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# STUDIES ON DENSITY AND VISCOSITY OF DYSPROSIUM CAPROATE AND CAPRYLATE IN METHANOL

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**Abstract**

***The studies of density, viscosity and specific viscosity of solution of dysprosium soaps (caproate and caprylate) in methanol was found to increase with increasing soap concentration and with the number of carbon atom in the soap molecule . The viscosity 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. The result show that the densities of soaps solution in benzene- methanol increases with increasing soaps concentration.***

***Keywords :- Density, viscosity, cmc, specific viscosity, molar volume.***

## I. INTRODUCTION

The study of metallic soaps are being widely used in academic and industrial fields. 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 (caproate and caprylate) 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 50-550C . The purity of of the soaps was checked by the determination of melting points caproate 1240C and caprylate 1350C. 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 (caproate and caprylate) 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).

**Table 1. Density and Viscosity of Dysprosium Caproate in Methanol at 40±0.05$^0$C**

| S.No. | Concentration $Cx10^4$ (g mol $L^{-1}$) | Density ρ (Kg $m^{-3}$) | $\rho - \rho_0$ /C | Viscosity η x $10^3$ | Specific viscosity $\eta_{sp}x10^3$ | 1/C x $10^{-3}$ | $(\eta/\eta_0)^2$ | $1/\log(\eta/\eta_0)$ | $C^2$ x $10^8$ | $\eta_{sp}/C^{1/2}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 729.37 | 35.7 | 0.488 | 31.71 | 10 | 1.064 | 71.43 | 1 | 3.17 |
| 2 | 2 | 732.21 | 32.05 | 0.503 | 63.42 | 5 | 1.131 | 37.74 | 4 | 4.5 |
| 3 | 3 | 735.03 | 30.77 | 0.516 | 90.9 | 3.33 | 1.19 | 24.45 | 9 | 5.29 |
| 4 | 4 | 737.17 | 28.43 | 0.529 | 118.39 | 2.5 | 1.251 | 20.66 | 16 | 5.9 |
| 5 | 5 | 738.86 | 26.12 | 0.543 | 147.99 | 2 | 1.318 | 16.69 | 25 | 6.72 |
| 6 | 6 | 741.15 | 25.58 | 0.557 | 177.59 | 1.67 | 1.387 | 14.12 | 36 | 7.12 |
| 7 | 7 | 744.32 | 26.46 | 0.571 | 207.19 | 1.43 | 1.457 | 12.34 | 49 | 7.67 |
| 8 | 8 | 747.08 | 26.6 | 0.586 | 238.9 | 1.25 | 1.535 | 10.74 | 64 | 8.54 |
| 9 | 9 | 750.06 | 26.95 | 0.598 | 264.27 | 1.11 | 1.598 | 9.3 | 81 | 8.8 |
| 10 | 10 | 753.33 | 27.53 | 0.611 | 291.75 | 1 | 1.669 | 8.98 | 100 | 9.13 |

**Table 2. Density and Viscosity of Dysprosium Caprylate in Methanol at 40±0.05$^0$C**

| S.No. | Concentration $Cx10^4$ (g mol $L^{-1}$) | Density ρ (Kg $m^{-3}$) | $\rho - \rho_0$ /C | Viscosity η x $10^3$ | Specific viscosity $\eta_{sp}x10^3$ | 1/C x $10^{-3}$ | $(\eta/\eta_0)^2$ | $1/\log(\eta/\eta_0)$ | $C^2$ x $10^8$ | $\eta_{sp}/C^{1/2}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 730.53 | 47.3 | 0.49 | 35.94 | 10 | 1.073 | 58.82 | 1 | 3.6 |
| 2 | 2 | 734.01 | 41.05 | 0.508 | 73.99 | 5 | 1.153 | 32.26 | 4 | 5.29 |
| 3 | 3 | 737.13 | 37.76 | 0.524 | 107.82 | 3.33 | 1.227 | 22.22 | 9 | 6.35 |
| 4 | 4 | 739.97 | 35.43 | 0.535 | 131.08 | 2.5 | 1.279 | 18.87 | 16 | 6.55 |
| 5 | 5 | 741.86 | 32.12 | 0.553 | 169.13 | 2 | 1.367 | 14.71 | 25 | 7.68 |
| 6 | 6 | 744.55 | 31.25 | 0.562 | 188.16 | 1.67 | 1.412 | 13.33 | 36 | 7.83 |
| 7 | 7 | 747.37 | 30.74 | 0.577 | 219.87 | 1.43 | 1.488 | 11.63 | 49 | 8.15 |
| 8 | 8 | 749.88 | 30.1 | 0.596 | 260.04 | 1.25 | 1.588 | 10 | 64 | 9.29 |
| 9 | 9 | 751.87 | 28.97 | 0.614 | 298.09 | 1.11 | 1.685 | 8.85 | 81 | 9.93 |
| 10 | 10 | 754.13 | 28.33 | 0.629 | 329.81 | 1 | 1.768 | 8.06 | 100 | 10.32 |

**Table 3 : Value of Different constant From Viscosity at 40±0.05$^0$C**

| Soaps | | | Jones-Dole's Equation | | Moulik'sEquation | |
|---|---|---|---|---|---|---|
| | Einstein Equation | Vand's equation | A | $Bx10^{-2}$ | M | $Kx10^{-3}$ |
| Dysprosium Caproate | 1.08 | 7.30 | 0.74 | 2.02 | 1.11 | 5.37 |
| Dysprosium Caprylate | 1.51 | 8.32 | 1.57 | 3.51 | 1.13 | 5.84 |

**Viscosity**

The viscosity $\eta$ and specific viscosity $\eta_{sp}$ 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 $\eta$ vs. soap concentration C and of specific viscosity $\eta_{sp}$ 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 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 . $(\eta/\eta_0)^{2=}M+KC^2$

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

Where $\bar{V}$,C,Φ.H,$\eta_0$, and $\eta_{sp}$ 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 $\eta_{sp}$ 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 $\eta_{sp}$ vs. soap concentration C are agreement with the values obtained from density and viscosity data. The plots of $\eta_{sp}$/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 chain length of the soap molecules .

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 (table3). 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. 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 andJjones and Jole.

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