PRJ, Vol. 2 (January 1990); P. 67–70, 5 FIGS, 1 TABLE.

Short Note

EVALUATION OF OIL FIELD CORROSION INHIBITORS BY NACE STATIC TEST METHOD AND THE WHEEL TEST METHOD

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تقييم موانع التآكل بالحقول النفطية باستعمال طريقتي الإختبار الساكن والعجلة الدوارة

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تم إختيار وتقييم أربعة من موانع التآكل المتعددة والشائعة الإستعمال في الحقول النفطية الليبية ، وذلك باستعمال طريقتي الإختبار الساكن والعجلة الدوارة ووجد أن نتائج العجلة الدوارة أكثر واقعية من نتائج الإختبار الساكن نظراً لتقارب طبيعة التجربة الأولى من الظروف البيئية الموجودة بالحقل ، وتشير النتائج بأن مانع التآكل الذي يشار إليه في هذه التجربة برقم III يوفر أعلى قدر من الحماية من التآكل.

INTRODUCTION

There are many types of inhibitors which were developed by empirical testing [1]. Many of the known inhibitors are proprietary of the producing companies so that their composition is not released by the formulators [2]. Inhibitors act on the environment in different ways, such as adsorbing to the metal surface to form an invisible thin film or visible coat which protects the metal from the aggressive environment [3]. The type and concentration of inhibitor that can be used in specific corrosive environment is established by testing [4].

Oil and Gas production facilities are known to experience corrosion problems due to the aggressive nature of the produced fluids and gases [5]. Carbon steel is the most common construction material used in the fabrication of the oil production and gas processing equipment. By nature carbon steel is susceptible to corrosion attack in presence of brine and associated carbon dioxide and hydrogen sulphide. It is also well established that the corrosion inhibitors affect the anodic or cathodic reactions or both. The adsorbtion of the corrosion inhibitor is accepted to be dominating the entire surface rather than specific anodic or cathodic sites, resulting in the stifling of both reactions [6]. Inhibitors attach to metal surface by their polar groups such as organic N, amines, S and OH groups. The size, orientation, shape, and electric charge of molecule determine the effectiveness of the inhibitor [6].

The effectiveness of inhibitors in protecting oil and gas production facilities is dependent on the inhibitor composition and the aggressiveness of oil field produced fluids and gases. Inhibitors must be tested under simulated or nearly simulated oil field conditions in order to prove their performance and ability to reduce the corrosion attack of the produced fluids and the associated corrosive gases.

The objective of the paper is to evaluate performance of different inhibitors manufactured by different suppliers.

EXPERIMENTAL

To achieve test conditions as close as possible to the actual conditions of the corrosive environment in the oil field, test medium must contain the corrosive species known to exist in the oil field fluids. NACE static test method [7] and NACE wheel test method [8] are both designed so that the corrosive test medium be used under atmospheric pressure. Only saturation concentrations of the corrosive gases can be achieved under atmospheric pressure at room temperature.

For the purpose of saturating the synthetic brine with the corrosive gases an apparatus was developed as shown schematically in Fig. 1.

The wheel test method is a dynamic test performed by placing fluids (oil, brine and inhibitor) in 250 ml bottle with low carbon steel coupon; and capping the bottle. The bottle is then agitated for a period of 72 hrs by securing it to the circumference of a "wheel" and rotating it. At the end of this time the metal coupon is

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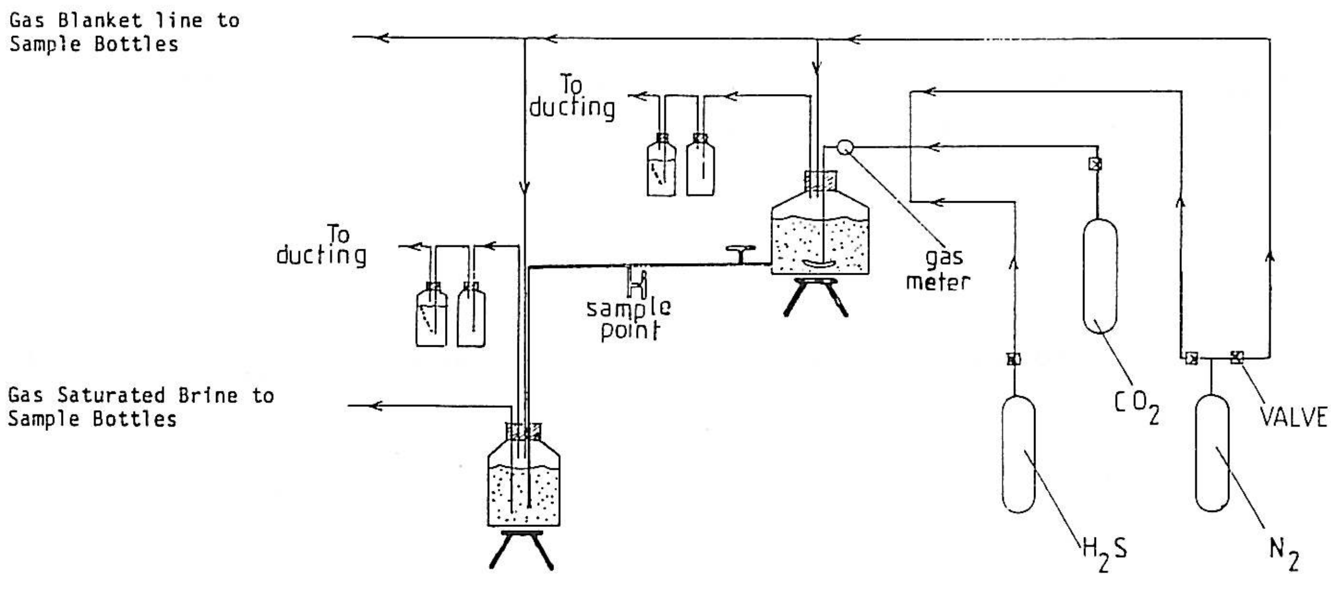

FIG. 1. Schematic diagram of the gas purging system and gas blanket system.

removed and cleaned and the weight loss is measured.

The static test method is a test which does not involve stirring or shaking. Similar quantities of four corrosion inhibitors were added into six hundred ml bottle as per NACE Standard. Brine and crude oil (450, 50 ml) respectively were added one after the other. At the end of the test duration coupons were removed and cleaned and the weight losses were measured.

RESULTS AND DISCUSSION

Four types of corrosion inhibitors namely (Inhibitor I, Inhibitor II, Inhibitor III, Inhibitor IV) were evaluated by using wheel test method [8] and static test method [7]. The tests were performed at five different concentration (0, 10, 25, 50, 100 ppm) of each inhibitor under the same experimental conditions as shown in Table 1.

The most important parameters are temperature and velocity. Test temperature for both tests were 50°C. Velocity for wheel test was chosen to be 6 rpm. The effect of temperature is generally conceded that the effectiveness of inhibitors usually is adversely influenced by increases in temperature and the effect of the velocity is important in inhibition performance of inhibitors as inhibition usually is affected by high velocity. On the other hand, performance of certain inhibitors in some environment is affected by too low velocity. The comparative inhibition efficiency of different types of corrosion inhibitors are shown in Fig. 2 for the Wheel Test Method.

Fig. 3 shows the percent of inhibitions of inhibitor I, inhibitor II, inhibitor III, and inhibitor IV at different concentrations tested under static test conditions. The effect of the different inhibitor concentrations on the corrosion rate is shown in Fig. 4 and Fig. 5. Fig. 2 shows that inhibitor III is the best corrosion inhibitor at concentration lower than 75 ppm, by comparison below this concentration inhibitor I shows the lowest percent of inhibition efficiency at all concentrations.

It is clear from Fig. 3 that inhibitors III and IV are better. Inhibitor II performs the least and has the lowest efficiency.

This is also supported by the results of the calculated

Table 1. Test conditions for all experiments

Test method	Temperature (°C)	Time (hrs)	CO_2 solubility at room temp.	H_2S solubility at room temp.	O_2 solubility at room temp.	Crude Oil (ml)	Brine (ml)
Wheel test method	50	72	1.5 g/l	3.5 g/l	0.001 g/l	85*	85*
Static test method	50	168	1.5 g/l	3.5 g/l	0.001 g/l	50*	450*

*As per NACE standard.

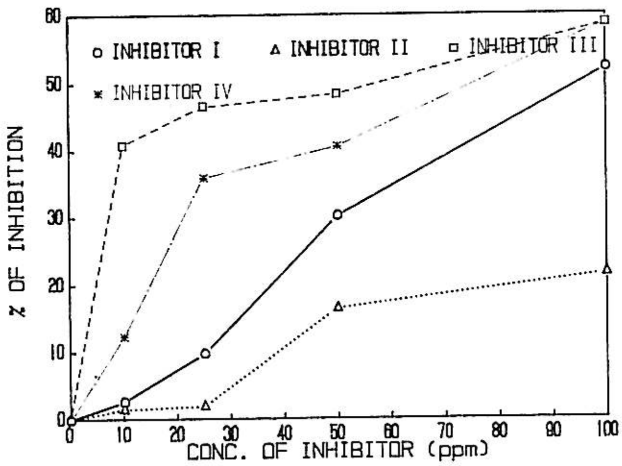

FIG. 2. Corrosion testing for different types of crude oil corrosion inhibitors by using wheel test method.

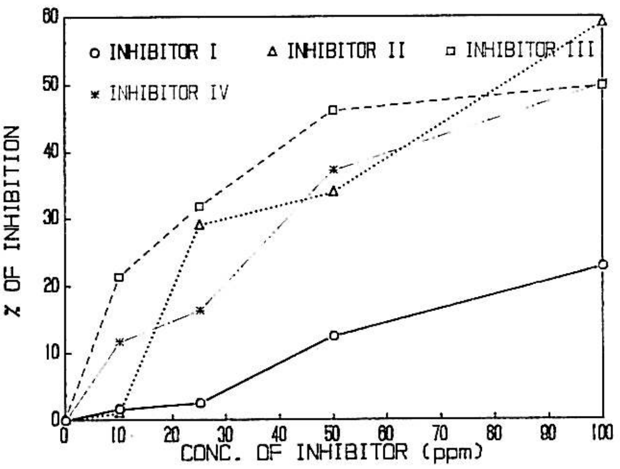

FIG. 3. Corrosion testing for different types of crude oil corrosion inhibitors by using static test method.

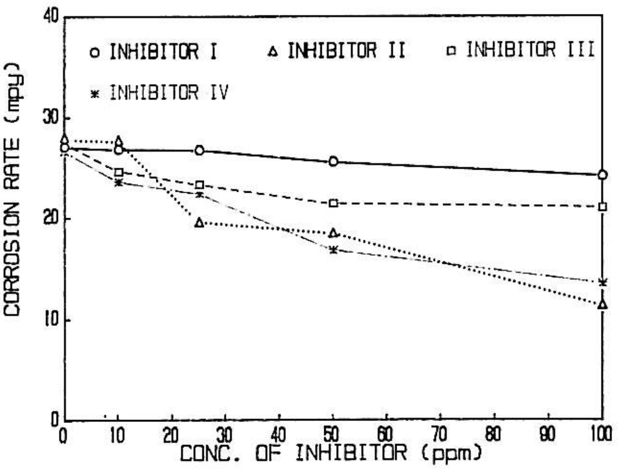

FIG. 4. Corrosion testing for different types of crude oil corrosion inhibitors by using wheel test method.

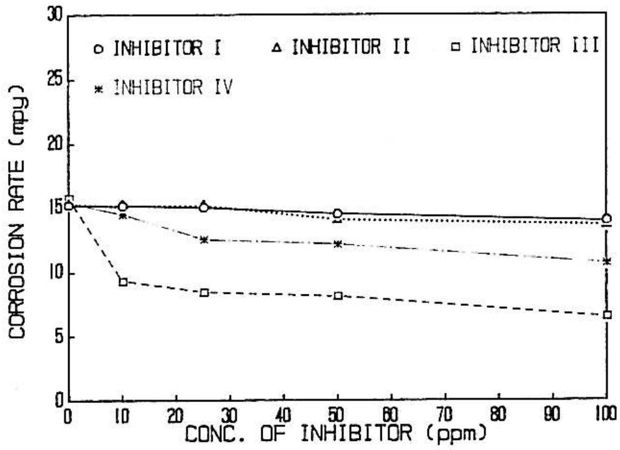

FIG. 5. Corrosion testing for different types of crude oil corrosion inhibitors by using static test method.

corrosion rate as illustrated in Fig. 4 for the wheel test and Fig. 5 for the static test. By comparing the wheel test method and the static test method the first one is more reliable than the second, since conditions in the wheel test method are closer to field conditions. The wheel test method involves rotation which attempts to simulate the time and frequency of specimen immersion in both phases (brine and Crude oil).

Structure of inhibitors was not disclosed by manufacturers. Therefore it is rather difficult to discuss how they differ from each other in their performance. IR Spectroscopy of inhibitors was carried out. The analysis revealed that the inhibitors are amine types.

CONCLUSION

1 The maximum possible percentage of inhibition which could be achieved was only 60%. This is offered by inhibitor III in the static test method and by inhibitor II in the wheel test method.
2 The optimum percent of inhibition in both the wheel test method and static test method was shown by inhibitor III.
3 The optimum level was 47% inhibition which required 30 ppm and 50 ppm of the inhibitor III in static and wheel test methods respectively.

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