Sensitivity Analysis of F Reservoir in M Area

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Abstract. The sensitivity analysis of F reservoir in M area is carried out by core laboratory experiment. The experimental results show that F reservoir in this area belongs to medium weak-strong water sensitivity, strong acid sensitivity and medium strong alkali sensitivity, and its speed sensitivity is very weak, and its sensitivity is basically weak-no speed sensitivity. Through laboratory experimental analysis, it provides a basis for rational selection of injection fluid for F reservoir in this area.

1. Introduction

Sensitive minerals, such as clay, carbonate, silicate and sulfate, commonly exist in oil and gas reservoirs. These minerals come into contact with solid particles carried by foreign fluids, such as drilling fluid, well washing fluid, well killing fluid, fracturing fluid and acidizing fluid. Because these fluids do not match with reservoir minerals and sensitive minerals, the reservoir seepage capacity decreases, that is, the reservoir is damaged to varying degrees. Sensitivity to various types of formation damage, that is, reservoir sensitivity, and the experimental data of reservoir sensitivity evaluation is the basic data of oil and gas field exploration and development, and also the basic data that must be referred before the design of various well fluids, so the evaluation of reservoir sensitivity is very important[1].

Through core observation and analysis of laboratory data, the clay mineral content in F reservoir in this area is relatively high, with the total content ranging from 11.0% to 24.0%, with an average of 16.7%. Among them, the content of illite-montmorillonite mixed layer is 30.0%~71.0%, chlorite is 1.0%~51.0%, illite is 11.0%~29.0%. In order to fully understand the sensitivity characteristics of F reservoir in this area, core laboratory tests were carried out.

2. Water Sensitivity

The low salinity injected water causes clay swelling, dispersion and migration after entering the reservoir, which causes the seepage channel to change and the permeability of reservoir rocks to change. According to SY/T5358-2010 Evaluation Method of Reservoir Sensitive Flow Experiment [2], 10 samples were selected for water sensitivity experiment, with an average gas permeability of 1.68mD and a water sensitivity index of 53.73. The experimental results (Table 1) show that with the decrease of salinity of formation water, the permeability loss increases, which indicates that the water sensitivity of F reservoir in this area is serious, mainly medium weak-strong water sensitivity.
Table 1. F Evaluation data table of water sensitivity degree of reservoir core

| serial number | Core No. | Gas permeability (mD) | Water sensitivity index | Critical concentration of water sensitivity (mg/l) | Water sensitivity intensity |
|---------------|----------|-----------------------|-------------------------|--------------------------------------------------|-----------------------------|
| 1             | 28-2     | 0.04                  | 48.72                   | 7420.00                                           | Moderately weak water sensitivity |
| 2             | 3-1      | 0.63                  | 47.02                   | 7420.00                                           | Moderately weak water sensitivity |
| 3             | 2-3      | 0.75                  | 57.17                   | 7420.00                                           | Moderately strong water sensitivity |
| 4             | 24-1     | 0.89                  | 54.08                   | 10000.00                                         | Moderately strong water sensitivity |
| 5             | 8-3      | 1.09                  | 44.46                   | 7420.00                                           | Moderately weak water sensitivity |
| 6             | 13-3     | 1.25                  | 43.02                   | 7420.00                                           | Moderately weak water sensitivity |
| 7             | 15-1     | 1.51                  | 29.09                   | 7420.00                                           | Weak water sensitivity |
| 8             | 1-2      | 1.69                  | 74.47                   | 10000.00                                         | Strong water sensitivity |
| 9             | 30-1     | 2.82                  | 70.13                   | 10000.00                                         | Strong water sensitivity |
| 10            | 33-3     | 6.15                  | 69.18                   | 10000.00                                         | Moderately strong water sensitivity |
| average       |          | 1.68                  | 53.73                    |                                                  |                             |

3. Acid Sensitivity
Acid liquor reacts with reservoir minerals to produce precipitation or release particles, which leads to the change of reservoir rock permeability. According to SY/T5358-2010 Evaluation Method of Reservoir Sensitive Flow Experiment [2], 10 samples were selected for acid sensitivity experiment, with an average gas permeability of 2.28mD and an acid sensitivity index of 31.33. The experimental results (Table 2) show that the reservoir of F oil layer in this area is mainly sensitive to strong acid.

Table 2. F Evaluation Data Sheet of Sensitivity Degree of Reservoir Rocks

| serial number | Core No. | Gas permeability (mD) | Acid sensitivity index | Acid sensitivity strength |
|---------------|----------|-----------------------|------------------------|---------------------------|
| 1             | 12-2     | 0.54                  | 36.10                  | Strong acid sensitivity |
| 2             | 14-3     | 1.60                  | 32.62                  | Strong acid sensitivity |
| 3             | 15-3     | 1.34                  | 43.11                  | Strong acid sensitivity |
| 4             | 17-1     | 0.73                  | 13.55                  | Moderately weak acid sensitivity |
| 5             | 25-3     | 1.78                  | 19.75                  | Moderately strong acid sensitivity |
| 6             | 26-2     | 0.98                  | 53.84                  | Extremely acid sensitive |
| 7             | 32-2     | 1.12                  | 31.59                  | Strong acid sensitivity |
| 8             | 33-4     | 8.96                  | 35.21                  | Strong acid sensitivity |
| 9             | 34-1     | 0.79                  |                        | Acid-insensitive |
| 10            | 35-1     | 4.98                  | 16.19                  | Moderately strong water sensitivity |
| average       |          | 2.28                  | 31.33                  |                             |

4. Alkali Sensitivity
The alkaline liquid reacts with reservoir minerals, resulting in precipitation or clay dispersion and migration, which leads to the change of reservoir rock permeability. According to SY/T5358-2010
Evaluation Method of Reservoir Sensitive Flow Experiment [2], 10 samples were selected for alkali sensitivity experiment, with an average gas permeability of 5.29mD, alkali sensitivity index of 54.59 and critical PH value of 7.0. The experimental results (Table 3) show that the alkali sensitivity of F reservoir in this area is strong, and with the increase of PH value, the permeability decreases, and its sensitivity is moderate to strong alkali sensitivity.

### Table 3. Evaluation Data Table of Alkali Sensitivity Degree of Oil Layer Core

| serial number | Core No. | Gas permeability (mD) | Alkali sensitivity index | Critical PH value | Alkali sensitivity |
|---------------|---------|-----------------------|--------------------------|-------------------|-------------------|
| 1             | 1-1     | 1.01                  | 56.78                    | 6.5               | Moderately strong alkali sensitivity |
| 2             | 5-3     | 1.80                  | 56.83                    | 6.5               | Moderately strong alkali sensitivity |
| 3             | 7-1     | 1.19                  | 68.43                    | 6.5               | Moderately strong alkali sensitivity |
| 4             | 11-1    | 0.55                  | 64.35                    | 6.5               | Moderately strong alkali sensitivity |
| 5             | 15-2    | 1.64                  | 55.17                    | 6.5               | Moderately strong alkali sensitivity |
| 6             | 16-3    | 1.41                  | 58.33                    | 6.5               | Moderately strong alkali sensitivity |
| 7             | 21-3    | 37.80                 | 24.24                    | 8.0               | Weak alkali sensitivity |
| 8             | 24-2    | 0.83                  | 33.22                    | 6.5               | Moderately weak alkali sensitivity |
| 9             | 29-3    | 5.90                  | 54.20                    | 9.5               | Moderately strong alkali sensitivity |
| 10            | 34-3    | 0.73                  | 74.38                    | 6.5               | Strong alkali sensitivity |
| average       |         | 5.29                  | 54.59                    | 7.0               |                    |

5. Flow Rate Sensitivity
According to SY/T5358-2010 evaluation method of reservoir sensitive flow experiment [2], nine samples were selected to carry out the velocity sensitivity experiment, with an average gas permeability of 2.06mD and a permeability damage rate of 5.46%. The experimental results (Table 4) show that the velocity sensitivity of this reservoir is very weak, and its sensitivity is basically weak-no velocity sensitivity.

### Table 4. Evaluation Data Table of Velocity Sensitivity Degree of Oil Layer Core

| serial number | Core No. | Gas permeability (mD) | Permeability damage rate (%) | critical speed (ml/min) | Speed sensitivity intensity |
|---------------|---------|-----------------------|------------------------------|-------------------------|----------------------------|
| 1             | 4-2     | 1.75                  |                              |                         | Weak speed sensitivity    |
| 2             | 8-2     | 0.68                  |                              |                         | Weak speed sensitivity    |
| 3             | 16-1    | 0.78                  |                              |                         | Weak speed sensitivity    |
| 4             | 19-1    | 1.09                  |                              |                         | Weak speed sensitivity    |
| 5             | 23-2    | 0.97                  |                              |                         | Weak speed sensitivity    |
| 6             | 23-3    | 1.30                  |                              |                         | Weak speed sensitivity    |
| 7             | 31-1    | 3.54                  | 18.80                        | 0.25                    | Weak speed sensitivity    |
| 8             | 31-2    | 1.55                  | 16.07                        | 0.25                    | Weak speed sensitivity    |
| 9             | 32-1    | 6.88                  | 14.29                        | 0.10                    | Weak speed sensitivity    |
| average       |         | 2.06                  | 5.46                         | 0.20                    |                            |
6. Conclusion

According to the above experimental results, the following conclusions can be drawn: F reservoir in M area belongs to medium weak-strong water sensitivity, strong acid sensitivity, medium strong alkali sensitivity, weak velocity sensitivity-no velocity sensitivity. Therefore, we should pay great attention to water sensitivity, acid sensitivity and alkali sensitivity without considering velocity sensitivity when injecting water.

References

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