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# Gas Ratio Analysis in Hovsan Oil Field

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**Abstract:** Gas Ratio Analysis is best of the analysis in mud logging system which during drilling time is very important for catch formation. This analysis can help geologist that to decide which layers have oil and gas. Also with this analysis, we can compare that wireline jobs has been right place or not. So after calculate ratio analyses, we can put same place then can compare with wireline curves. In that time, we can see that where exactly have oil and gas. With this method, we can reduce cost and we can do safety job. In Azerbaijan Gas Ratio Analysis has been used in Pirsa at Oil field and has been gotten good result after perforation. Now this method use in Hovsan and Zigh oil field by the mudloggers which belong Surachani district.

**Key words**: Oil, Gas, lithology, wireline, mudlogging.

## 1. Introduction

Gas readings are most commonly obtained from the mud system by placing a separator or gas trap in the ditch (possum belly) or flow-line. Extracted gas is drawn into the mud logging unit where its contents are measured by a variety of gas detectors; usually a total hydrocarbon detector, a chromatograph, a $CO_2$ detector and a $H_2S$ detector. Total gas detectors that monitor for nitrogen, various sulfides and hydrogen may also be used. The amount of gas recorded is dependent upon many variables, including:

- Volume of gas per unit volume of formation;
- Degree of formation flushing;
- Rate of penetration;
- Mud density and Mud viscosity;
- Formation pressure;
- Gas trap efficiency;
- Gas detector efficiency;
- Variability of mud flow rate.

Due to the variability of gas analysis they are generally used only in a qualitative manner. Comparisons to other wells can only be down when indications are similar (i.e. between wells drilled by the same rig, with the same gas trap/detector system and similar mud types).

Gas readings are used with reference to a "background level". The gas readings are then displayed graphically on either the mud log and or the geologists mudlog. This allows an easy evaluation of the relative amounts of gas recorded. Contractors usually record total gas as either a percentage, ppm or in the form of gas units. A gas unit may vary from 0.02% to 0.033% depending upon contractor. The use of percent or ppm allows for better comparison between wells and contractors. A understanding of the mud logger's gas detectors is important when reviewing gas data. The equipment between companies does differ. For example, some companies use chromatographs that do not measure the pentanes (C5), which could be important if the geologist is correlating with another mud log containing C5's. Gas detectors may be of two types, an older catalytic variety or the more modern FID (Flame Ionization Detector) type. CCD detectors use a catalysis approach (that is the catalytic oxidation of gas upon a filament in the presence of air), while the FID use flame ionization (the ionization of a sample into charged hydrocarbon residues and free electrons by combustion). The type of equipment used should be known by the geologist as the two methods are affected differently when non-hydrocarbon gases are present. The catalytic detectors upper limit of

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sensitivity is approximately 9.5%. At this point not enough oxygen is available for catalysis. A “negative” response occurs in the presence of $CO_2$, and the detector is affected by large quantities of nitrogen. Variations in temperature also cause a thermal drift of catalytic detectors. FID detectors are not affected by quantities of nitrogen, $CO_2$ or temperature variations. To assist in post-well evaluation, the Wellsite Geologist should ask the mud loggers to note the type of gas detection equipment on the mud log. In addition, establish with the client how produced gases (i.e. connection and trip gases) are to be reported. For example, they will be reported as percent above background gas or as a total percentage.

*1.1 Gas*

As mentioned earlier, many factors affect the amount of gas recorded at the surface. Prior to discussing these at length some definitions are necessary.

True zero gas: The value recorded by the gas detectors when pure air is passed over the detection block (generally done during calibration). To ensure a zero mark, the detectors should be zeroed prior to drilling, at casing points, logging points, etc.

Background zero gas: The value recorded by the gas detectors when circulating, off-bottom, in a clean, balanced bore hole. Any gases monitored will be from contaminants in the mud or from gas recycling. This value is the baseline from which all gas readings are referenced for the striplog and mud log, but not plotted on the logs. This value will change with respect to changes in the mud system (adding diesel) and hole size, and should be re-established periodically.

Background gas: This is the gas recorded while drilling through a consistent lithology. It often will remain constant, however, in overpressured formations, this value may show considerable variation. This is the gas baseline which is plotted on the striplog and mud log.

Gas show: This is a gas reading that varies in magnitude or composition from the established background. It is an observed response on the gas detector and requires interpretation as to the cause. Not all gas peaks are from drilled formation, some may occur as post-drilling peaks.

Connection gases: Gas peaks produced by a combination of near-balance/under-balanced drilling and the removal of the ECD (Equivalent Circulating Density) by stopping the pumps to make a connection. They are often an early indicator of drilling overpressured formations. These should be noted, but not included as part of a total gas curve.

Trip Gases: Gas peaks recorded after circulation has been stopped for a considerable time for either a bit trip or a wiper trip. As with connection gases, substantial trip gases can indicate a near balance between the mud hydrostatic pressure and the formation pressure, they should be recorded but not included as part of a total gas curve. Like other logs, the mud log is a depth-related plot displaying certain physical characteristics of the formations being drilled. In the mud log’s case, gas curves are changes in the concentration and composition of formation hydrocarbons. Like other logs, there are baselines or thresholds values, from which deviations may indicate significant events. One such baseline is gas present in normally pressured formations. There may be significant contributions by extraneous factors and the baseline itself may vary (in laminated formations it may oscillate to extremes), but it will provide a standard upon which events will be judged. It is essential that absolute magnitude not be the only basis upon which gas show evaluation is made. The magnitude of a gas show is quantitative only to the air/gas sample obtained and measured at the detector. In correlating gas shows between different wells (especially where a change of rig or engineering approach is involved), the major parameters are curve profiles and relative compositions. As with the correlation of wireline logs, care should be taken to match up overall curve character and not just individual high and low values. Individual values are never reproducible and extremely high values should always be suspect, and are of little "correlative" use. Logs showing a difference of several orders of magnitude in gas concentrations may be easily correlated by overlaying gas curves and recognizing significant peaks or variations in the form of the curve. Similarly, the significant event may be the appearance of a new component or a notable change in the relative concentration of two or three compounds. At no time should the absolute magnitude of a gas show be taken as a basis for any quantitative statement. As stated earlier, no gas show should ever be considered in isolation. Reference should always be made to the preexistent background value. The gas phase at surface may not, and probably will not, have the same composition as the gas phase in-situ. It will nevertheless reflect the overall hydrocarbon composition (i.e. liquid and gas) of the reservoir, and chromatographic analysis can be used by skilled log interpreters as an important key to evaluation. Again, it is not simply the magnitude of gas shows, but their relative composition linked with all other log parameters which is the key factor. In addition to the conventional log presentations of gas show data, certain mathematical treatments are available by mud logging companies as an aid in interpreting gas shows. Although some of these are attempted normalization (adjustments of the Total Gas values for the normalizing of known downhole effects), most are treatments for chromatographic analyses in order to determine characteristic responses typical of known hydrocarbon types.

*1.2 Gas Normalization*

The quantification of gas shows is unattainable with current mud logging technology. The many in-situ and drilling variables are almost impossible to calculate during initial evaluation. In-situ variables include porosity, relative permeability, gas saturation, temperature, pressure, solubility and compressibility of the gases. Once penetrated by the drill bit, other variables come into play, such as flushing, drill rate, pump rate, hole size, rock and gas volume, differential pressure and temperature, phase changes and surface losses.

Normalization is the mathematical treatment of parameters affecting gas shows. Attempts have been made to cover all the downhole variables, such as saturation, temperature, pressure, etc. however, for truly accurate results by these methods, wireline log evaluation must be made first to arrive at a "safe" figure. Gas normalization does not try to cover surface losses, due to the great variations in flow-line and ditch geometries, flow rates and gas trap efficiencies (though studies have been made to determine gas trap efficiency). The most common form of normalization involves correction for drill rate, hole size and pump rate because these parameters are continuously monitored while drilling and can be immediately entered into normalization equations.

## 2. Materials and Methods

*2.1 Correlation*

The comparison of relative concentrations of the various hydrocarbons seen in a chromatogram (C1-C5) often has diagnostic value in qualitatively estimating the type and quality of a petroleum reservoir. Such a comparison has also been useful in stratigraphic correlation, where a distinct and characteristic hydrocarbon boundary may be recognized, even when no lithological facies boundary is evident. The study of relative concentrations of light alkanes has been done by various people to evaluate maturity levels and migration modes of petroleum reservoirs. Studies of n-heptane and iso-heptane ratios have been conducted to determine maturity and thermal history classifications of petroleum. Ratio studies of C2-C4 and especially the butane isomers have been used to determine the effect of diffusion in primary migration and the possible maturity trends shown by these studies. These studies, however draw on data not readily available in normal wellsite logging, and practically all gas ratio studies performed at the wellsite are used to determine the type and quality of petroleum reservoirs. Such studies are mathematical treatments of the hydrocarbon species (C1-C5) using relative concentrations such as C2/C1, C3/C1, etc. Plots from these studies will often yield distinctive "character" or "events" not always immediately evident from the chromatogram itself. Two such ratio methods used are the "Rectangular Plot" and the "Triangular Plot". Though originally designed for steam-still reflux mud or cutting samples, then have been adapted for gas trap readings.

When using either plot, the following corrections must be made:

• Removal of all contamination gas readings, such as diesel, trip gas, connection gas, recycled gas (see Table 1);

• Correction for background gas. The relative concentrations must be read above background gas;

• More than one reading must be done to have any interpretative value.

*2.2 Rectangular Plots*

The rectangular plot uses the ratios C1/C2, C1/C3, C1/C4 and C2/C3 (or C1/C5) and plots the results on a semi-logarithmic grid (see Fig. 1). Values of these ratios are allocated to potential productivity, where:

Several "rules of thumb" for the rectangular plot are:

• Productive dry gas zones will yield mainly (or only) methane. However, abnormally high ratios may indicate gas in solution in a water zone;

• If C1/C2 falls in the oil section, but C1/C4 is high in the gas section, the zone may be non-productive;

• If any ratio is lower than the preceding ratio, the zone is probably nonproductive;

• If C1/C4 is lower than C1/C3, the zone is probably water wet.

When plotted, the results tend to be in conclusive and a careful review of all log information can yield a more definitive evaluation. In practice, this type of plot can be useful as an illustrative tool and as one component in a complete evaluation.

*2.3 Triangular Plots*

The triangular plot (see Fig. 2) requires the calculation of the ratios C2, C3 and nC4 to the total of all gases detected (expressed as a percentage). Lines representing those percentages are then drawn on a triangular grid. As with the rectangular plot, all gas percentages are taken above background.

**Table 1 Gas relations.**

| Relations Ⅱ | Oil zone | Gas zone | Other productive |
|---|---|---|---|
| C1/C2 | 2-10 | 10-35 | < 2 and > 35 |
| C1/C3 | 2-14 | 14-82 | < 2 and > 82 |
| C1/C4 | 2-21 | 21-200 | < 2 and > 200 |

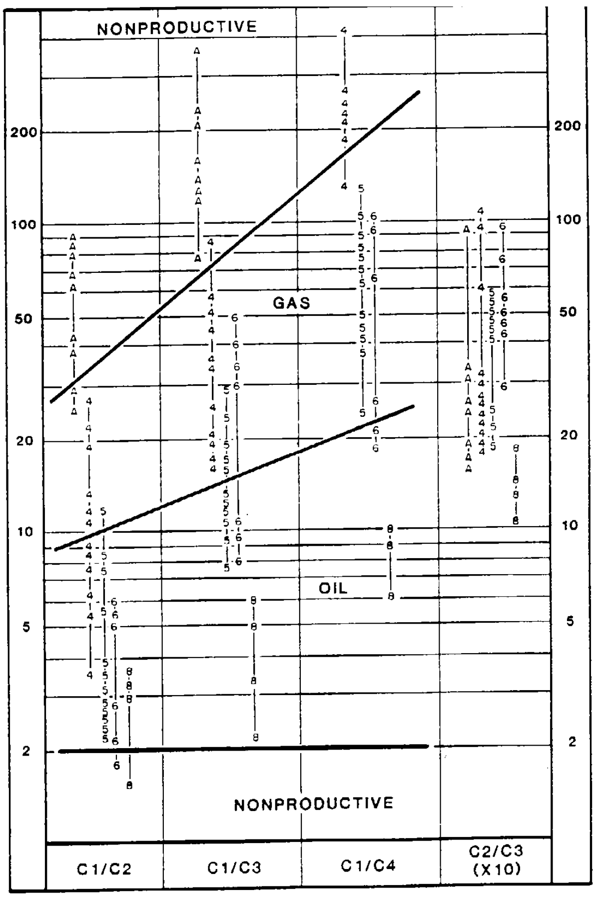


**Fig. 1 Rectangular plot.**

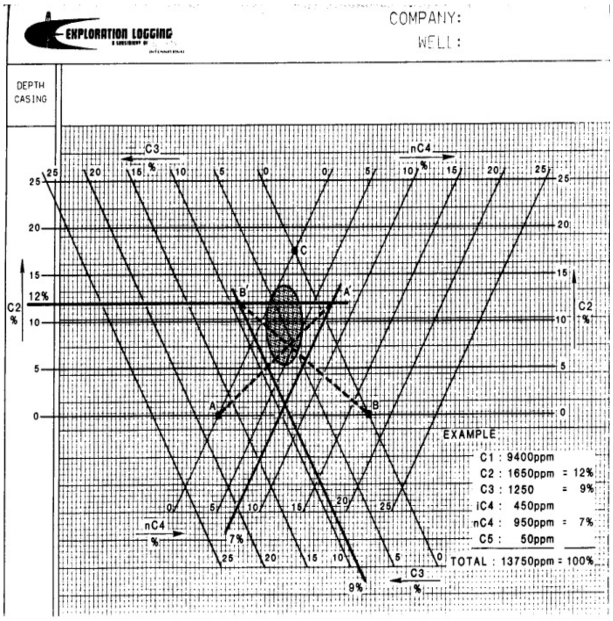


**Fig. 2 Triangular Plot.**

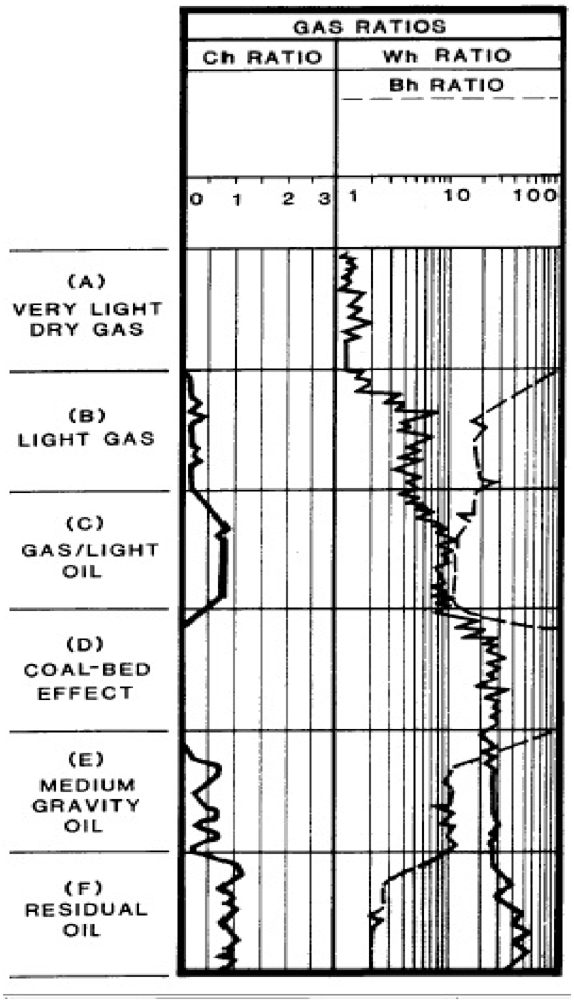


**Fig. 3 Gas ratio method.**

- If the apex of the triangle is up, gas is indicated—the smaller the up-apex triangle, the more water wet the gas.
- If the apex is down, oil is indicated—the larger the down-apex triangle, the heavier the oil.
- If the intersection of the lines between B to B' and A to A' occurs within the plotted ellipse, the zone is considered to be productive.

*2.4 Gas Ratio Method*

Gas ratio method (see Fig. 3) is a combination of three ratios, which when plotted together suggests a fluid character. The ratios are designed to be plotted on a depth log (unlike the Rectangular and Triangular plots) and still provide interpretative results. They were designed for ditch gas values rather than steam-still or DST values. The following ratios are used:

Hydrocarbon Wetness Ratio (Wh): when this parameter $\frac{C_2 + C_3 + C_4 + C_5}{C_1 + C_2 + C_3 + C_4 + C_5} \times 100$ is plotted (Table 2) it will increase with an increase in both gas and oil densities. Guidelines for the interpretation are:

Hydrocarbon Balance Ratio (Bh): this parameter $\frac{C_1 + C_2}{C_3 + C_4 + C_5}$ is related to the density of the reservoir fluid, decreasing with an increase in fluid density.

Hydrocarbon Character Ratio (Ch): this parameter $\frac{C_4 + C_5}{C_3}$ is used when excessive methane is present, which tends to retard the Wh and Bh ratios, affecting their curve movement. The Ch can also be used as a check and will aid in determining whether gas, oil or condensate potential is indicated.

**Table 2 Witness ratio relations.**

| Wh (%) | Fluid potential |
|---|---|
| < 0.5 | Non-productive dry gas |
| 0.5-17.5 | Potential gas–Increasing density with increasing Wh (%) |
| 17.5-40 | Potential oil–Increasing density with increasing Wh (%) |
| > 40 | Residual oil |

The interpretation of these ratios is a study of the relationships of the Wh, Bh and Ch curves and values. The first step is the study of the Wh, using the previously mentioned setpoints to determine the fluid character. Secondly, comparing the relationship of the Bh to the Wh will assist in confirming the fluid character in the following manner:

If the Bh is > 100, the zone is excessively dry gas;

If the Wh is in the gas phase and the Bh > Wh, the closer, the values/curves and the denser the gas;

If the Wh is in the gas phase and the Bh < Wh, gas/oil or gas/condensate is indicated;

If the Wh is in the oil phase and the Bh < Wh, the greater the difference/separation, the denser the oil;

If the Wh is in the residual oil phase and Bh < Wh, residual oil is indicated.

After comparing the Wh and Bh values/curves, the Ch is checked if situation 2 or 3 occur:

If the Ch < 0.5, gas potential is indicated and the Wh vs. Bh interpretation is correct;

If the Ch > 0.5, gas/light oil or condensate is indicated.

We can see these methods in below table and figures (Table 3, Fig. 4) which has been in Hovsan oil field

**Table 3 Result of interpretation.**

| Oil-gas-condensate indicates | | | | | | | | If BH > 100 excessive dry gas | Depth (m) | if CH < 0.5 wh and BH interpretation is correct | Depth (m) | If CH > 0.5 gas/light oil or condensate indicated | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dry gas If wh < 0.5 | Depth (m) | Potential gas wh-0.5 to 17.5 | Depth (m) | Potential oil wh-17.5 to 40 | Depth (m) | Residual oil Wh > 40 | Depth (m) | | | | | | |
| If BH > WH denser gas<br>If BH < WH gas/oil or gas/condensate | Has not<br>has not | | has not | If BH < WH the denser the oil | 3,933-3,937<br>3,941-3,958<br>4,093-4,119<br>4,191-4,201<br>4,215-4,222<br>4,259-4,262 | If BH < WH the residual oil | 2,031-3,933<br>9,37-3,941<br>3,958-4,093<br>4,119-4,191<br>4,201-4,215<br>4,222-4,259<br>4,262-4,296 | | Has not | | Very little | | 2,031-4,296 |

1. 3,933-3,937 m, 3,941-3,958 m, 4,093-4,119 m, 4,191-4,201 m, 4,215-4,222 m and 4,259-4,262 m intervals have denser oil.
2. 2,031-3,933 m, 3,937-3,941 m, 3,958-4,093 m, 4,119-4,191 m, 4,201-4,215 m, 4,222-4,259 m and 4,262-4,296 m intervals have residual oil.

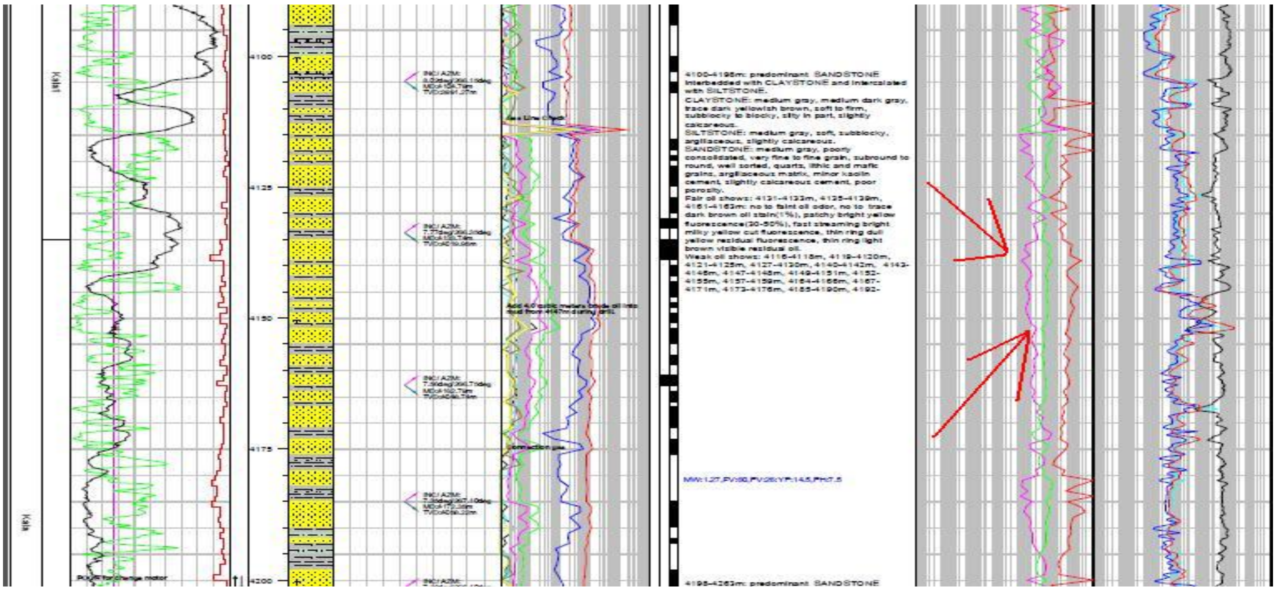

**Fig. 4 Gas ratio curves in composite Log.**

## 3. Result and Discussion

According above methods Samir Hashimov has made Table 3 who study Azerbaijan State Oil Academy.

Table 3 now is using in Surachani district, AOC company and using Qaradagh district, Pirsaat Hong Kong Company area. After we make full Table 3, we can say that on the oil well which zone have oil and which zone has gas. After comparison this method with wireline and mudlogging job it has been same result.

## 4.Conclusion

It means that this method help wireline team that make good desicion about perforation. In Azerbaijan I use gas ratio methods under composite log name. If we can look picture we can see wireline datas, oil layers, lithology, total gas, another gases and finally we can see modern gas analyses methods. When we compare those parameters, oil layers with modern methods (wh, bh and ch) this time we can see that those parameters and modern methods are the same and this show to us that which layer have oil and gas in the oil wells.

## References

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