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Influence of the HLB parameter of surfactants on the dispersion properties of brine in residue

Lei Zhang *, Guohe Que

State Key Laboratory of Heavy Oil Processing, University of Petroleum, Dongying 257061, China

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Abstract

In order to study the relationship between the hydrophilic–lipophilic balance of surfactants and the dispersion properties of brine in residue, using droplet size and droplet distribution analytical method were determined on emulsions prepared with emulsifier blends of varying hydrophilic–lipophilic balance (HLB) values the required HLB values of emulsion. The objective of this study was to investigate the effect of HLB on the dispersion properties of brine in residue. The type of emulsion was prepared using emulsifiers with various hydrophilic–lipophilic balance values. The droplet size and droplet distribution varied widely among emulsions containing emulsifiers with different HLB values. The results obtained in this study indicate that the different systems of residue/brine need different HLB values. The HLB value of the emulsion with the least dispersion ratio or the least average droplet diameter was taken as the system of residue/brine required HLB the required HLB values of $(NH_4)_6Mo_7O_{24}{\cdot}4H_2O$, $Co(NO_3)_2$, $NiSO_4$, $Ni(NO_3)_2$ and $FeSO_4$. The results showed that the values of HLB were determined as different system of emulsion.

Keywords: Residue; Surfactant; Dispersity; Hydrophilic–lipophilic balance

1. Introduction

The hydrophilic–lipophilic balance (HLB) value, an empirical parameter representing the content of hydrophilic and hydrophobic groups of a surfactant, has often been employed in the formulation of emulsion products. Emulsifiers for W/O-type emulsions are usually hydrophobic with low HLB values, while emulsifiers with higher HLB number are often used in the preparation of o/w-type emulsions. The emulsifiers which are used to prepare the o/w emulsions have HLB values from 9.6 to 17.6 and the emulsifiers were dissolved in aqueous phase. The emulsifiers which are used to prepare W/O emulsions have HLB values from 4.7 to 6.7 and Surfactant's hydrophilic–lipophilic balance (HLB) value is an expression of the surfactant's molecule affinity to the oil and water phases. They are based on classical emulsion science and the HLB concept, most surfactants can be assigned a numerical value representing the hydrophilic–lipophilic characteristics, which determine the type of emulsion. Bancroft's empirical rule states that the phase in which the emulsifiers more soluble is generally the continuous phase [1]. The HLB of the surface-active agent therefore plays an important role in determining the dispersion properties [2]. The HLB gives a simple index for the molecular balance of the surfactant at an O/W interface and also it provides a simple way to select the surfactant for the preparation of an emulsion. Systematic quantitative evaluation of the influence of HLB on the dispersion properties of brine in residue. It is now realised that the effective hydrophile/lipophile balance depends not only on the structure of the emulsifier but also on the temperature, oil type and salinity [3,4]. In the present study, we attempted to investigate the effect of the HLB on surfactants to the dispersion properties of residue/brine emulsion.

2. Experimental

2.1. Materials

The atmospheric residues were obtained from Xinjiang, Liaohe, Daqing, respectively, The properties were listed in Table 1. The surfactants used were Tween 80 and Span 80.

* Corresponding author. Fax: +86 546 8391971.
E-mail address: zhanglei16888888@163.com (L. Zhang).

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Table 1
The properties of Kelamay, Liaohe, Daqing atmospheric residues

Items	KLAR	LHAR	DQAR
Density (20 °C) (g/m^3)	0.9442	0.9817	0.9130
Viscosity (100 °C) (mm^2/s)	108.7	314.8	106
Condensation point (°C)	2.0	26	44
C (wt%)	86.60	86.80	87.10
H (wt%)	12.50	11.58	12.30
H/C	1.73	1.59	1.69
S (wt%)	0.13	0.39	0.20
N (wt%)	0.41	0.85	0.40
Carbon residue (wt%)	7.01	13.4	9.1
Ash content (wt%)	0.085	0.05	0.011
Molecular weight (VPO)	471	–	1120
Saturate (wt%)	50.4	31.08	38.40
Aromatic (wt%)	22.2	26.13	34.00
Resin (wt%)	27.2	40.06	27.50
Heptane asphaltene (wt%)	0.2	2.73	0.14

2.2. Methods

2.2.1. Emulsion preparation

Emulsions were made by stirring at moderate shear in a beaker (15 min at 500 rpm with a two blade stirrer). The weight of residue is about 40 g, the quantity of brine is 5% of residue. The hydrophilic emulsifiers were solved in brine; the hydrophobic emulsifiers were solved in toluene at a need ratio. Emulsifier and brine were added to residue. The concentration of emulsifiers, Span 80 and Tween 80 were used in the emulsions of residue/brine. The emulsions were prepared using the formative method of interface complex, the required amount of Span 80 was dissolved in the oil phase and that of the Tween 80 in the aqueous phase, the emulsions brine in residue with HLB values ranging from 4.3 to 15.0 were first prepared by blending together the emulsifiers in different ratios.

2.2.2. Droplet size analysis

Droplet sizes were measured by laser diffraction with a Malvern Mastersizer. The diameter of the microscale sample pool in the optical transparent upper phase (W/O emulsion) was measured at 313 K by dynamic light scattering (DLS) (He–Ne laser; 3.0 mW, 633 nm) (HPPS, HPP5001, Malvern Instruments, Worcestershire, UK). The output from the HPPS was reanalyzed as the Sauter mean droplet diameter (d_{32}) [5]. d_i is the diameter of emulsion droplet in i class; n_i is the number of emulsion droplet in i class:

$$d_{32} = \frac{\sum_i nid_i^3}{\sum_i nid_i^2}$$

Dispersion deviation coefficient $\delta = D_{90} - D_{10}/D_{50}$ (D_n, D is the droplet diameter and n is the percent).

Table 3
The required HLB about dispersion system of Daqing atmospheric residue/brine

Span 80/ Tween 80	HLB	Average diameter (μm)	Dispersion deviation coefficient
9:1	5.37	12.6	0.70
8:2	6.44	11.3	0.68
7:3	7.51	10.3	0.64
6:4	8.58	9.8	0.62
5:5	9.65	5.8	0.55
4:6	10.72	10.6	0.72
3:7	11.79	12.8	0.74
2:8	12.86	14.6	0.79
1:9	13.93	16.7	1.10

3. Results and discussion

3.1. The emulsion required HLB values with different residue [6]

The emulsion required HLB values were determined using droplet size analysis. The Sauter mean droplet diameter (d_{32}) and droplet distribution are important parameters in appraising the dispersion effect of the brine of $CuSO_4$ in residue. Emulsions with HLB values ranging from 5.37 to 11.79 were first prepared by blending together the emulsifiers of Span 80 and Tween 80 in different ratios.

The smallest mean droplet diameter was attained at HLB 12.86 for Kelamay atmospheric residue/brine, 9.65 for Daqing atmospheric residue, 10.72 for Liaohe atmospheric residue. Tables 2–4 show that the changing trends of the mean diameter are same for three kinds of residue. The mean diameter decreases firstly with the increase of HLB, an amount to the least value and then increase with the increase of HLB. The HLB number can be used as a representation of the surfactant polarity. Emulsifiers or combination of emulsifiers having HLB (hydrophile–lipophile balance) values close to that were required of the oil phase, Tables 2–4 show that different atmo-

Table 2
The required HLB about dispersion system of Kelamay atmospheric residue/brine

Span 80/Tween 80	HLB	Average diameter (μm)	Dispersion deviation coefficient
9:1	5.37	14.6	0.91
8:2	6.44	13.5	0.83
7:3	7.51	12.6	0.78
6:4	8.58	11.6	0.73
5:5	9.65	10.7	0.71
4:6	10.72	9.7	0.69
3:7	11.79	8.1	0.66
2:8	12.86	4.9	0.50
1:9	13.93	7.2	0.67