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# Sana oilfield chrome micro gel system Indoor evaluation of the static gelling concentration limit

Di Wang <sup>a</sup>, Yujia Jiao <sup>b</sup>

School of Petrochemical Engineering, Northeast Petroleum University, Daqing 166318, China

<sup>a</sup>286788704@qq.com, <sup>b</sup>125812800@qq.com

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## Abstract

Selecting the chrome micro gel which prepared using 25million molecular weight polymers, HD-4 or HD-5 type cross-linking agent without shearing to respectively evaluate Sana Oilfield chrome micro gel system for static gelling concentration limits. The results show that the minimum concentration of polymer gelling is 350 ~ 400 mg/L and minimum concentration of the corresponding cross-linking agent gelling is 80 ~ 90 mg/L. The gelling time of lower concentration of chrome gel system is general between 24 hours and 36 hours. After gelling, the viscosity of the system will raise significantly which shows that chrome micro gel system has been gelling.

## Keywords

Sana oilfield, chrome micro gel system, static gelling, concentration limit, Classification number: TE 357, Document code: A.

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## 1. Introduction

Sana development zone has carried out field experimentation and popularization and application to chrome micro gel system in five blocks of different stages of polymer injection in class I and class II oil layer since 2003. This system has achieved better test effect than conventional polymer flooding. Each experiment plot with the characteristics of their reservoirs respectively quantify the alternating parameters of chrome micro gel system concentration, slug size, curing time and polymer slug. In order to make the chrome micro gel flooding oil technology own stronger principle when it applies to the selection of well and layer and standardize parameters design to form a set of technical standards. And then gives a better guide to the field experimentation and popularization and application. Therefore, it is necessary to optimize minimum concentration limit of chrome micro gel system gelling which can improve recovery efficiency and at the same time save chemical agent to reduce development costs. [1-3].

## 2. Experimentations

### 2.1 Experimental reagents and Equipments

Polymer: Poly-acryl-amide with relative molecular weight of 25 million which was produced by Daqing assistant factory. Its effective content is 88 percent. Cross-linking agent: Cr<sup>3+</sup> + cross-linking agent with model of HD-4 and HD-5 whose effective content is 2.5% which was produced by Beijing Shitong huaao oilfield chemistry Technique Co., Ltd. It has been prepared into dark green liquid in laboratory. Water: 2# preparation station of the seventh operating area of Daqing oilfield secondary production plant. Sewage: sewage of the third east injection station in south of seventh operating area of Daqing oilfield second oil production plant.

Experimental equipments: the United States DV-III Brookfield viscosity meter (oil displacement system initial viscosity test using zero rotor and 6r/min (unless over range) speed), the German IKA blender, constant temperature box of Hai Hua of Petroleum Equipment Co., Ltd, electronic balance and so on[4].

Experimental temperature: 45 °C

## 2.2 Experimental method

We should taking out a certain amount of 25 million molecular weights polymer to dissolve in clean water with blender to mix them for 2 hours and then placing for more than 12 hours to form polymer mother liquid. When prepare chrome micro gel system, we can prepare it with clear water and dilute it with sewage. After stirring in water with the sewage for half an hour, pouring in different types of cross-linking agents to respectively determine the initial system viscosity and 60 hours when we can achieve the indoor evaluation of minimum concentration limit of chrome gel system on the number of different types of cross-linking agents under 45°C. System concentration is based on L + Cr20 mg/L. Every time to rise concentration of polymer by 50 mg/L or cross-linking agent by 10 mg/L, through the experiments before, it is concluded that system gels when polymer concentration reaches to 500 mg/L or cross-linking agent concentration reaches 90 mg/L. As for it 25 million molecular weights with such concentration is bound to gel. 500 mg/L polymer + 90 mg/L cross-linking agent is the ceiling on experimental design to make polymer concentration and the cross-linking agent concentration cross and correspond. The experiment scheme is in table 1

Table 1 The experimental scheme

NO.	polymer concentration (mg L <sup>-1</sup> )	NO.	cross-linking agent concentration /(mg L <sup>-1</sup> ) cross-linking agent concentration
1	150	1	20
2	200	2	30
3	250	3	40
4	300	4	50
5	350	5	60
6	400	6	70
7	450	7	80
8	500	8	90

## 3. Experimental results and analysis

The minimum gelling concentration limits of HD-4 cross-linking agent is determined at the early formulation of the chrome micro gel system. Viscosity curve rises slowly when concentrations of the polymer and cross-linking agent increase. The system has not gelled, so the viscosity at average 10 mPa s. With the increasing of curing time, the viscosity curve will increase significantly when the concentration of polymer is more than 300 mg/L and the concentration cross-linking agent is more than or equal to 80 mg/L. When other viscosity curves of concentration system remain basically unchanged, the chrome micro gel system begins to gel. Its viscosity reaches about 30 mPa s. After curing for 60 hours, we can detect the viscosity. when the concentration of polymer is more than 300 mg/L and cross-linking agent concentration is more than or equal to 80 mg/L, the viscosity curve continues to rise and remain stable without appearing dehydration or excessive cross-linked viscosity

decline. So the minimum gel polymer concentration limit is 350 mg/L and corresponding cross-linking agent is 80 mg/L of the chrome micro gel system which are prepared by 25 million molecular weights [5] see Figure 1-2.

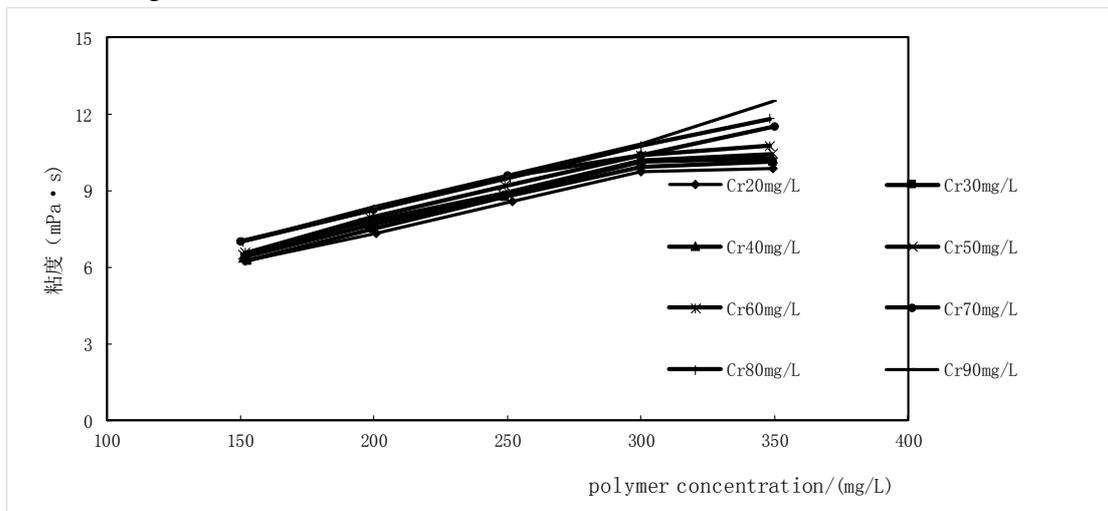


Figure1 HD - 4 cross-linking agent initial viscosity changes

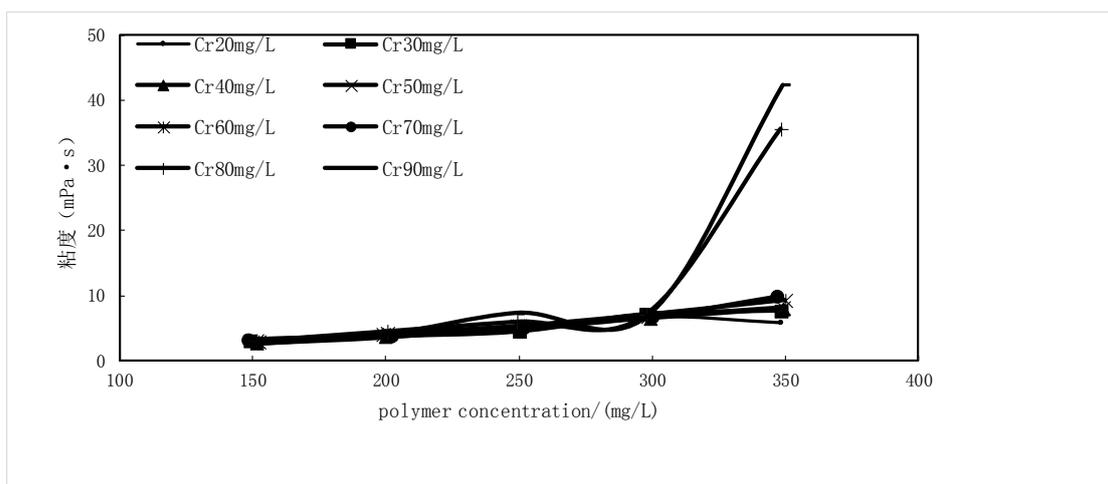


Figure 2 HD - 4 cross-linking agent viscosity changes at 60 hours

Determination of the minimum gel concentration limits of HD-5 cross - linking agent

With HD-5 cross-linking agent, the initial viscosity curve of chrome micro gel system with a preparation of 25 million molecular weights shows a rising trend in fluctuation. But there is no significant difference between HD-5 and HD-4 cross-linking agent. The initial viscosity remains at about 10 mPa s. The viscosity curve will increase significantly when the concentration of polymer is more than 300 mg/L and the corresponding concentration cross-linking agent is more than or equal to 80 mg/L and is significant different from other concentration curves. When the maximum viscosity is at about 40 mPa s, the system begins to gel. Continuously monitoring the viscosity of the system reaches 60 hours. The viscosity curve is not stable when the concentration of cross-linking agent reaches 80 mg/L. It appears dehydration and the viscosity decreased to 10mPa s below. So to make sure HD-5 cross-linking agent minimum polymer concentration is 400 mg/L and the concentration of corresponding cross-linking agent is 90 mg/L see figure 3-4.

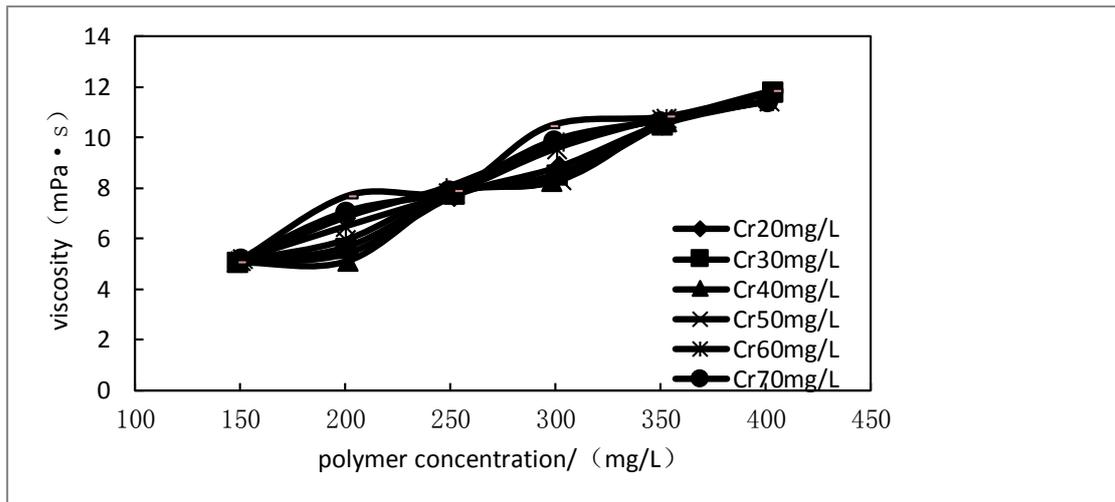


Figure3 HD - 5 cross-linking agent initial viscosity changes

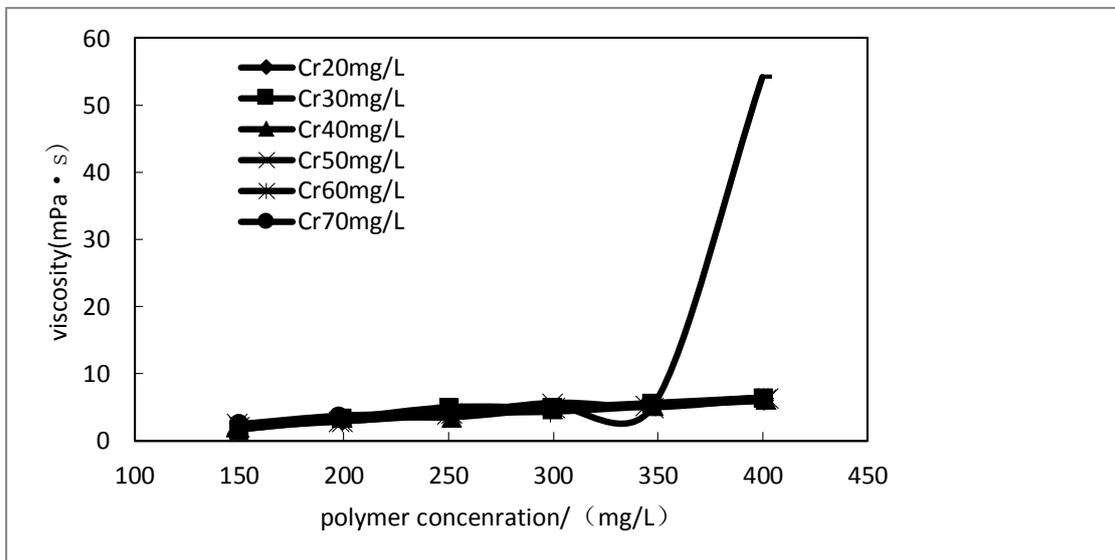


Figure4 HD - 5 cross-linking agent viscosity changes at 60 hours

The lower the core permeability is, the greater the pressure rises and the moisture decreases and the recovery efficiency increases after the injection of nanometer-micrometer sphere liquor. As a result, nanometer-micrometer sphere displacement agent has good effect on the lower permeability reservoirs and the lower the permeability is, the better the effect is within limit

#### 4. Conclusion

Through the indoor experiment, we selected and determined the suitable displacement parameters of nanometer-micrometer sphere liquor for the characteristic of Pubei 2 fault block oil reservoir: The best injection concentration is 2, 000 mg/L. The best injection rate is 0.2 PV. The optimal injection speed is 0.3 ml/min.

Nanometer-micrometer sphere has good displacement effect on the lower permeability natural core. On the basis of water drive recovery efficiency, the improvement value of recovery efficiency can reach 13% ~ 15%. And the injection pressure is lower. It can effectively reduce the moisture content. So it can be used as an oil displacement agent of low permeability reservoirs.

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