

# Study on Critical Concentration of Dynamic Gelation of New Chromium Crosslinker

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**Abstract:** A chrome gel system with 13 million molecular weight and 19 million molecular weight polymer and DQ-8 cross-linking agent is dynamically gelled under different conditions of 50-mesh and 100-mesh screens under different shear rates. Concentration limit. The experiment shows that the critical concentration of 13 million molecular weight gelation is 500-700mg/L, and the critical concentration of new cross-linking agent in the system is 80mg/L-90mg/L. The system of new cross-linker is cut by steel mesh. The post-gelation time is prolonged. Between 6h-10h, after 12 days of testing, the viscosity of the chrome gel system after gelation can still remain above 1000mPa·s, and the viscosity of the ungelatinized solution drops below 10mPa·s.

## 1. Introduction

In daqing oil field, the new chrome crosslinking agent and polymer configuration of chromium gel system achieved good development effect, become the important component of the polymer flooding, in order to further optimize the new crosslinking agent in oil field application, according to the reservoir property and fluid characteristics of test area, the new crosslinking agent for polymer configuration parameters optimization. The new crosslinking agent is more targeted in well selection and layer selection in the application process, and the parameters in the system are quantified to better guide the field application, so as to achieve the purpose of reducing cost and increasing efficiency[1-3].

## 2. Experimental part

### 2.1 Experimental materials

Polymer: molecular weight 13 million, 19 million, effective content 90%

New crosslinking agent: Cr<sup>3+</sup> crosslinking agent independently developed by Daqing Oilfield, the model is DQ-8, and the effective content is 3%.

Water used for the experiment: water from the South Third Injection Station of Daqing Oilfield.

Experimental equipment: Brinell viscometer, thermostat, high temperature and high pressure core gripper, steel fake core, etc.

Experimental temperature: 45°C.

### 2.2 Experimental steps:

(1) Take polymers with different molecular weights, use clean water to configure mother liquor, and age for more than 12 hours.

(2) When preparing the target solution, clear water was used, and a new crosslinking agent was added into the target solution of polymers with different molecular weights to prepare the chromium gel system.

(3) The configured target liquid is loaded into the intermediate container, and the 50 mesh and 100 mesh screen are loaded into the steel dummy core, so that the gel system configured with different concentrations of polymers and new crosslinking agents is shears by different mesh screens. Simulate different shear rates.

(4) The initial viscosity of the chromium gel system was measured by connecting the sample at the exit end, and the viscosity of the system was measured again at the sample points at different times.

### 2.3 Experimental scheme

The concentration of the two molecular weight polymers was increased by 100mg/L, and the concentration of the new crosslinking agent was increased by 10mg/L. The experimental schemes of 50 mesh and 100 mesh were shown in the table below:

Table 1. Experimental protocol

| Polym er type | Polymer concentrati on | Chromium crosslinker concentrati on | Polym er type | Polymer concentrati on | Chromium crosslinker concentrati on |
|---------------|------------------------|-------------------------------------|---------------|------------------------|-------------------------------------|
| 13 million    | 500 mg/L               | 70 mg/L                             | 19 million    | 400 mg/L               | 70 mg/L                             |
|               | 600 mg/L               | 80 mg/L                             |               | 500 mg/L               | 80 mg/L                             |
|               | 700 mg/L               | 90 mg/L                             |               | 600 mg/L               | 90 mg/L                             |

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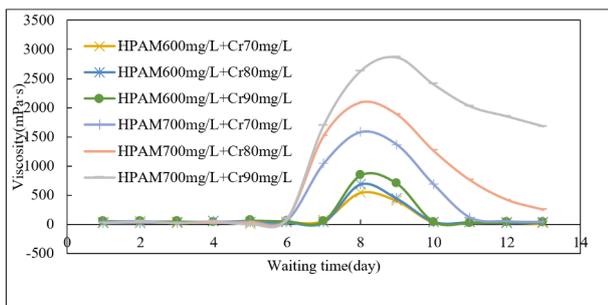
### 3. Experimental results and analysis

#### 3.1 The critical concentration of 50 mesh chromium gel system

##### 3.1.1 Critical gelling concentration of 13 million polymer - new crosslinker system.

The prepared chromium gel system was prepared by using 13 million molecular weight and new chromium crosslinking agent. The configured chromium gel system was shearing through the steel core equipped with 50-mesh screen. The initial viscosity of the solution was measured at the exit section and the viscosity of the system was detected at different monitoring points[4].

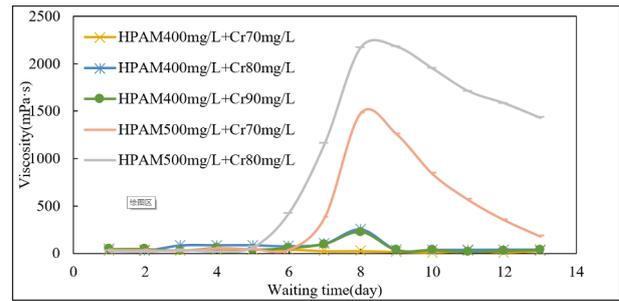
As can be seen from Figure 1, when the concentration of the new crosslinking agent is 70mg/L and 80mg/L, the molecular weight of the polymer is 13 million, and the concentration varies from 500mg/L to 700mg/L, the viscosity of the chromium gel system shows a sharp decline after rising, but the viscosity fails to remain stable. With the increase of the coagulation time, the viscosity of the system drops sharply after dehydrating and breaking the glue. It eventually dropped to less than 10mPa·s. When the polymer concentration reaches 700mg/L and the cross-linking agent concentration reaches 90mg/L, the viscosity of the chromium gel system rises rapidly. When the peak value reaches 3000mPa·s, after a long time of viscosity detection, it can still reach more than 1500mPa·s. Therefore, for the 13 million molecular weight polymer, after the shear of 50 mesh screen, the critical gelling concentration of the system is HPAM700mg/L+Cr90mg/L[5-7].



**Figure 1.** 50 mesh screen 13 million molecular weight different formula concentration curve

##### 3.1.2 Critical gelling concentration of 19 million polymer-new crosslinker system.

The chromium gel system was prepared by using 19 million molecular weight and the new chromium cross-linking agent. The configured chromium gel system was shearing through the steel core equipped with a 50-mesh screen. The initial viscosity of the solution was measured at the exit section, and the viscosity of the system was detected at different monitoring points.



**Figure 2.** 50 mesh screen 19 million molecular weight different formula concentration curve

The figure 2 shows that when the chromium gel system also after 50 mesh sieve of shear, due to the increase of polymer molecular weight, so new crosslinking agent and polymer gel critical concentration decreases, when the polymer concentration below 500 mg/L, although crosslinking agent concentration of 90 mg/L, but the system did not gel, drops rapidly after the peak viscosity, Finally, the viscosity of the system was lower than 10mPa·s. Only when the concentration of the polymer reached 500mg/L and the concentration of the new chromium cross-linking agent reached 80mg/L, the system formed gel. When the viscosity of the system was measured at different detection points, the viscosity was still higher than 1000mPa·s. The critical gelling concentration of chromium gel system is HPAM500mg/L+Cr80mg/L.

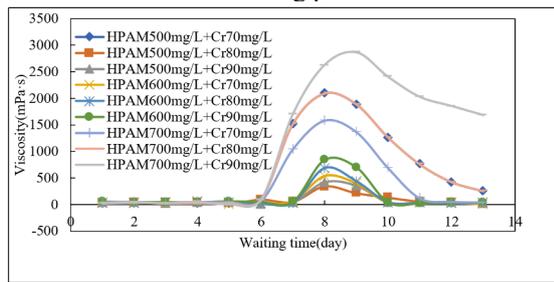
Compared with 13 million and 19 million molecular weight polymers under the shear condition of 50 mesh screen, when the polymer concentration is the same, the larger the molecular weight is, the closer the three-dimensional network structure between the molecules is, and the lower the critical concentration of gumming. Under the same polymer molecular weight and the same concentration conditions, the viscosity of the system gradually increased with the increase of the concentration of chromium crosslinker, but the effect of increasing the concentration of crosslinker on the system concentration was less than that of increasing the concentration of polymer and the molecular weight of polymer. Therefore, in the field application process, we can reasonably plan the field injection by analyzing the weight of the influence of polymer molecular weight, polymer concentration and crosslinking agent concentration on the chromium gel system concentration[8].

#### 3.2 The critical concentration of 100 mesh chrome gel system

##### 3.2.1 Critical gelling concentration of 13 million polymer - new crosslinker system.

The chromium gel system was prepared by using 13 million molecular weight and the new chromium crosslinker. The configured chromium gel system was shears through the steel core equipped with a 100-mesh screen. The initial viscosity of the solution was measured

at the exit section, and the viscosity of the system was detected at different monitoring points.

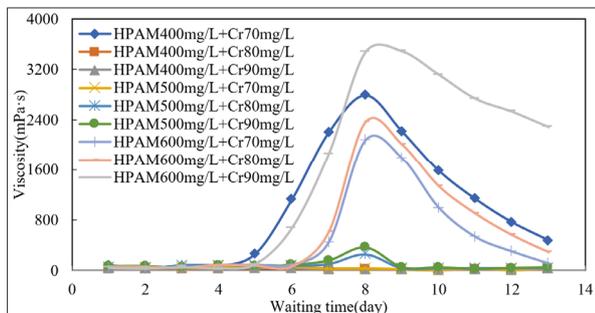


**Figure 3.** 100 mesh screen 13 million molecular weight different formula concentration curve

As shown in the figure above, when the concentration of the polymer and the new crosslinking agent was the same as that of the 50-mesh screen, the shear rate increased with the increase of the mesh number, so the concentration of the polymer increased by 100mg/L under the condition that the concentration of the crosslinking agent and the molecular weight of the polymer were the same. Although at the concentration of HPAM700mg/L+Cr80mg/L, The viscosity of the system is maintained for a long time, and the peak viscosity is above 2000mPa.s. However, in the end, the chromium gel system is still dehydrated and broken, and the viscosity drops sharply, and finally drops to less than 10mPa.s. Therefore, under the condition of 100 mesh screen and 13 million molecular weight, The critical gelling concentration of chromium gel system is HPAM700mg/L+Cr90mg/L.

### 3.2.2 Critical gelling concentration of 19 million polymer-new crosslinker system.

The chromium gel system was prepared by using 19 million molecular weight and new chromium crosslinking agent. The configured chromium gel system was passed through the steel core equipped with a 100-mesh screen for shearing. The initial viscosity of the solution was measured at the exit section, and the viscosity of the system was detected at different monitoring points.



**Figure 4.** 100 mesh screen 19 million molecular weight different formula concentration curve

As shown in Fig. 4, under the condition of the same mesh mesh, the molecular weight increased to 19 million, so under the condition of the same crosslinking agent, the polymer concentration decreased to a certain extent.

However, since the molecular weight difference of the polymer was not large, the system could only form gel when the concentration of the crosslinking agent reached 90mg/L. However, under the condition of 19 million molecular weight, the peak viscosity reached more than 3500mPa.s, which was higher than about 2800mPa.s of 13 million molecular weight. Although the chromium gel system with the concentration of polymer at 600mg/L and the concentration of cross-linking agent below 90mg/L also had the phenomenon of temporary gelation, the final viscosity still could not remain stable. Therefore, under the condition of 100 mesh screen and 19 million molecular weight, the critical gel-forming concentration of the chromium gel system is HPAM600mg/L+Cr90mg/L.

Under the condition of 100 mesh sieve, compared to 13 million and 19 million molecular weight allocation of chromium gel system compared with 50 mesh sieve conditions, two kinds of molecular weight under the condition of critical gel concentration are less than 50 mesh sieve, due to the increase of shear rate, serious damage to between polymer molecular structure, decrease caused by molecular interaction, show the system viscosity reduced[9].

## 4. Conclusion

(1) The critical gelling concentration of chromium gel system with different mesh mesh and different molecular weight is shown in the table below:

**Table 2.** Critical concentration of gelation of chrome gel system under different mesh screens and different molecular weight conditions

| Screen mesh | Polymer molecular weight | Polymer concentration | Concentration of the new crosslinker |
|-------------|--------------------------|-----------------------|--------------------------------------|
| 50 mesh     | 13 million               | 600mg/L               | 90 mg/L                              |
|             | 19 million               | 500mg/L               | 80 mg/L                              |
| 100 mesh    | 13 million               | 700 mg/L              | 90 mg/L                              |
|             | 19 million               | 600 mg/L              | 90 mg/L                              |

(2) The gelation time of the new chromium crosslinker is generally 4-6 days. After shearing, the gelation process of the system becomes slow, which can provide reference for the injection time in the field.

(3) When the mesh number of the screen increases, the shear rate increases, and the critical gelling concentration of both the polymer and the new crosslinking agent increases. Under the condition of the same crosslinking agent concentration, the critical gelling concentration of the 19 million molecular weight polymer is less than 13 million polymer.

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