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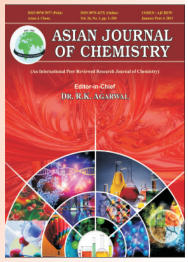

Synthesis and Properties of 3-Hexadecyloxy-2-hydroxypropyl Triethyl Ammonium Chloride

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3-Hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride was synthesized by using hexadecanol, triethylamine, epichlorohydrin, *etc.* as raw materials. The surface properties of product were studied *e.g.*, critical micelle concentration, surface tension and so on. The product shows good surface activity. The corrosion inhibition performance of product to A3 carbon steel was studied in acidic medium. Given the conditions that in acidic medium, the immersion lasted for 72 h, under 25 °C and the concentration of product is 0.40 mmol/L, the corrosion inhibition rate is 93.61 % over A3 steel. The result showed that 3-hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride has good capacity in inhibiting corrosion.

Keywords: Hexadecanol, Synthesis, 3-Hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride (HPAC), Corrosion inhibition.

INTRODUCTION

Along with the fast growing of oil extracting technology come the problems like the up going rate of water composition within the oil fields' production and the worsening situation of the composition of recovered sewage. To minimize the environmental contamination caused by sewage efflux and also to reduce water wastage, we shall afflux the well treated sewage back under ground for oil displacement. However, the re-injected water contains CO_2, H_2S, inorganic salts and types of bacteria like sulphate-reducing bacteria, iron bacteria and saprophytes which would still multiply at mass propagation may raise the occurrence where water pipelines and drilling equipment are badly damaged[1-4]. Research and development of efficient corrosion inhibitor to prevent corrosion and damage of oilfield sewage on oil pipelines and equipment is one of the important topics of oilfield wastewater treatment[5,6]. Currently the main types of sterilization antiseptic used of oilfield water injection systems are non-oxidative, oxidative and composite sterilization antiseptic. Literature reports that 12-alkyl-2 methyl benzyl ammonium chloride (1227) is a commonly used of non-oxidative quaternary ammonium cationic ones. So, we designed and synthesized a new substance. This study used hexadecanol, triethylamine, epichlorohydrin as raw materials while by bringing hydroxyl groups and ether groups into the typical structure of quaternary ammonium molecules for the synthesis of 3-hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride (HPAC). The one of raw materials takes from renewable resources fatty alcohol. The synthesis process is simple with high yield and formation of less by-products. The product has good thermal stability and biodegradability. In the laboratory, we analyzed the surface tension of the synthetic product and examined the corrosion inhibition performance of product to A3 carbon steel. Because its groups include water-soluble hydroxyl group and ether group, which would improve its dispersion within oil and water, increase the surface activity of surfactant, strengthen the quaternary ammonium to adsorption of bacteria. Therefore the overall effect of antiseptic was strengthened[7-9].

EXPERIMENTAL

All the chemicals used are of analytical reagents grade.

Formation of intermediate: 0.1 mol hexadecanol, 1.2 g TEBAC, 4.4 g NaOH and 10 mL solvent are added into a four-necked flask with temperature control stirrer. Then 0.2 mol epichlorohydrin are dropped into the flask dropwise at a speed of 10S/D under 45 °C. Stir strongly until the effect comes to an end before putting away the solvent. The viscous intermediation alkylglycidyl ether in pale yellow is made after washed and dried.

Formation of the target product 3-hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride (HPAC): Alkylglycidyl ether, 0.1 mol triethylamine and 50 mL absolute ethanol are added into the 250 mL dried four-necked flask. Let it reaction under 50 °C for 3 h before steaming ethanol out. The target product HPAC is obtained by recrystallization.

RESULTS AND DISCUSSION

Surface properties: Critical micelle concentration (cmc) is the important parameter of surfactant performance. Surface tension (γ) of HPAC of different concentration aqueous solution with the 25 °C is measured by using JC2000CI surface tension meter. We drew a γ-log c curves and get the result that when cmc is 0.6 mmol/L, the surface tension (γ) is 35.1 mN/m (Fig. 1).

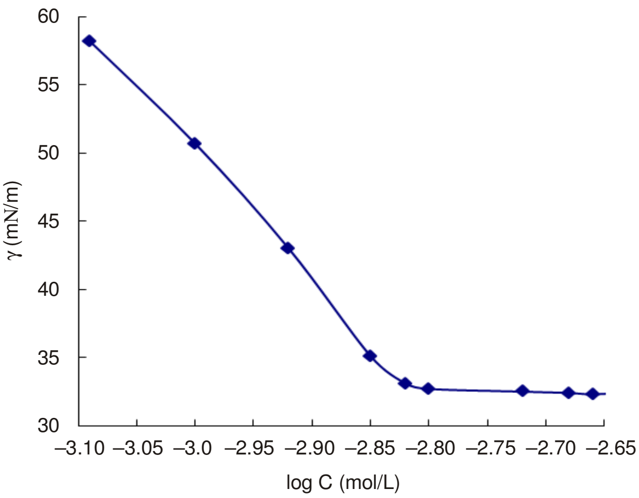

Fig. 1. γ-log c curve of HPAC solution

As shown in Fig. 1, the surface performance is compared with traditional cationic surfactant dodecyltrimethyl ammonium chloride; the product is of lower cmc. The product has a better surface activity. The reason is that the product with the group -OH, ether group-O- and the three ethyl attached to nitrogen atom make it arrangement relatively closely in the surface adsorption layer. Its molecular structure decides the low level of interfacial tension.

Evaluation over inhibition performance

Test method: Reference to the standard SY/T5273-2000 set by the oil and gas industry, we choose the rotating corrosion coupon weight loss method and examined the corrosion inhibition performance of product towards A3 carbon steel.

Preparation on coupon: Dip all the A3 coupon successively into acetone and absolute ethanol before taking out, cleaning them up with absorbent cotton and drying them with filter paper. Then measure and calculate the surface A and weigh them accurate (0.0001 g) and preserve them in dry containers for further usage.

Test on coupon: Immerse the prepared coupon into the corrosion inhibition solution which is a mixture of 10 % hydrochloric acid and the product of different concentration aqueous solution. The temperature of the test solution is 25 °C and the whole test is set for 72 h. Then we started running the equipment and let the coupon spin rotated at 80 r/min and lasted for 72 h. The blank test meanwhile was carried out.

Treatment with on coupon: After the test, the coupon are take out immediately and immerse them into the pickling solution for 3-5 min after being cleaned up with brush. Then take them out and wash with tap water and again immerse them into sodium hydroxide solution for around 30 sec before being taken out and washed up with distilled water. And then clean and dry them up with filter paper. Again immerse them into absolute ethanol for around 3 min and dry them up with filter paper. Put them all on a dry containers for up to 4 h and weigh them accurate (0.0001g). So we may calculate the corrosion rate and corrosion inhibition rate with the eqn. 1, 2.

$$V = \frac{m_0 - m}{A \times t} \quad (1)$$

In the formula, V is the corrosion rate, g/m^2 h; m$_o$ is the initial weight of the steel coupon, g; m is the weight of the steel after being taken away those corrosion products, g; A is the superficial area of the steel, m^2; *t* is the corrosion time period, h.

Corrosion inhibition rate η formula:

$$\eta(\%) = \frac{(V_0 - V)}{V_0} \quad (2)$$

In the formula, η is the corrosion inhibition rate, %; V_0 is the corrosion rate for the blank sample, g/m^2 h; V is the rate after the addition of the product solution, g/m^2 h.

Test result: By using the weight loss method, we measured and calculated the corrosion rate and the corrosion inhibition rate of A3 steel affected by synthetic products with different concentration under 25 °C. In the experiment we observed that surface of the blank steel was attached with large quantities of air bladders. When there are bubbles escaping time to time and caused the surface of steel turn into black.

While the surface was bright after some quantity addition of synthetic products solution, only with few cloud points emerged.

The data of the corrosion rate and the corrosion inhibition rate are listed in Table-1.

TABLE-1
CORROSION RATE AND CORROSION INHIBITION OF HPAC

c (m mol/L)	Corrosion rate (g/m^2 h)	Corrosion inhibition rate (%)
0	11.3213	-
0.10	5.7390	49.30
0.20	2.9288	74.13
0.30	1.6948	85.03
0.35	1.1016	90.27
0.40	0.7166	93.61
0.45	0.3917	93.98
0.50	0.3498	94.12

As shown in Table-1, when the concentration is at low level, the rate of corrosion inhibition is low as well. While with the concentration of the synthetic products goes up, the corrosion rate goes down gradually compared to the up going situation of corrosion inhibition rate. When the concentration of HPAC is 0.40 mmol/L, the corrosion inhibition rate reaches up to 93.61 %, which means that the product has good in corrosion inhibition performance. When the concentration increases up to 0.45 mmol/L, the corrosion inhibition rate comes into steady. The reason is that hydrophilic groups of the alcohol ether quaternary ammonium surfactants attached to the surface of the steel through either physical attachment or chemistry attachment in the acidic medium. In opposite, the hydrophobic groups which away from the metal surface, in turn arranged in direction forming an anti-water protective film over the metal surface. The protective film prevents water molecular from penetrating into metal surface as well as the metal ions are restricted diffusion to the aqueous solution. It also prevents other corrosive media immersion. When the concentration is quite low, surfactants cannot fully attached to the surface of metal and that is in low condense over the surface so the corrosion inhibition rate is quite low. While with the up going of the concentration, molecular that attached to the surface of mental are gradually increasing. The structure of hydrophobic groups turns into vertical state from bending form. This change forces the protective film into dense which enhance the rate of corrosion inhibition[10].

Conclusion

3-Hexadecyloxy-2-hydroxypropyl triethyl ammonium chloride (HPAC) was synthesized by using hexadecanol, triethylamine, epichlorohydrin as raw materials. The surface properties of product were studied: such as critical micelle concentration, surface tension and so on. The product shows good surface activity. The corrosion inhibition performance of product to A3 carbon steel was studied in acidic medium. Given the conditions that acidic medium, the immersion lasted for 72 h, under 25 °C and the concentration of product is 0.40 mmol/L, the corrosion inhibition rate is 93.61 % over A3 steel. The result showed that HPAC has good capacity in inhibiting corrosion.

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