

## An overview of the evaluation of oil-water layers with light hydrocarbon analysis

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**Abstract:** - Light hydrocarbon analysis technology is an auxiliary evaluation technology developed in recent years. It is mainly used in the evaluation of oil, gas and water layer, the degree of water washing and the degree of water flooding in the later stage of oilfield development. In this paper, light hydrocarbon analysis technology is used to evaluate the oil and gas layer. Light hydrocarbon is an important part of the petroleum and natural gas, in crude oil content was highest in the group divided the most abundant, its generation, migration, accumulation and destruction is similar to oil but often has many unique characteristics, which contains abundant chemical information increasingly the attention of geologists and logging workers. In recent years, the relevant application research work has been continuously enriched and deepened and achieve remarkable results. In practical application, some feasible methods of oil and gas water layer interpretation have been formed, which has laid a good foundation for the development of light hydrocarbon geochemical logging work.

**Keywords:** - light hydrocarbon technology; reservoir; evaluation; parameter;

### I. INTRODUCTION

"Light hydrocarbon" refers to the crude oil in the gasoline fraction, i.e. C<sub>1</sub> to C<sub>9</sub> hydrocarbons in normal crude oil accounted for about 20% - 40%. Light hydrocarbon comprise alkanes, cycloalkanes and aromatic three hydrocarbons, in the underground rock and gas light hydrocarbon composition often dominated by methane, the content can reach more than 90%. [1]The rest of the composition is a very small amount of heavy hydrocarbon gases, as well as CO<sub>2</sub>, N<sub>2</sub> and other inorganic gases. In the oil reservoir, the light hydrocarbon composition is more complex, as long as the formation conditions can be volatile, dissolved, adsorbed in rock or groundwater in the light hydrocarbons are likely to exist.

### II. INTRODUCTION OF LIGHT HYDROCARBONS

#### 2.1 Compound composition of light hydrocarbons

Light hydrocarbon is a complex multicomponent mixtures and reservoir rock in crude oil can be analysis detection light hydrocarbon as more than 100 kinds of compounds, the composition features generally to normal alkane and isoalkane mainly, also contains rich cycloalkanes, but aromatic hydrocarbon content is less. Figure 2-1 typical light hydrocarbon compounds.

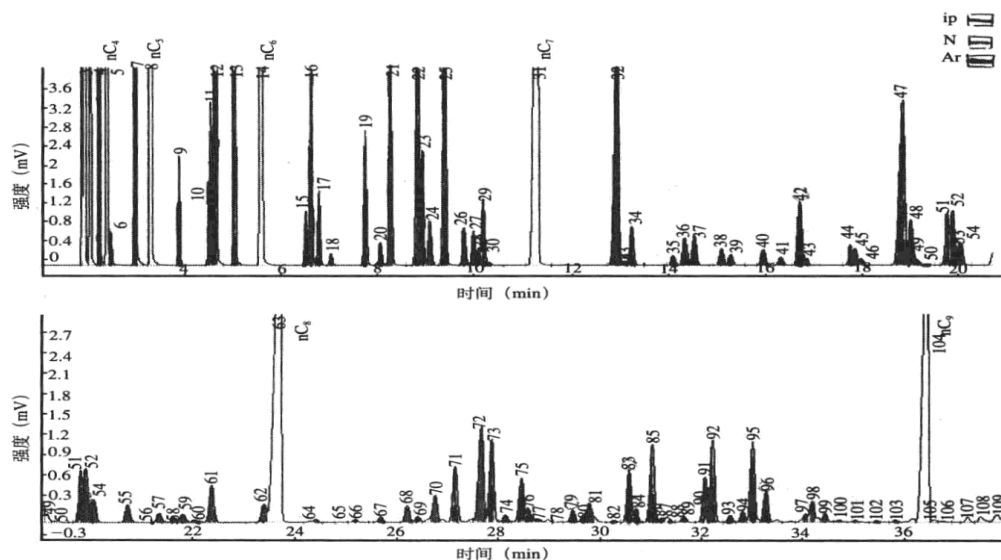


FIG. 2-1 Composition of typical light hydrocarbon compounds

## **2.2 Main factors affecting the light hydrocarbon compositions of reservoir rocks or oil**

In general, petroleum and natural gas has physical and chemical properties of roughly the same, but the reservoir rock in crude oil, light hydrocarbon chemistry in different basins or regions and different layers of the composition is very different, it reflects the diversity of petroleum chemical composition and complexity. Which is closely related to the reason for the difference between the oil and the formation and transformation of geochemical conditions and the whole process. [2] There are 3 parts:

One is the type and nature of the original organic matter causes the inner aspect of the sea, and terrestrial organic matter determined by sedimentary environment;

The two is the degree of thermal evolution of organic matter, involving the burial history and geothermal gradient;

Three is the oil and gas migration, oil reservoir alteration, such as biodegradation, oxidation, water washing etc.. In these three factors, the oil alteration effect on oil properties sometimes exceeds two.

## **III. BRIEF INTRODUCTION OF LIGHT HYDROCARBON TECHNOLOGY**

### **3.1 The analytical method of light hydrocarbon**

At present, both the oil and gas samples or rock samples, there have been many mature methods of light hydrocarbon analysis. Different methods for its principle and analysis condition, light hydrocarbon analysis points have great differences in composition and content.

#### **3.1.1 Analysis of rock adsorbed hydrocarbon**

Various analysis methods based on adsorbed hydrocarbons in the rocks are more focused on how to hydrocarbon adsorption desorption process from the rock. Because of differences in the content of light hydrocarbon degassing conditions determined by analysis of the composition and its characteristics. Therefore, the degassing process is the key of rock adsorbed hydrocarbon. [3] The analysis method of adsorption hydrocarbon rock mainly has the following several:

##### **(1) Gas extraction method**

The gas film solid formulation is put forward by Kolb in the volatile phase equilibrium analysis and the theory of continuous gas extraction theory. By continuous gas samples, the volatile components continuously from the rock surface desorption, collect the gas extracted by cold trap, finally by capillary gas chromatography for the separation and identification. The whole process is as follows: take rock samples, the sample sealed, do not make light hydrocarbon natural evaporation. To be broken before analysis sample to about 60 mesh, load the sample tube, the sample tube into the gas extraction device, carrier gas (usually hydrogen, nitrogen or helium) through the sample tube. According to the actual situation, the samples can be analyzed at room temperature, also can be properly heated, in order to facilitate the high boiling fraction of desorption. The hydrocarbons adsorbed in the sample are brought into a cold trap, which is connected to the back end of the sample tube. And then quickly heat the cold, so that the light hydrocarbon accumulation in the cold trap can be evaporated and carried into the gas chromatography system for separation and identification. Finally, we get the chromatographic analysis data of the adsorption of light hydrocarbons in the rocks.

##### **(2) Heat evaporation gas stripping method**

The device of thermal evaporation method is similar to that of gas extraction technology. The system is composed of gas source, sample tube, cold trap and gas chromatography analysis system. The major difference is the sample adsorbed light hydrocarbon not by gas extraction and desorption, but through the heating device to sample heated to high temperatures, driven by light hydrocarbons with high temperature and evaporation desorption, and by carrier gas with the cold trap cooling enrichment. When the sample light hydrocarbon volatilization after rapid heating, cold trap, hydrocarbon trapping and vaporization by gas chromatography.

This skill can be analyzed under C<sub>15</sub> hydrocarbons. When the temperature of evaporation at 150 DEG C, but the temperature is too high may lead to part of the heavy hydrocarbon molecules decompose, and olefin, easily lead to excessive interference, and distortion analysis.

##### **(3) Acid dissolution method**

Due to the surface adsorption force, the silicon and aluminum compounds in the rock and the rock particles have a certain adsorption capacity to various hydrocarbons. Rock in the underground crushing out to the ground, in the preservation and crushing process will be a loss of adsorbed hydrocarbon, but for the most part, especially the high carbon arrays are still preserved. Because they are combined with the mineral molecules in the rock, it is necessary to heat or add acid under vacuum to destroy their molecular composition and so on. This method is very effective for the adsorption of silica and carbonate minerals, such as strong adsorption, easy to be decomposed by acid. Flow figure as shown below (3-1).

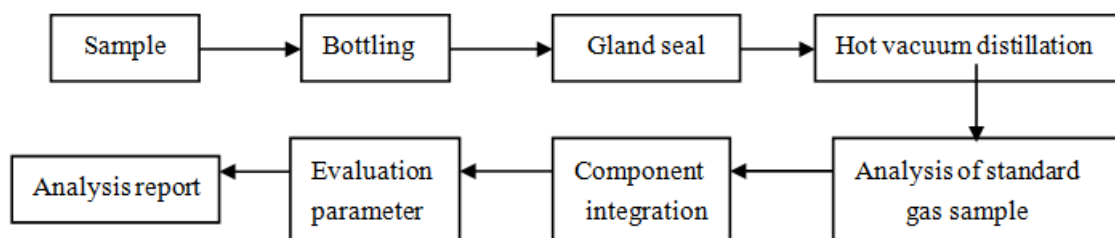


FIG. 3-1 Flow chart of light hydrocarbon analysis method

### 3.1.2 Analysis method

The method uses the HP-PONA capillary column<sup>[4]</sup>, the inner diameter is 0.2mm, the length is 50m, the film thickness is 0.5  $\mu$ m, and the solid phase is 100% poly two methyl silicone.

Chromatographic analysis condition: the inlet temperature is 200 degrees Celsius, the FID temperature is 300 degrees Celsius, the initial column temperature 35 degrees, the constant temperature 5min, with 2 /min temperature programmed to 70 degrees, and then to 3 /min temperature programmed to 90.

Using hydrogen as carrier gas, gas, flow rate is 30-40ml/min, the split ratio is 20:1; the tail gas is blown with nitrogen, the flow rate is 20-25ml/min, the air flow rate is 350-400ml/min, and the pressure is 20psi.

### 3.1.3 Qualitative method

After the analysis of the sample analysis to deal with the results of the analysis of accurate and qualitative, qualitative identification of the chromatographic peak is a representative of what compounds<sup>[5]</sup>. At present, the qualitative methods of conventional chromatography include reference fingerprint spectrum and literature data, retention time, retention index, qualitative analysis, qualitative analysis and chemical reaction. The qualitative and qualitative methods are not suitable for the qualitative analysis of the whole composition of petroleum. Reference method has big error, component is not full to qualitative issues, and the use of qualitative time of instrument stability and operating conditions retain the strict requirements, due to the retention time value with the variation of experimental conditions, such as oven temperature, column oven heating rate, flow rate of carrier gas and change will have a significant impact on the value of retention time; he instrument different data can not well repeated, even on the same instrument due to the effect of column temperature and flow conditions, to obtain component retention time of highly reproducible is also very not easy. This has brought great difficulties to the qualitative analysis and it is easy to make mistakes. Retention index is a kind of qualitative parameter with good reproducibility and stability, which is used to calibrate the retention behavior of substance close to its back and back two normal alkanes as reference peak. Retention index expression of chromatographic separation of the main advantages is that it only by the influence of chromatographic column and column temperature, and the specific operating conditions has nothing to do, this ensures that the data can be compared with each other and with flexible, convenient, accurate rate higher characteristic.

### 3.1.4 Quantitative method

Normalized, according to the standard method and internal standard method with quantitative methods commonly used, and measured parameters and each kind of quantitative Fang Nong peak area and peak high technology. Each of them has practical range and advantages and disadvantages. Quantitative analysis according to the specific circumstances of the flexible and correct selection is very important.

We have to analyse the is in the same sampling and desorption conditions, samples of the same volume of the sucked out of the physical adsorption amount of light hydrocarbon, is adsorbed by the sample of physical adsorption quantity of light hydrocarbons of mutual comparison, the purpose of which is to get a value of the trend, then according to the determined issued with outliers in the sample, and then judge and prediction samples corresponding to the oil-gas information formation and the underlying strata. So light hydrocarbon analysis does not need the absolute quantification method, by the peak area was calculated for each single hydrocarbons by normalization method of quantitative analysis. The relative quality of FID<sup>[6]</sup> on hydrocarbon response value (FM) value is basically equal. The molecule has one carbon atom, there is a response value for carbon response. Different molecular weight alkanes, cycloalkanes and aromatics, in addition to methane and benzene and other compounds are about 1. Therefore, the correction factor for the light hydrocarbon quantity is the "1" in addition to methane and benzene. Although there may be errors, it is very suitable and convenient for the general analysis(Table 3-1).

**Table 3-1 The effective carbon number of each group**

Atom	Type of organic matter	Effective carbon number	Atom	Type of organic matter	Effective carbon number
C	Alkane	1.0	O or N	Primary alcohol or primary amine	-0.6
C	Aromatic hydrocarbon	1.0	O or N	Secondary alcohol or secondary amine	-0.75
C	Olefin	0.95	O or N	Tertiary alcohol or tertiary amine	-0.25
C	Alkyne	1.30	Cl	Two or more of the alkane carbon	-0.12
C	Carbonyl	0	Cl	Olefin carbon	0.05

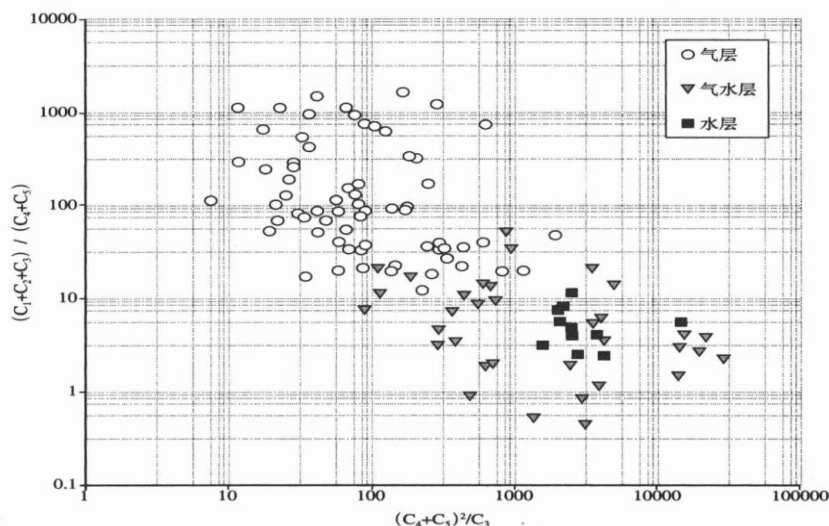
**3.2 Light hydrocarbon analysis parameters for oil and water layer identification chart**

**3.2.1 Light hydrocarbon ratio parameter intersection graph**

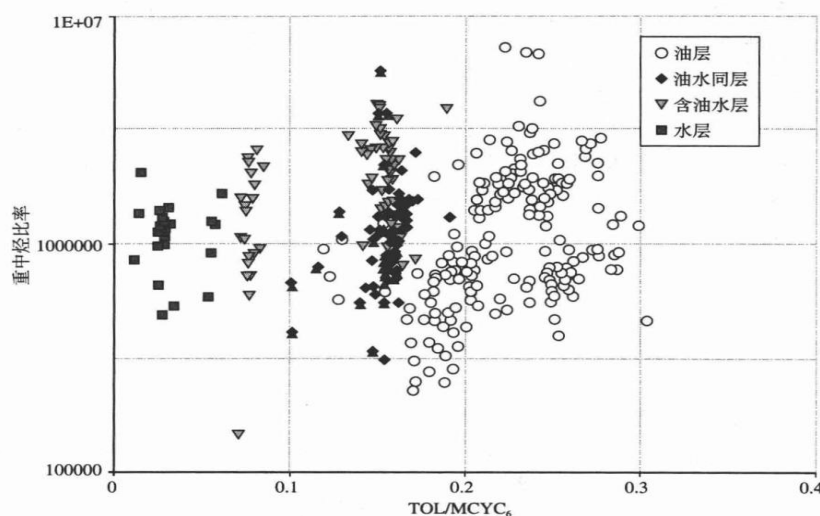
When the groundwater, in natural gas can be thermite group share is groundwater away. The reservoir rock of the gas composition changes<sup>[7]</sup>.

The horizontal coordinate  $(C_4+C_5)^2/C_3$ : the gas reservoir C3 content is greater than C4 and C1 content, this ratio is small; the reservoir water content C3 reduces obviously, this ratio increases;

Vertical coordinate  $(C_1+C_2+C_3) / (C_4+C_5)$ : due to the higher content of methane and ethane, the ratio of C3 and C5 decreased significantly, and the ratio decreased significantly(Figure 3-2);



**3.2.2 Toluene / cyclohexane methyl - heavy hydrocarbon ratio interpretation chart**



**FIG. 3-3 Toluene/methyl cyclohexane-heavy hydrocarbon ratio interpretation chart**

Storage layer oil C<sub>6</sub>-C<sub>9</sub> size is to determine the storage layer is an important indicator of oil and gas shows that larger values, reflect reservoir oil and gas saturation is higher and higher, due to the aromatic water solubility is much larger than the cycloalkanes<sup>[8]</sup>, the change trend of TOL/MCYC<sub>6</sub> can fully reflect the underground crude oil by water change made(Figure 3-3).

### 3.2.3 TOL/MCYC<sub>6</sub>-MCYC<sub>5</sub>/22DMC<sub>4</sub> interpretation chart

In the normal oil, heterogeneous hexane following concentration series: 2-methyl pentane > 3-methyl pentane > 2,3-dimethylbutane>2,2-dimethylbutane, when crude oil by water washing or biodegradation and heterogeneous hexane bioresistance coincided with normal oil heterogeneous concentration series instead. The water is washed by the water and the water is taken away by the water, which causes the TOL/MCYC<sub>6</sub> to become smaller. Through TOL/MCYC<sub>6</sub> MCYC<sub>5</sub>/22DMC<sub>4</sub> interpretation chart can effectively identify oil and water changes, the residual oil and water layer identification effect better(Figure 3-4).

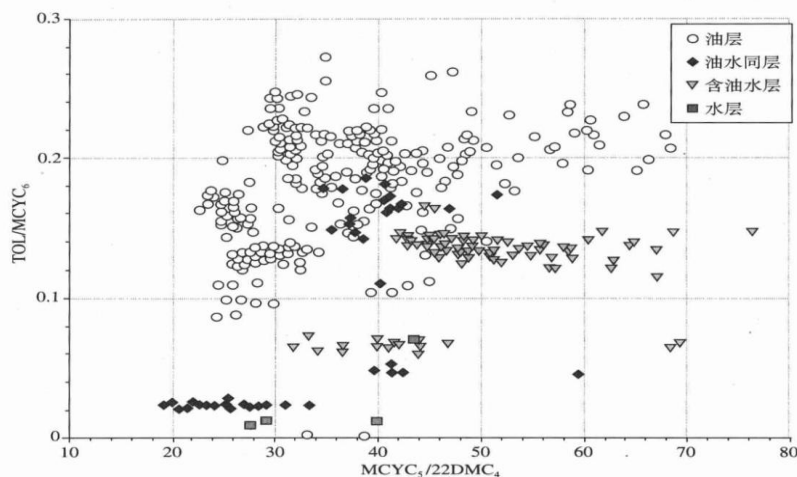


FIG. 3-3 TOL/MCYC<sub>6</sub>-MCYC<sub>5</sub>/22DMC<sub>4</sub> interpretation chart

## IV. CONCLUSION

The selection of light hydrocarbon parameters is the key to solve the geological problems with the full use of light hydrocarbon data. Using light hydrocarbon data evaluation of oil, gas and water is a constantly summarize and understand the process and the application data to master may cause of light hydrocarbon parameters, then divided the region to establish the relationship between the light hydrocarbon parameters and oil, gas and water. Article mentioned in the chart are some of the new plate, in the practical application we can try to use, should be based on innovation. In short, light hydrocarbon analysis there are many parameters with good geological significance, but has not been used, so the light hydrocarbon analysis method for identification and evaluation of oil, gas and water is not particularly good, need for geologists continuous efforts and innovation.

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