

1 **Supporting Information**

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3 **Reviving the Potential of Vermiculite-Based Adsorbents: Exceptional**  
4 **Ibuprofen Removal on Novel Amide-Containing Gemini Surfactants**

5 **Xianqi Hu\*, Zhuang Ma**

6 Department of Chemical Engineering, Hebei Petroleum University of Technology, Hebei 067000, P. R. China

7 \*Corresponding author: Xianqi Hu (huxianqi@cdpc.edu.cn)

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### 1.1. Characterization

The FT-IR spectroscopy (FT-IR, Nicolet IS10 FT-IR spectrometer), X-ray diffractometer (XRD, BRUCKER D8 ADVANCE), thermogravimetric analysis (TG-DTG, NETZSCH STA 449 F5/F3 Jupiter), EA (Vario EL cube) were conducted to for structural characterization.

The structural characters of organo-Vts were characterized by: Fourier transformed infrared spectroscopy (FT-IR, Nicolet Magna 560 E.S.P FT-IR spectrometer in the range of 4000-400  $\text{cm}^{-1}$  at resolution of 4  $\text{cm}^{-1}$ ), X-ray diffractometer (XRD, in the  $2\theta$  range from  $1^\circ$  to  $10^\circ$  at the scanning rate of  $1^\circ \text{min}^{-1}$ ), thermogravimetric analysis (TG-DTG, METLER TOLEDO, from 30 to 800  $^\circ\text{C}$  at  $10^\circ \text{C min}^{-1}$ , nitrogen atmosphere), elemental analysis (EA, Vario MACRO cube). All samples were all dried at 60  $^\circ\text{C}$  overnight before characterization.

### 1.2. Adsorption experiment

Batch adsorption experiments were adopted for evaluating the adsorption performance of organo-Vts. Analysis about the influence factor (modifier dosage, adsorption time, initial IBP concentration, temperature and solution pH) and adsorption mechanism (adsorption kinetics, isotherms and thermodynamics) was conducted by mixing 0.03 g of organo-Vts and 30 mL of IBP solution under varying conditions, respectively. The concentration IBP is measured by UV-vis. The adsorption amounts ( $q_e$ ,  $\text{mg g}^{-1}$ ) were obtained by the following equation [S1]:

$$q_e = \frac{C_0 - C_e}{m} V \tag{S1}$$

where  $q_e$  is the adsorption amount onto adsorbent ( $\text{mg/g}$ ),  $C_0$  and  $C_e$  are the initial and equilibrium dye concentrations ( $\text{mg/L}$ ), respectively,  $m$  represents the mass of adsorbent ( $\text{g}$ ) and  $V$  stands for the volume of solution ( $\text{mL}$ ).

Standard batch adsorption experiments were carried out on three organo-Vts by changing the modifier dosage (5\*3 groups), adsorption time (9\*3 groups), orthogonal experiment of temperature and concentration (15\*3 groups), pH values (5\*3 groups), and regeneration cycles (3\*2 groups). All parallel adsorption experiments were conducted in three times. Therefore, almost 324 groups of batch adsorption tests were conducted.

### 1.3 The adsorption kinetics, isotherms and thermodynamics

The equations of pseudo-first- (S2), pseudo-second order (S3) and intra particle diffusion (S4)

1 models, the Langumir (S5), Freundlich (S6) and Redlich-Peterson (S7), as well as thermodynamic  
 2 parameters (S8 and S9) are expressed as follows:

$$3 \quad \log(q_e - q_t) = \log q_e - \frac{k_1}{2.303} t \quad (S2)$$

$$4 \quad \frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t \quad (S3)$$

$$5 \quad q_t = k_1 t^{1/2} + C \quad (S4)$$

6 where  $k_1$  ( $\text{min}^{-1}$ ) and  $k_2$  ( $\text{g} (\text{mg min})^{-1}$ ) were the pseudo-first-order and pseudo-second-order rate  
 7 constants.  $q_e$  ( $\text{mg g}^{-1}$ ) and  $q_t$  ( $\text{mg g}^{-1}$ ) were the adsorption capacities at equilibrium and at time  $t$   
 8 (min), which represents contact time. All these unknown parameters can be determined from plots  
 9 of  $\log(q_e - q_t)$  against  $t$  and  $t/q_t$  against  $t$ .  $k_{id}$  ( $\text{mg g}^{-1} \text{min}^{-1/2}$ ) is the rate constant of the intra-particle  
 10 diffusion kinetic model, the values of  $C$  and  $k_{id}$  can be determined from the intercept and slope of  
 11 the linear plotted of  $q_t$  against  $t^{1/2}$ , respectively.

12 The Langmuir, Freundlich and Redlich-Peterson isotherms were expressed as follows:

$$13 \quad q_e = \frac{Q_m K_L C_e}{1 + K_L C_e} \quad (S5)$$

$$14 \quad q_e = K_f C_e^{1/n} \quad (S6)$$

$$15 \quad q_e = \frac{A C_e}{1 + B C_e^g} \quad (S7)$$

16 where  $q_e$  ( $\text{mg/g}$ ) is the adsorption capacity onto per unit mass of adsorbent at equilibrium,  $C_e$  is the  
 17 solute equilibrium concentration ( $\text{mg/L}$ ),  $q_m$  ( $\text{mg/g}$ ) is maximum adsorbed amount in the theoretical.  
 18  $k_L$  ( $\text{L/mg}$ ),  $k_f$  ( $\text{mg/g}$ ) and  $n$  represent the constants of Langmuir and Freundlich, respectively.  $A$  ( $\text{L/g}$ )  
 19 and  $B$  ( $(\text{L/mg})^g$ ) are the Redlich–Peterson model constant.  $g$  fluctuated between 0 and 1 with two  
 20 limiting behaviors: Langmuir form for  $g = 1$  and Henry's law form for  $g = 0$ .

21 Thermodynamic parameters could be calculated using the following equations:

$$22 \quad \ln K_L = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT} \quad (S8)$$

$$23 \quad \Delta G^\circ = -RT \ln K_L \quad (S9)$$

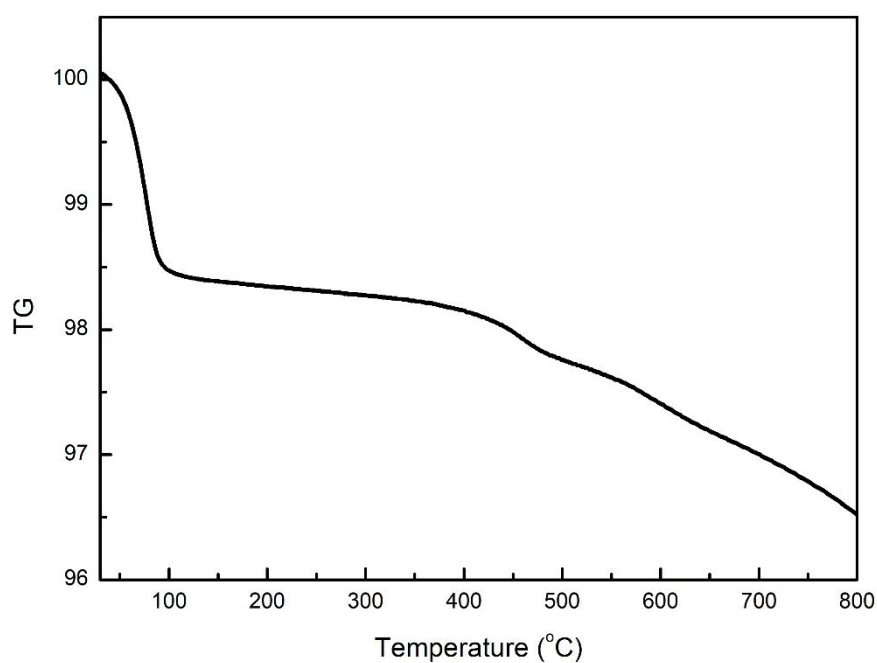
1 where  $K_L$  is the Langmuir constant,  $q_e$  and  $C_e$  have the same definitions with above equations.  $R$  is  
 2 the universal gas constant (8.3145 J/(mol K)) and  $T$  represents the absolute temperature in Kelvin.  
 3 The values of  $\Delta H^\circ$  and  $\Delta S^\circ$  can be extrapolated from intercept and slop of  $\ln K_L$  versus  $1/T$ .

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**Table S1 Elemental analysis data of HDAB, HDAHD and HDAPX**

Samples	Elemental analysis (wt%)					
	C		H		N	
	Cal.	Test	Cal.	Test	Cal.	Test
HDAB	60.8	59.93	10.43	11.01	6.45	7.37
HDAHD	59.31	60.09	11.11	10.18	6.44	7.42
HDAPX	62.88	63.12	10.04	10.96	6.11	7.09

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Fig. S1 The TG curve of Na-Vt.