a depth 2440 m. The gas specimens content dry gas (methane C_1) and wet gas (ethane C_2, propane C_3, butane C_4, pentane C_5) with quite good concentrations (max 395000 ppm in total gas) in the well.

The methods of gas ratio analyses are gas quality ratio, Haworth & Whittaker ratios and oil indicator detecting fluid type and gas saturation, which are fundamental aspects that require immediate assessment while drilling [2]. The two fundamental aspects may predict by using gas shows and their gas ratio analyses. It is possible to display these ratios in real time. Recently, results have successfully been used to reveal fluid composition [2] using following gas ratios: (1) Gas quality ratio (GQR) for identifying gas quality, the good quality gas (GQR) between 0.8 and 1.2 [3]; (2) oil indicator (O) for evaluation (listed in Table 3) of a productive reservoir, ranges 0.01-1 with increasing gas and oil density [5]; and (3) Haworth & Whittaker ratios such as character (Ch < 0.5 indicate productive gas phase and Ch > 0.5 productive liquid phase), wetness and balance (interpretation of Wh and Bh listed in Table 2) for detecting formation fluid changes such as fluid contacts as gas-oil contact (GOC) or oil-water contact (OWC):

$$GQR = \frac{\text{Total Gas}}{\text{C1} + \text{C2} + \text{C3} + \text{C4} + \text{C5}} \quad (1)$$

$$\text{O} = \frac{\text{C3} + \text{C4} + \text{C5}}{\text{C1}} \quad (2)$$

$$W\square = \frac{C2+C3+C4+C5}{C2+C3+C4+C5} \times 100; \quad \text{Bh} = \frac{\text{C1}+\text{C2}}{\text{C3}+\text{C4}+\text{C5}}; \quad \text{Ch} = \frac{\text{C4}+\text{C5}}{\text{C3}} \quad (3)$$

Table 2. The data for interpretation of Haworth & Whittaker ratios [5]

Balance ratio	**Wetness**	**Reservoir fluid and production potential**
> 100		Very light, dry gas.
<100	<0.5	Possible production of light, dry gas
Wh <Bh<100	0.5-17.5	Productive gas, increasing in wetness
<Wh	0.5-17.5	Productive, very wet gas or condensate or light oil with high GOR
<Wh	17.5-40	Productive oil with decreasing gravity
<< Wh	17.5-40	Lower production potential of low gravity, low gas saturation oil
	>40	Non-productive, very low gravity, residual oil

Table 3. The data for interpretation of oil indicator ratio [5]

Range:	0.01-0.07	0.07-0.10	0.10-0.40	0.40-1.0
Evaluation:	Dry gas	Condensate, light oil with high GOR	Oil	Residual oil

Results of gas ratio analyses are described and interpreted on the following sections:

(1) *The gas quality ratio result* of the well show that gas-containing intervals have a good quality gas and GQR between 0.8-1.2 (see in Figure 1). The good quality gas distributions which are located between 0.8-1.2 start from 1830 meter with 1 in GQR accompanying up to 1.2 in different depths until the end of borehole where mostly gas samples closely approach to 1.2. Among the area of GQR (0.8-1.2) only one gas sample has a position in 0.8 which was detected in 1875 m and other gas samples have more 1 and up to 1.2 in the indicated good quality area whereas seven gas samples have out position form framework of good quality gas (more than 1.2 in GQR). The seven gas samples start from 1820 m (where GQR is 1.5) synchronically increasing GQR until 2350 m. These gas samples have probably methane compounds (max value 120 000 ppm in 2350 m), because the seven gas samples repeat the same depth of the drill well and similar positions in log charts, which are shown in Figure 1. The aspect is confirmed also in a lithological column (see in Figure 1) and a description of field report that in the depths of the drill hole are located coal-containing layers where the seven gas samples were detected and acquired.

(2) *The results of Haworth & Whittaker ratios (Ch, Bh, Wh)* indicate that the intervals between 1800-2500 meters are productive in hydrocarbon gas and oil. The result of character (Ch) ratio reveals the hydrocarbon (HC) product is productive gas phase character and in balance (Bh) the HC has light gravity oil and productive oil with decreasing gravity whereas the wetness (Wh) affirm it and indicating some non-productive area as well (see in Figure 2).

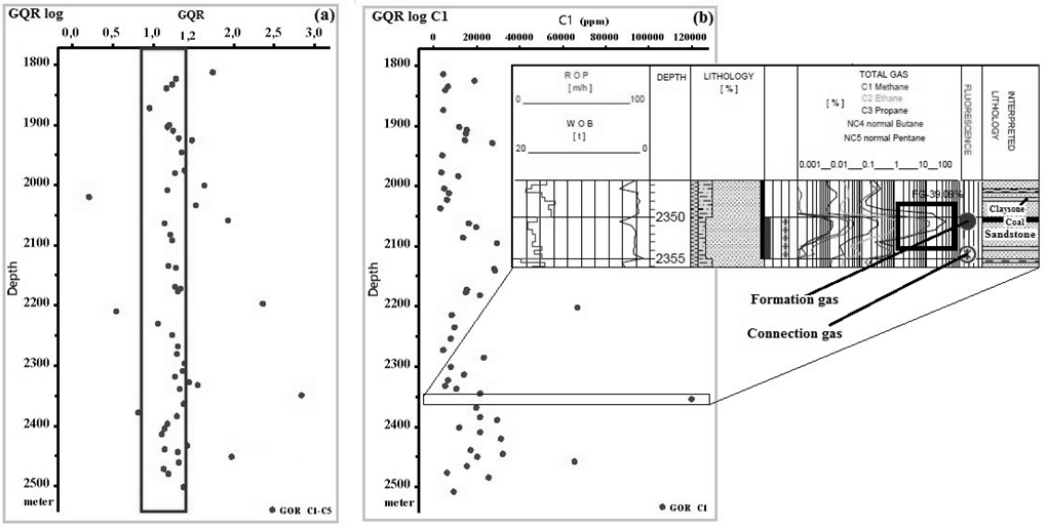

Fig. 1. Gas quality ratio chart (a) alongside with methane (b) concentration chart for the well ((a) - the red vertical allotment is good quality area of GQR between 0.8-1.2; (b) - the black one methane gas peak zone)

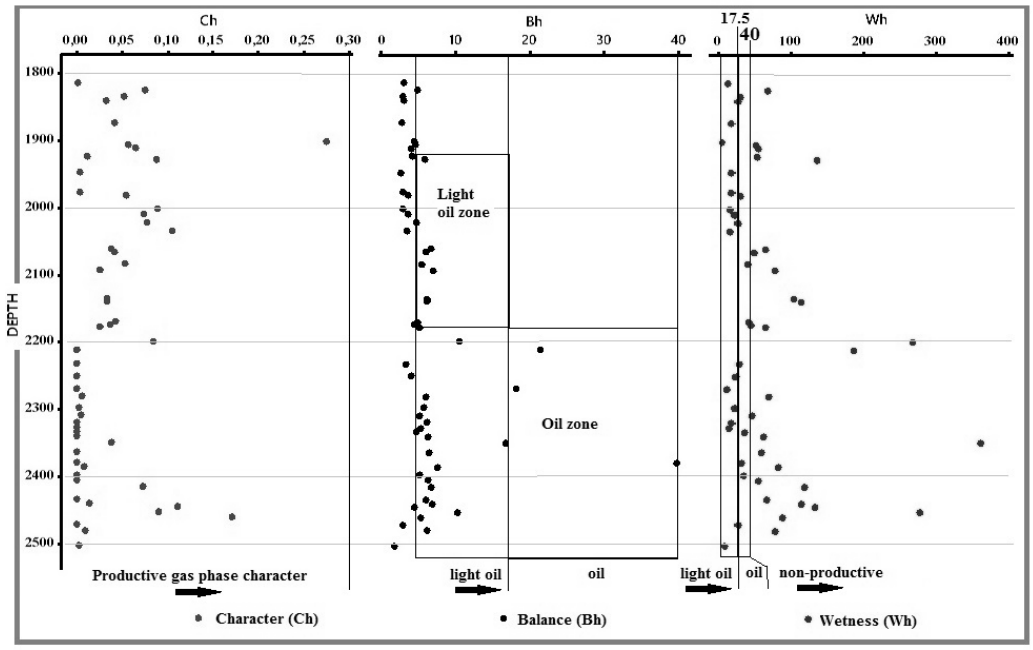

Fig. 2. Interpretation of results of Haworth & Whittaker ratios (Wh, Bh, Ch)

(3) The result of oil indicator ratio shows that there are three productive zones of the reservoirs. They are dry gas zone (first zone), productive light oil (second one) and oil zones (third one). The ratio indicates on gas condensate and oil contact in a depth 2170 m. In contrast of oil indicator ratio result and well logging result has a similar confirmation with using reservoirs allotments in Figure 3. In the zone 1 which is dry gas has lower percentage (0.92%) of formation gas in depths between 1830-1845 meters, where located coal formation with thickness up to 1 m. In the 2nd zone maximum HC with middle percentage of formation gas (4.9 %) in 1930 m and the 3rd zone includes two formation gases, the first formation gas highest value 39.09%, because coal formation concentrated to methane gas in 2350 m and the second one has more middle value 15.46% in 2455 m.

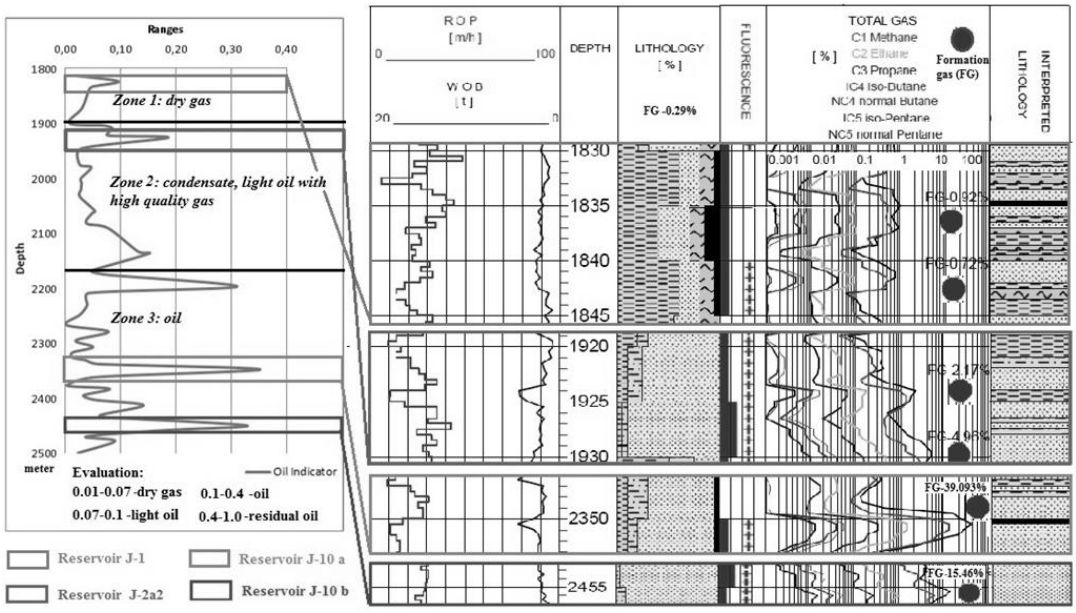

Fig. 3. Interpretation of oil indicator ratio withmud logging data (master log)

In discussion, the studied four reservoirs of the filed through the drill hole of 328 are all productive with different hydrocarbon phases. The four reservoirs may predict their productive potential on the following four sections:

(1) The reservoir of J-1 contents productive hydrocarbon gas in intervals between 1800-1900 meters.

(2) The reservoir of J-2a2 has light oil with high quality gas condensate in intervals between 1900-1950 meters.

(3) The reservoir J-10a comprises productive hydrocarbon oil and appearing coal methane gas in 2350 meter.

(4) The reservoir J-10b has more productive oil occurrence with high formation gas and absence of coal formation.

Conclusion

It may suppose that the reservoirs J-10b, J-2a2, J-10a and J-10b are potential productive zones with oil presence, due to the gas ratio analyses and the results with interpretations were confirmed field laboratory analysis (binocular microscopy and fluorescence testing unit) on cutting samples (from the same depth) during the well drilling in the field. As shown the results in the work can say that the gas ratio analyses are relevant to predict productive zones with indicating hydrocarbon potential in reservoirs. The analyses are reliable to use in while a well drilling with obtaining immediate descriptions of hydrocarbon zones and their evaluation.

Acknowledgment

I thank to "Drill-lab Kazakhstan" company which helped to take oil filed experience and collect gas samples of Agilent gas chromatography.

This work was supported by the project of EFOP-3.6.1-16-2016-00011 at University of Miskolc, Hungary.

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