Study on the Quantitative Measurement Technique of the Micro Fracture Surface

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Abstract. The quantitative study on the distribution of cracks and micro cracks is a major problem in the study of reservoir properties of tight and lithologic regions In view of this problem, the present study is to evaluate the cracks by indirect method, and the direct evaluation method is lack of micro cracks This paper tries to combine the results of electronic scanning electron microscopy and image data processing method, which can directly test the density of micro cracks The test results prove that the method is convenient and feasible, and has a strong reference value for engineering practice and scientific research.

1. Introduction
Fractures and microfractures are one of the main forms of oil and gas reservoir in shale, tight rock and carbonate rock areas The fracture system generated by tectonic stress in carbonate rock is the main reservoir space and seepage channel [1] The quantitative study on the distribution of fractures and micro fractures is a major problem in the study of reservoir properties in tight lithologic areas Therefore, it is of great significance to study the quantitative description of micro fractures At present, there is no research on the quantitative measurement of micro fracture density in tight fractured rock at home and abroad Due to the need of petroleum exploration and development; the quantitative description method of fractures has been a research topic of many scholars at home and abroad
In terms of structural fracture evaluation, many scholars at home and abroad have studied field and core fractures (Murray, 1968; fan Golf lat, 1989. Henk and nemcock, 2008) [2-3] Conventional logging curves are used to identify and evaluate lithology and fractures (Bremer, 1999; Bourlange et al, 2003), and artificial intelligence network technology is used to study reservoir fractures (Barton, 1998). In the aspect of fracture logging response, the corresponding model of conventional logging curve is established according to core and imaging data to guide fracture evaluation of non coring wells and reservoirs. Previous studies on fracture evaluation have been carried out from field fracture statistics, core observation statistics and well logging fracture interpretation and Statistics (Hou Guiting, 1994; Zhou Xingui et al, 2003; Zeng LianBo et al, 2007;2008. Zhang Qinglian et al, 2010; Ju Wei et al 2011; Li le et Ā, 2011; Meng Qingfeng et al, 2011; Zhang Peng et al, 2011) [4-5], In addition, beneficial exploration has been carried out in the aspects of fracture formation mechanism and influencing factors of structural fracture development [6-8]. All of these studies have laid a foundation for the evaluation of fracture development degree in tight sandstone reservoirs. But at present, these studies mainly focus on the description of large-scale fractures in the structure, and do not involve the
quantitative description of micro fractures. Moreover, the current research is to evaluate the fracture by indirect method, and there is no direct evaluation method for micro fracture. In this paper, through the high-resolution electronic scanning electron microscope, combined with the image data processing method, a trial experiment was carried out on the micro crack surface density direct test, which has a strong reference significance for engineering practice and scientific research methods.

2. Testing Principle and Method
Among the fracture parameters that affect reservoir properties, fracture density is the most important physical property parameter. Fracture density can be divided into linear density, area density and bulk density. Because the linear density cannot truly reflect the fracture density, it is only relative density, and although the volume density can truly reflect the fracture density, it is difficult to measure [9-10]. Therefore, this paper mainly uses the surface density of micro fractures to study the development degree of micro fractures. The calculation formula of area density is as follows:

\[ f = \frac{\sum Li}{S} \]

\( f \)---Area density, \( \mu m^{-1}; \) \( Li \)---Length of each crack, \( \mu m; \) \( S \)---Length of each crack, \( \mu m^2 \)

In recent years, with the development of computer and information digitization technology and the application in scanning electron microscope, the performance of scanning electron microscope has taken place a new leap, the operation is faster and the use is more convenient. It is one of the most widely used microscopic analysis instruments in many fields such as scientific research and industrial production.

According to the definition and formula of fracture surface density, the whole micro fracture surface density of rock sample is obtained by using high-definition image obtained by electronic scanning electron microscope (SEM) combined with image processing and analysis technology. There are two key issues

1) Representativeness of test samples: due to the small size of rock samples used in SEM, it is necessary to obtain small-scale rock samples from a large rock sample for scanning operation. In this process, small-scale rock samples are required to be representative to overcome the influence of heterogeneity. In order to solve this problem, in the same large-scale rock sample, 10 groups of small-scale rock samples are obtained in different positions, with 6 pieces in each group. Then, the test data are analysed according to the probability distribution of statistical theory, and reasonable values are obtained.

2) The development scale of micro cracks: different from the homogeneous cement samples processed in the laboratory, the composition and structure of actual engineering rock samples are often more complex, even in the same small-scale rock samples, there are often micro cracks of various scales. In the process of scanning electron microscope, all micro cracks cannot be captured at the same time. Therefore, all effective micro cracks are collected by scanning and analysing in different scales.
3) The surface treatment of small rock samples: this method can be used to quantitatively describe the micro cracks, which are different from the common scanning rock sample treatment method, and cannot be used for cutting, polishing and other surface treatment of rock samples.

3. Surface density test results of micro cracks
According to the above method, the fracture surface density of 10 groups of samples was tested by high resolution electron microscope, and 60 data and 60 SEM photos were obtained. In this paper, a group of data is taken as an example to show the test results of micro cracks in the form of data table and pictures.

The test results are shown in table (1). For the same small-scale rock sample, in order to capture all the effective micro fractures, six different scales were used to be scanned and analysed one by one. The effective micro cracks were collected. The length of the micro cracks was 19800µm, the total area of the rock sample was 25000000 µm², and the surface density of the micro fractures was 0000792 µm⁻¹. The scanning electron microscope images are shown in Fig. 2.

![Figure 2. Scanning picture of micro cracks](image)

| Sample serial number | Magnification | Microcrack length, um | Total block area, um² | Surface density of microcrack, um⁻¹ | Description of rock sample |
|----------------------|---------------|-----------------------|-----------------------|------------------------------------|-----------------------------|
| 1                    | 350K          | 19800                 | 25000000             | 0000792                            | Pores and microcracks       |
| 2                    | 10K           |                       |                      |                                    | microcracks                 |
| 3                    | 150K          |                       |                      |                                    | microcracks                 |
| 4                    | 150K          |                       |                      |                                    | Dissolution fracture        |
| 5                    | 130K          |                       |                      |                                    | Cracks and cracks are not developed |
| 6                    | 1000          |                       |                      |                                    |                             |

4. Summary
Literature research shows that for the quantitative description of natural rock microcracks, the research at home and abroad is based on the indirect method of fracture evaluation, lack of direct evaluation
method. This paper attempts to combine the results of SEM and image data processing method, which can directly test the surface density of micro cracks. The test results show that the method is convenient and feasible, and has strong reference significance for engineering practice and scientific research methods.

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