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Studies on Density and Viscosity of Dysprosium Soaps in Methanol

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ABSTRACT

The density ,viscosity and specific viscosity of solution of dysprosium soaps (butyrate and valerate) in methanol was found to increase with increasing sopa concentration and with the number of carbon atom in the soap molecule . The viscisity results have been explained on the basis of the equations proposed by Einstein, Moulik, Vand and Dole The values of the molar volume calculated by Einstein's and Vand's** equation **are agreement with each other.

Keywords:- Density, viscosity, CMC, specific viscosity, molar volume.

I. INTRODUCTION

The studies [1-14] on higher rare metal carboxylate have not been carried out systematically so far although these metal carboxylate have found wide applications in various industries. The present work deals with the density and viscosity measurement of the solution of dysprosium soaps (butyrate and valerate) in methanol.

II. EXPERIMENTAL

All chemicals used were of BDH/AR grade, Dysprosium soaps were prepared by direct metathesis of sodium soap with slight excess of aqueous solution of dysprosium nitrate at 50-55^{0}C . The purity of of the soaps was checked by the determination of melting points butyrate 148^{0}C and valerate 128^{0}C. The absence of hydroxyl groups in these soaps was confirmed by IR spectra. The densities were determined with a dilatometer and Ostwald's type viscometer was used for measuring the viscosity of the soap solutions.

III. RESULT AND DISCUSSION

Density

The density of the solutions of dysprosium soaps (valerate and butyrate) in methanol increases with increasing soap concentration and with the number of carbon atoms in the soap molecule (tables 1-2). The plots of soap vs density concentration are characterized by an intersection of two straight lines at a definite soap concentration which corresponds to the CMC of the soap (table 3). The extrapolated values of the density ρ_0(valerate:0.7940, butyrate:0.7937 g mL^{-1}) are in agreement with the experimental value of density(0.7942 g mL^{-1} at 40^{0}C) of the solvent.

Table (1): Density and Viscosity of Dysprosium Butyrate in Methanol at 40±0.05^{0}C.

s. no.	Concentration Cx10^3 (g mol L^{-1})	Density ρ (g mL^{-1})	Viscosity η(cP)	Specific viscosity η_{sp}x10^3	η_{sp}/C	$\eta_{sp}/C^{1/2}$	$(\eta/\eta_0)^2$	$1/\log(\eta/\eta_0)$
1	2	0.7974	0.539	7.5	3.75	0.17	1.02	309.1
2	4	0.8014	0.543	15.0	3.75	0.24	1.03	155.1
3	6	0.8052	0.548	24.3	4.05	0.32	1.05	95.9
4	8	0.8086	0.552	31.8	3.98	0.36	1.06	73.6
5	10	0.8128	0.558	43.0	4.30	0.43	1.09	54.7

6	20	0.8312	0.579	82.2	4.11	0.58	1.17	29.1
7	30	0.8474	0.600	121.5	4.05	0.70	1.26	20.1
8	40	0.8638	0.618	155.1	3.88	0.78	1.33	16.0
9	50	0.8782	0.640	196.3	3.93	0.88	1.43	12.9

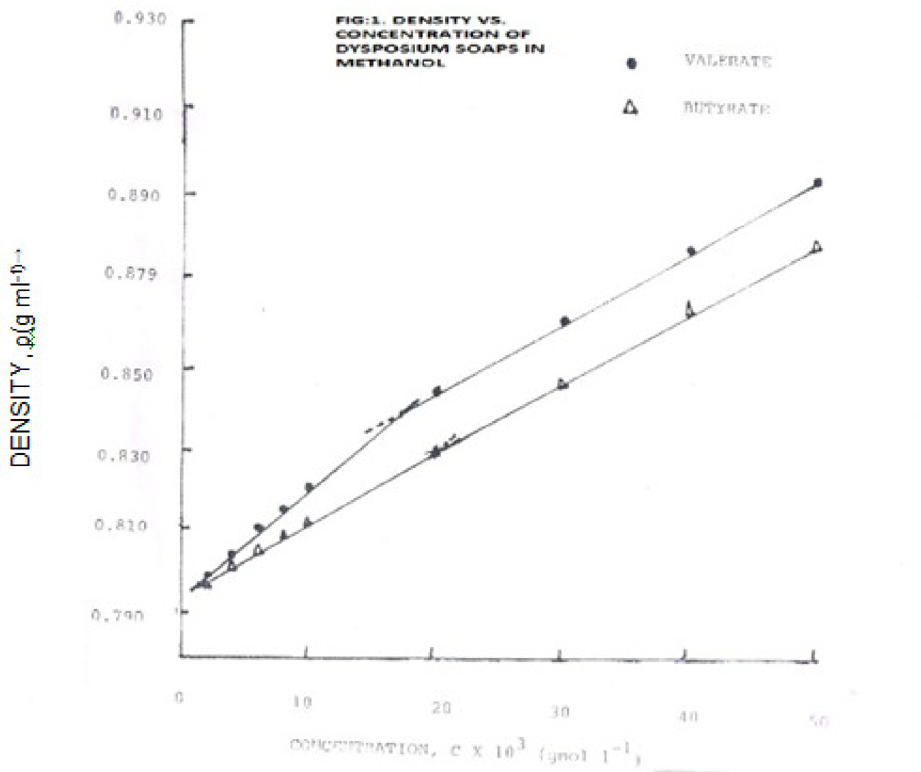

Table (2): Density and Viscosity of Dysprosium Valerate in Methanol at 40±0.05^{0}C.

Sample no.	Concentration Cx10^3 (g mol L^{-1})	Density ρ (g mL^{-1})	Viscosity η(cP)	Specific viscosity η_{sp}x10^3	η_{sp}/C	$\eta_{sp}/C^{1/2}$	$(\eta/\eta_0)^2$	$1/\log(\eta/\eta_0)$
1	2	0.7992	0.541	11.2	5.5	0.24	1.02	206.5
2	4	0.8042	0.547	22.4	5.6	0.36	1.05	103.8
3	6	0.8106	0.553	33.6	5.6	0.44	1.07	69.6
4	8	0.8152	0.558	43.0	5.4	0.48	1.09	54.7
5	10	0.8208	0.564	54.2	5.4	0.54	1.11	43.6
6	20	0.8452	0.590	102.8	5.1	0.72	1.22	23.5
7	30	0.8612	0.610	140.2	4.7	0.81	1.30	17.6
8	40	0.8772	0.630	177.6	4.4	0.89	1.39	14.1
9	50	0.8932	0.650	215.0	4.3	0.96	1.48	11.8

Table (3): Values Of Various Parameters from Viscosity Measurements of Dysprosium Soaps in Methanol at 40 ± 0.05^{0}C

S. no.	Name of soap	CMC (mol L^{-1})	$\bar{V}$(Einstein's Equation)	$\bar{V}$(vand's equation)	Φ	M	K	A	B	η_1
1	Valerate	0.017	2.20	2.44	5	1.04	830	0.16	5.77	5.74
2	butyrate	0.021	1.65	3.02	5	1.02	707	0.10	4.29	4.36

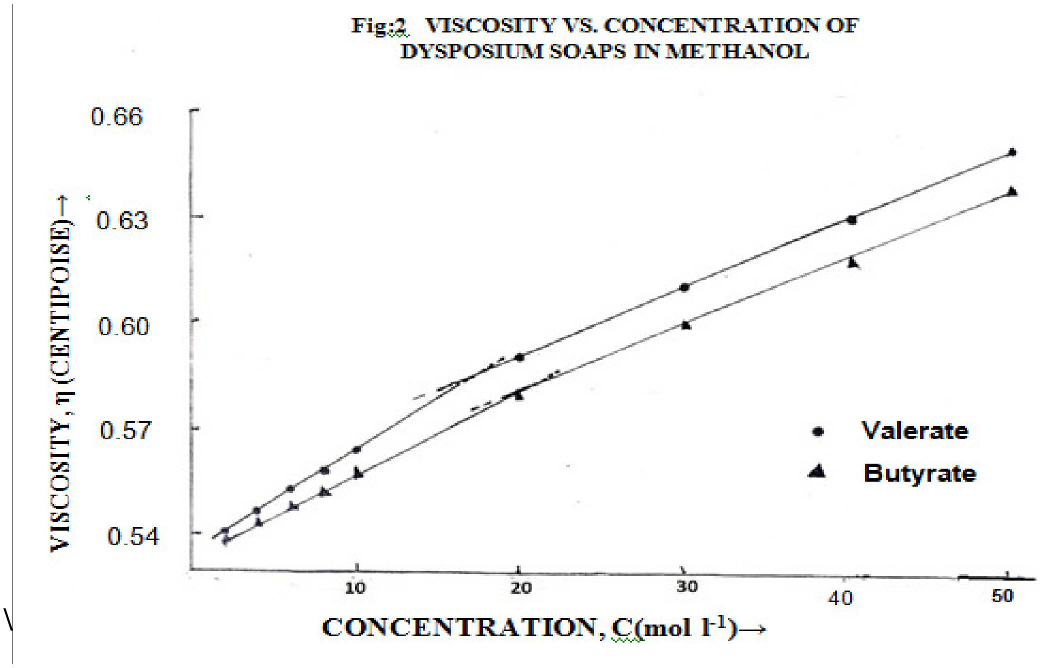
Fig:2 VISCOSITY VS. CONCENTRATION OF
DYSPOSIUM SOAPS IN METHANOL
0.66
0.63
0.60
0.57
0.54
VISCOSITY, η (CENTIPOISE)→
10
20
30
40
50
Valerate
Butyrate
CONCENTRATION, C(mol l-1)→

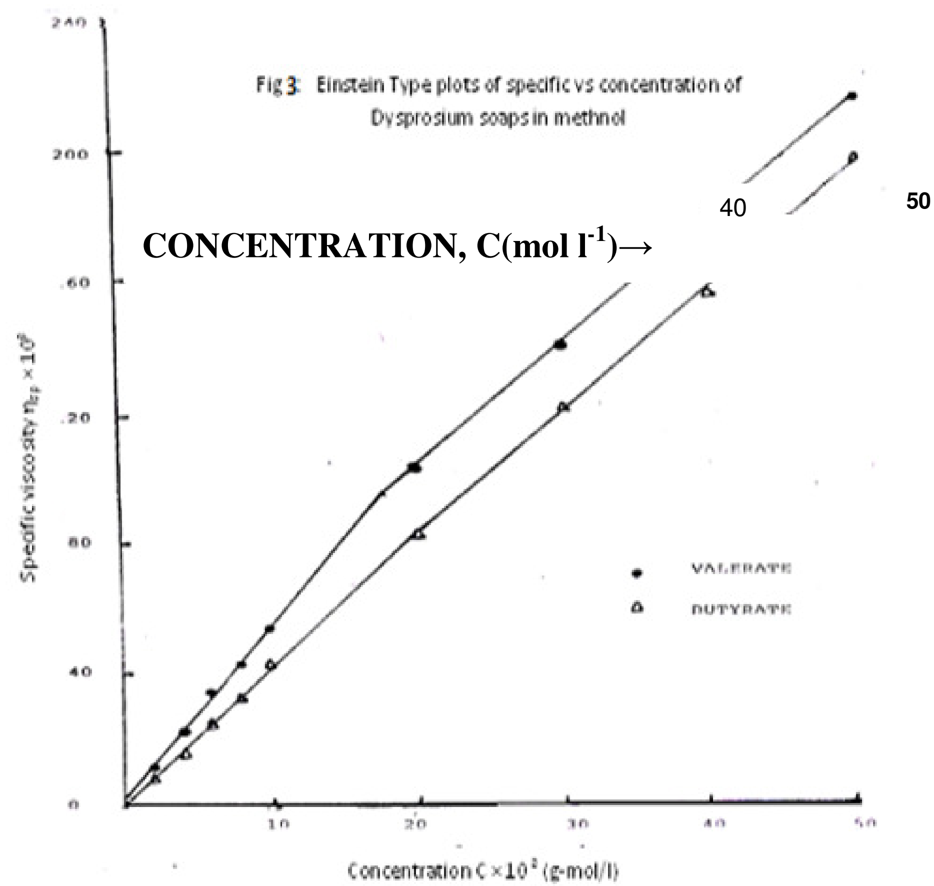
Fig 3: Einstein Type plots of specific vs concentration of
Dysprosium soaps in methnol
40
50
CONCENTRATION, C(mol l-1)→
240
200
.60
.20
80
40
0
Specific viscosity
VALERATE
BUTYRATE
10
20
30
40
50
Concentration C × 10² (g-mol/l)

Viscosity

The viscosity η and specific viscosity η_{sp} of the solutions of dysprosium soaps in methanol increase with increasing soap concentration(tables 1-2). The increase in viscosity may be due to the increasing tendency of the soap molecule to form aggregates with the increase in the soap concentration. The plots of viscosity η vs. soap concentration C and of specific viscosity η_{sp} vs. soap concentration C are characterized by an intersection of two straight lines at a definite soap concentration which corresponds to the CMC of these soaps. The plots of viscosity η vs. soap concentration have been extrapolated to zero soap concentration and the extrapolated values of viscosity η_0(0.536cP) are in the agreement with the viscosity of methanol(0.535cP at 40_0C).

The viscosity results have been interpreted in terms of equations proposed by Einstein[21],vand[22],moulik[23], and jones and dole[24]:

Einstein[21]: $\eta_{sp} = 2.5\ \bar{V}C$

Vand[22] : $1/C = (0.921/\ \bar{V})^{-1}.\ 1/\log(\eta/\eta_0)+\Phi\ \bar{V}$

Moulik[23] : $(\eta/\eta_0)^2 = M+KC^2$

Jones and Dole[24] : $\eta_{sp}/C^{1/2}=A+BC^{1/2}$

Where $\bar{V}$,C,Φ.H,η_0, and η_{sp} are the molar volume of soap, concentration, interaction coefficient, viscosity of the solution, viscosity of the solvent and specific viscosity respectively.

The plots of specific viscosity η_{sp} vs. soap concentration C below the CMC are linear with intercept equal to zero, which shows that Einstein's equation is applicable to these soaps solutions below the CMC. The molar volume of dysprosium soaps calculated from the slope of plots are recorded in (Table-3). The values of the CMC obtained from the plots of η_{sp} vs. soap concentration C are agreement with the values obtained from density and viscosity data. The plots of η_{sp}/C vs. concentration C below the CMC have been extrapolated to zero soap concentration and extrapolated values (i.e., the intrinsic viscosity,) increase with increasing chainlength of the soap molecules (Table).

The values of molar values calculated from the slope of the plots of 1/C vs $1/\log(\eta/\ \eta_0)$ (table viii) are in the agreement with the values calculated from Einstein's plots. The values of interaction coefficient Φ have been calculated from the intercept of these plots and are founded to be 5.0 for the solutions of dysprosium soaps in methanol.

The plots of $(\eta/\ \eta_0)^2$ against C^2 show that moulik's equation is applicable to the solutions of the dysprosium soaps. The values of Moulik's constant M and K have been obtained from the intercept and slope of these plots(table viii). The values of M and K increase with increasing chain length of soap molecules.

The plots of $\eta_{sp}/C^{1/2}$ vs $C^{1/2}$ indicate a break at a definite soap concentration which corresponds to the CMC of the soap. The values of the constants A and B obtained from intercept and slope of these plots below the CMC are recorded in table viii. The values of the constant B (soap-solvent interaction) are larger than those of constant A (soap-soap interaction), which confirms that the soap molecules do not show appreciable aggregation of the soap molecules below this concentration.

It is, therefore, concluded that the viscosity results for the solutions of dysprosium soaps may be satisfactorily explained in terms of equations proposed by Einstein, Vand, Moulik and Jones and Dole.

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