Physicochemical Study Of Cycloalkane/Alcohol-Based Non-Aqueous Systems

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ABSTRACT

In this research, the physicochemical characteristics of non-aqeous systems with alcohol and cycloalkane combinations are examined. Thermodynamic behavior, phase equilibria, and molecular interactions in these binary systems are the main areas of study. Combining cycloalkanes such as cyclohexane, cyclooctane, and cyclooctane with main alcohols such as methanol, ethanol, and butanol was our strategy. The structural and thermal properties of these mixes were examined using experimental methods such nuclear magnetic resonance (NMR) spectroscopy, infrared spectroscopy, and differential scanning calorimetry (DSC). The study's primary variables comprise solubility, density, viscosity, and refractive index. Complex intermolecular interactions between the alcohol and cycloalkane components are suggested by the data, which show substantial departures from ideal behavior. The results shed light on how solvent systems might be better designed and optimized for use in chemical engineering, cosmetics, medicines, and other industrial contexts. Further investigation into comparable binary and multicomponent mixes can be facilitated by the data, which also add to our overall knowledge of non-aqueous solvent systems.

Keywords *= cycloalkane, physicochemical characteristics, chemical engineering,*

I. INTRODUCTION

1.1 Physical and Chemical Characteristics Density, volume, hydrostatic pressure, hydrogen bonding, solubility, molecular weight, mole fraction, viscosity, and boiling and freezing points are all examples of physicochemical qualities.

1..1. Examples of Physicochemical Properties Related to Drugs

Researchers in the chemical sciences have focused mostly on the physicochemical characteristics of pharmaceuticals, although they have examined the physicochemical features of many other compounds as well. The delivery, activity, and chemical response of pharmaceuticals are together referred to as their physicochemical qualities. From drug delivery to drug activity and chemical reaction with the target cell, several physicochemical features of the medications play a significant role. 1.1 How Drugs Dissolve Drug solubility is one of the key characteristics. Solubility refers to the degree to which a medicine interacts with its target, which can be an organic solvent or an aqueous system, through hydrophobic and hydrophilic interactions, respectively. The atoms and molecules in these organic solvents interact in various ways. Such interactions can take the form of covalent bonds, hydrogen bonds, or dipole interactions. The drug's solubility is affected by the interactions between the drug and the water system. The pharmaceutical industry uses procedures to prepare medications that make them easily soluble in solvents since solubility is a crucial process for the drug's effect. They employ different solvents and surface-active chemicals, as well as alter the molecular structures of drugs, to achieve this goal.

1.2. Hydrogen Bonding Between Drug molecules and Target molecule

The ability to create hydrogen bonds is the third crucial physicochemical feature. Solubility in water is conditional on the ability of a chemical to establish an H-bond; insoluble compounds lack this ability. The drug molecule and

the target molecules may form hydrogen bonds either between or within themselves. Examples of substances whose activity is significantly impacted by hydrogen bonding include the disinfectant salicylic acid and the painkiller antipyrine.

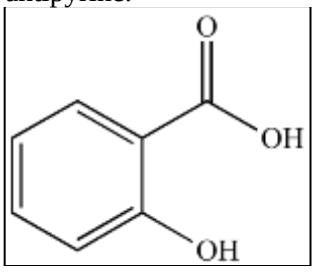

Figure 1.1 Salicylic Acid

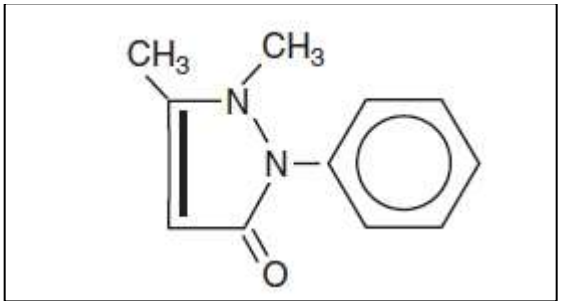

Figure 1.2 Antipyrine

1.3. Ionization of Drug Molecules:

The ionized version of the medicine transforms into easily soluble in water. In short, this ionization is necessary for the reaction of drugs with the target molecule and if the drug is not in the ionized form then it can easily cross the film of target system.

1.4. Complex Formation

In addition to having problems being absorbed, complex drug molecules also have problems penetrating the receptor's membrane. Keep in mind that even while the intricate manufacturing of drug molecules slows the absorption rate, it has no effect on the amount of active medicine. If the drug molecule combines with metals, it can have some unwanted side effects. For example, a gradual thinning of bones may result from a disease-inducing combination of an iron molecule and a medicine molecule. 1.1.2. Uses of Physicochemical Properties The physicochemical features of organic compounds can be used to assess their endurance. The length of time an organic compound stays in a given location before being converted chemically or biologically can be determined by analyzing its physicochemical properties. This time is estimated by looking at how quickly the organic component breaks down biologically or chemically. There are a variety of approaches to the estimation of these rates.

1.5. Cycloalkanes

The structural features of cycloalkanes, a class of alkanes, can include one or more carbon rings. They possess a standard formula

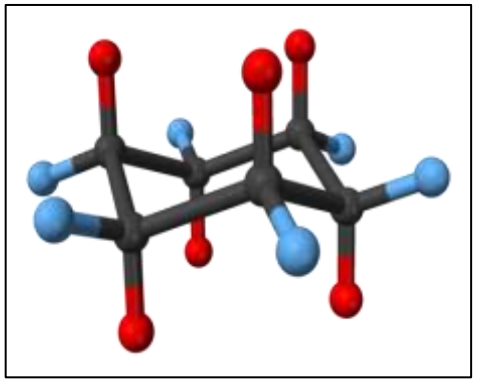

Figure 1.3 (3-D model of cyclohexane)

cyclohexane model Strain caused by bond angles indicates that the bond angles of the molecule are not optimal and the molecule is exhibiting strain. The geometry of cycloalkanes gives them greater energy values in theory. Their strain energy can be determined by comparing the standard combustion enthalpy of the cycloalkanes under examination with values computed using average bond energies.

1.6. Physicochemical Properties of Cycloalkanes

The physical properties of cycloalkanes are similar to those of alkanes, but they additionally exhibit higher values for some parameters, such as densities, melting temperatures, and boiling points, in comparison to alkanes. The primary factor contributing to these parameter values is the rise in the number of London forces. being greater. 1.1)

Table 1Table1.1 (Some physical parameters of cycloalkanes)

Cycloalkane	M.P	B. P	DENSITY
C_3H_6	145K	240.3K	1.88g/cm^3
C_4H_8	182K	285.5K	0.720g/cm^3
C_5H_{10}	179.1K	322.2K	0.751g.cm^3
C_6H_{12}	279.5K	353.7K	0.778g/cm^3
C_7H_{14}	261K	391.4K	0.811g/cm^3
C_8H_{16}	287.6K	422K	0.834g/cm^3
C_9H_{18}	283-284K	442K	0.8534g/cm^3
$C_{10}H_{20}$	282-283K	474K	0.871g/cm^3

This increase may occur because, as the number of carbon atoms in a ring increases, the number of bonds also increases, leading to bonds that are too strong to be dissolved. Section 1.2.4: Cycloalkanes and Their Uses Cycloalkanes are used in many different areas of industry and daily life. The medical field makes extensive use of them. As an example, adipic acid is synthesized using cyclohexane, one of the main cycloalkanes. Cyclohexanone and cyclohexanol are produced from nearly all of the cyclohexane that is consumed. The production of caprolactam and adipic acid requires both of these. Alcohols' physicochemical characteristics (1.3.)

1.7. Solubility

molecules of alcohol with each other due to the formation of H-bond with the increase in size and mass. Therefore, high energy is needed to overcome these H-bonds. Following figure is clearly representing the hydrogen bonding between the highly electronegative oxygen atom of ethanol and the electropositive hydrogen atom of water.

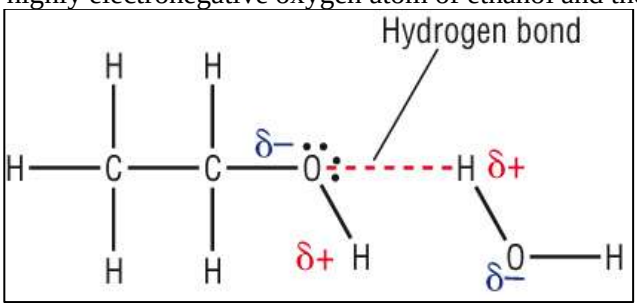

Figure 1.4 (H-bonding between ethanol and water molecules)

1.8. Viscosity

Alcohols' viscosity beyond boiling point is another crucial physical property. Viscosity is the measure of a liquid's resistance to flow. Increasing the length of the alcohol chain has a direct correlation with this. because of increase in the forces of attraction between the molecules that holds the molecules more strongly that's why viscosity gains the high value with the increase in the number of the molecules. Alcohols are polar in nature and their polarity has the third ranking

and the arrangement of H-bonds remains consistent throughout the entire alcohol series. The dispersion forces of Vander Waals are proportional to the length of the alcohol chain, since the strength of dipole forces grows as the number of electrons in a molecule rises. That's why high energy is absolutely necessary to manage the strong intermolecular interactions, which in turn cause alcohols to have high m.p. and b.p. values. Table 1.2 shows the boiling and melting points of various alcohols and alkanes; as can be seen, alkanes have substantially lower boiling points than alcohols.

Table 2 comparison between the boiling points of alkanes and alcohols

Alkane	B.P K)	Alcohol	B.P (K)
Methane	111	Methanol	337.7
Ethane	184.5	Ethanol	351.5
Propane	225.4	Propanol	371
Butane	272	Butanol	390.4

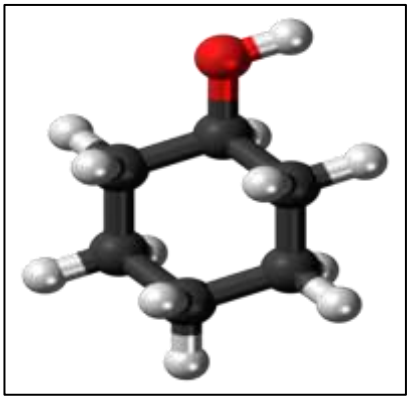

Figure 23-D model of cyclohexanol

II. 2 Literature

In 2019, Zebin Guo and Beibei Zhao studied lotus seed starch subjected to high-pressure homogenization. Spectral analyses revealed significant changes in the starch's structure and morphology, with reduced heat content and lower alteration temperatures. The homogenized seeds were also found to be more digestible than untreated ones.

In 2011, Nate Schulthesis and Ann Newman explored various cocrystals for pharmaceutical use, noting significant improvements in their physicochemical properties compared to other crystals. This stability made them valuable in the industry.

P Roy and colleagues (2015) highlighted that carbon nanodots with photoluminescence properties offer advanced applications. In 2015, S Soponronnarit and M Chiawwet found that high-temperature drying affects rice properties, with specific conditions optimizing the aging process.

G Liu et al. (2018) highlighted the role of two-dimensional materials in light absorption and their distinctive physicochemical properties.

C. G Liu et al. (2018) studied two-dimensional materials, noting their unique light absorption properties and potential for solar energy conversion. Z Rankovic (2015) emphasized the challenge of designing drugs that cross the brain's protective barriers. O Akkus et al. (2004) studied bone mass and flexibility with age, finding increased mineralization and carbonate replacement related to decreased flexibility.

J Liu et al. (2014) modified three starch types with hydrogen peroxide and sodium trimetaphosphate, finding that modified starches showed improved properties such as freeze-thaw stability and light distribution. G Li and F Zhu (2017) analyzed whole grain quinoa flour, noting that its properties were significantly influenced by starch content and interactions with non-starch components. SW Shin et al. (2015) discussed nanoparticle technology's potential and challenges, emphasizing the importance of physicochemical properties for safe application in biotechnology. G Hu et al. (2013) studied how nanoparticles interact with lung surfactant, revealing that hydrophobic nanoparticles move more freely compared to hydrophilic ones. M AB Velichenko et al. (2002) examined lead dioxide deposits on platinum, detailing how temperature and current affect their formation and longevity.

III. Experiment

3.1 Materials

3.1.1 Cyclohexane;

A cycloalkane, cyclohexane, was employed. Pure compound having a molecular formula of C6H12, a molar mass of 84.16 g/mole, and a concentration of 0.78 kg/l acquired from MERCK (Art. 2832).

3.1.2. Cyclohexanol;

Molecular formula C_6H_{12}, molar mass

M= 84.16g/mole, 0.78kg/l purchased from MERCK (Art.2832) with 99% purity.

3.1.3 Cyclohexanol;

Cyclohexanol was used as alcohol.

Molecular formula $C_6H_{11}OH$, molar mass M=100.16g/mole, 0.94kg/l purchased from MERCK-Schuchardt (Art.822328) with 99% purity.

3.1.4 Procedure

Everything made of glass washed and dried. The mass of the empty flask was measured. The mass of cycloalkane-alcohol-based non-aqueous systems was also determined using a comparable method.This method makes the cycloalkane- alcohol based non-aqueous systems from The range from 0% to 100% was calculated by deducting the weight of the mixed-system flask from the weight of the empty flask.

3.1.5 Calculation Weight of Cycloalkane-Alcohol Systems

The molecular weight of 52 systems with up to 100% (v/v) was determined. For this purpose, firstly the weight of empty flask was taken. Then this empty flask was filled with 100% (v/v) of the cyclalkane and again its weight was taken, then 3.84% (v/v) alcohol was added to this pure cycloalkane and its weight was noted. The process was repeated for 7.4 % (v/v), 10.7 %(v/v) …….50% (v/v) of alcohol. After getting the weight of all the 52 systems, the weight of all systems was step by step subtracted from the weight of the empty flask. In this way the weight of 52 systems with up to 100% (v/v) was calculated.

3.1.6 Calculation of Density

Density was calculated by using following equation:

$$\boldsymbol{\rho}=\frac{m}{V} \qquad (3.1)$$

Where $\boldsymbol{\rho}$ is density, v and m in the above equation are representing volume and solution's mass respectively.

1) 3.1.7 Calculation of Apparent Molar Volume

Apparent molar volume is calculated by using following equation

$$\phi_v = \frac{M}{\rho o} + 1000\frac{(\rho o - \rho)}{C} \qquad (3.2)$$

You may get the apparent molar volume, M, the molecular weight of the solvent (v/v), and the maximum percentage of pure solvent used to calculate the solution's density (v/v) in equation (2). was determined by plugging the concentration (C) into equation (3.1).

2) 3.1.8 Calculation of Molar Concentration

A solution's molar concentration was determined by dividing its molecular weight by its volume, and the formula for this type of concentration is as follows:

$$C = \frac{\text{number of moles of solute}}{\text{solution's total volume}} \qquad (3.3)$$

B. Results and Discussions

1) 4.1 Density of Mixed Solvent Systems

a) 4.1.1 Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 303K

Table 4.1 shows the density values of cycloalkane-alcohol based non-aqueous systems for a full molar ratio range of 0% to 100% at 303K, as computed by equation (3.1).

Table 3 Dimensional Shift of Mixed Solvent Systems as a Function of Component Volume/Volume at 303K)

S No.	**Percentage Of Cycloalkane (v/v)**	**Density Of the Mixed Systems/ (g/mL)**	**Percentage of Alcohol (v/v)**
1	100.00	0.7980	0.00
2	96.16	0.7981	3.84
3	92.60	0.7984	7.40
4	89.30	0.7985	10.70
5	86.30	0.7990	13.70
6	83.40	0.7991	16.60
7	80.70	0.7992	19.30
8	78.20	0.7993	21.80
9	75.76	0.7994	24.24
10	73.60	0.8001	26.40
11	71.50	0.8006	28.50
12	69.50	0.8009	30.50
13	67.60	0.8011	32.40
14	65.80	0.8013	34.20
15	64.20	0.8016	35.80
16	62.50	0.8017	37.50
17	61.00	0.8020	39.00
18	59.60	0.8027	40.40
19	58.20	0.8031	41.80
20	56.90	0.8035	43.10
21	55.60	0.8037	44.40
22	54.40	0.8040	45.60
23	53.20	0.8052	46.80
24	52.10	0.8061	47.90
25	51.10	0.8088	48.90
26	50.00	0.8095	50.00
27	50.00	0.9440	50.00
28	48.90	0.9346	51.10
29	47.90	0.9211	52.10
30	46.80	0.9182	53.20
31	45.60	0.9103	54.40
32	44.40	0.8976	55.60
33	43.10	0.8967	56.90
34	41.80	0.8856	58.20
35	40.40	0.8787	59.60
36	39.00	0.8732	61.00
37	37.50	0.8582	62.50
38	35.80	0.8450	64.20

39	34.20	0.8410	65.80
40	32.40	0.8380	67.60
41	30.50	0.8356	69.50
42	28.50	0.8330	71.50
43	26.40	0.8300	73.60
44	24.24	0.8240	75.76
45	21.80	0.8230	78.20
46	19.30	0.8220	80.70
47	16.60	0.8190	83.40
48	13.70	0.8160	86.30
49	10.70	0.8150	89.30
50	7.40	0.8140	92.60
51	3.84	0.8126	96.16
52	0.00	0.8072	100.00

Graphical Representation of the Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 303K

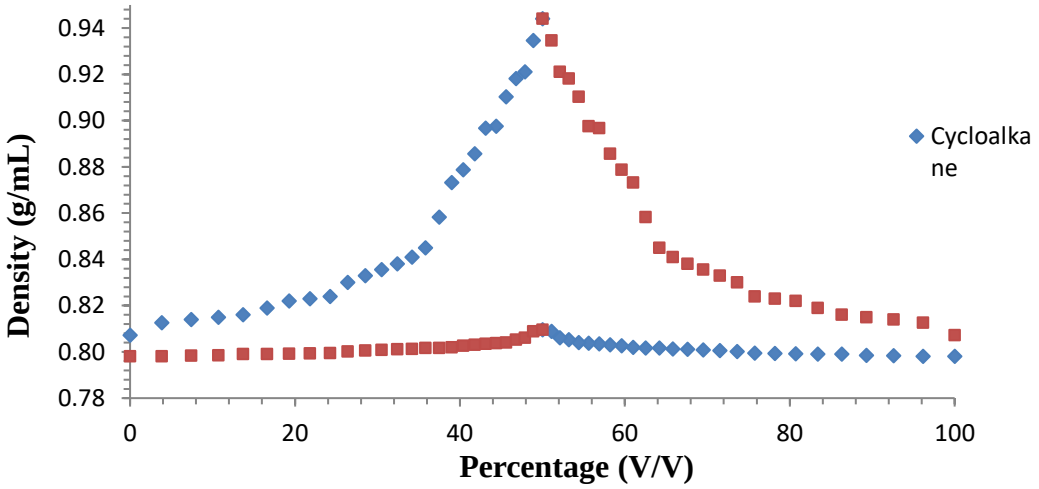

Figure 4.1 Graph showing change in Density of cycloalkane-alcohol based non aqueous systems(cyclohexane-Cyclohexanol) with respect to Percentage (V/V) of components of the systems at temperature 303K

As a function of the percentage (V/V) of components in the systems. The fact that cycloalkane and alcohol mix well at any concentration is seen in Figure 4.1. The data also shows that the density of the mixed systems increased when the alcohol content in the systems was gradually increased. The density was 0.7980 g/mL for pure cycloalkane (including no alcohol). On the other hand, the density of the mixed systems grew as the alcohol % rose.

Graphical Representation of the Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 307K

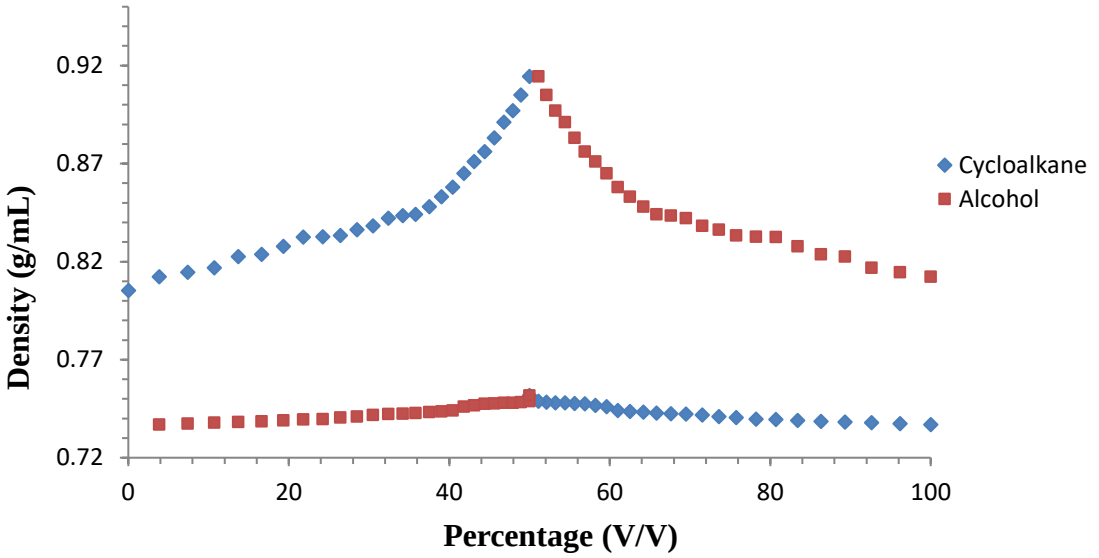

Figure 4.2 Graphical Representation of the Change in Density of Mixed Solvent Systems with

The system's density decreased to 0.8053 g/mL as a proportion of alcohol. Additionally, it shows that the density was 0.8053 g/mL when 100% alcohol was present (without any cycloalkane). However, density continued to rise up to 0.9144 g/mL as the fraction of cycloalkane in the mixed systems was gradually increased, and then began to decrease up to 0.7369 g/mL. The systems' densities were found to be maximal at a ratio of 50% cycloalkane to alcohol. It is possible that the development of some sturdy structures is responsible for this growth. increased the density of the systems.

b) 4.1.3 Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 310K

Table 4.3 displays the density values of cycloalkane-alcohol based non-aqueous systems, which were calculated at 310K using equation (3.1) for a complete molar ratio ranging from 0% to 100%.

Graphical Representation of the Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 310K

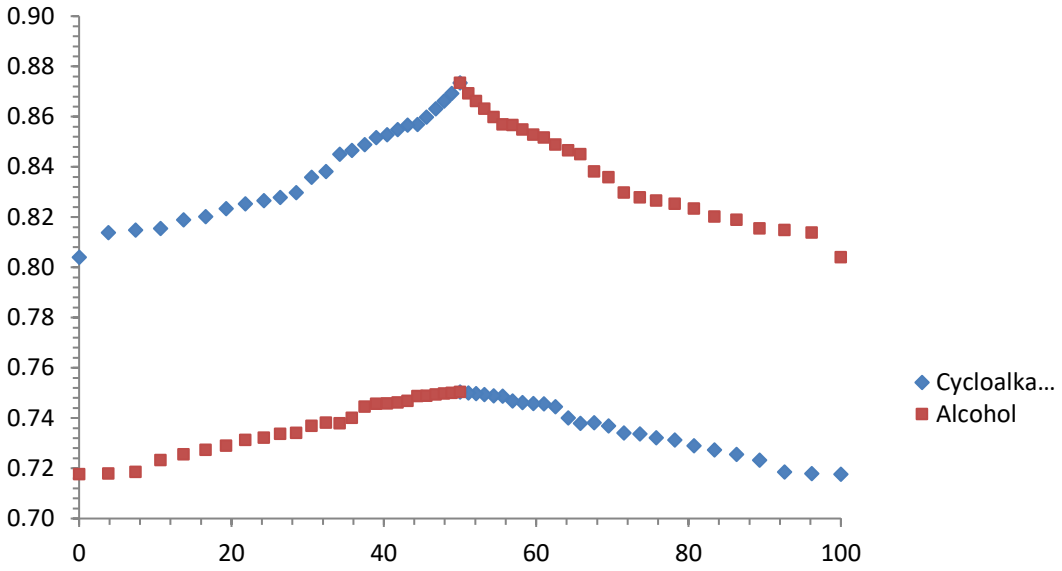

Figure 4.3 (At 310 K, the graph displays the ratio of the volume percentage of the components to the density of cycloalkane-alcohol based non-aqueous systems (cyclohexane-cyclohexanol).

Results comparable to those in Figure 4.1 and Figure 4.2 are shown in Figure 4.3. Specifically, it shows that with the level of system density was seen to be rising over time as a function of alcohol % in mixed systems. The density of pure cycloalkane (containing no alcohol) was 0.7176 g/mL. Density, however, continued to rise up to 0.7504 g/mL as the alcohol content was raised in the systems. It also shows that the density was 0.8040 g/mL for alcohol alone, without any cycloalkane. In systems where cycloalkane was added at a percentage, the density kept going rise until it reached 0.8734 g/mL. It was noted that the system density peaked at 50% cycloalkane and alcohol and then decreased after that. The intermolecular forces exerted by the interactions between the alcohol and cycloalkane molecules may account for this rise. At 50%, these forces were most prominent, which makes mixed systems denser.

Graphical Representation of the Comparison of the Change in Density of Mixed Solvent Systems with Percentage (V/V) of Components of the Systems at 303, 307 and at 310K

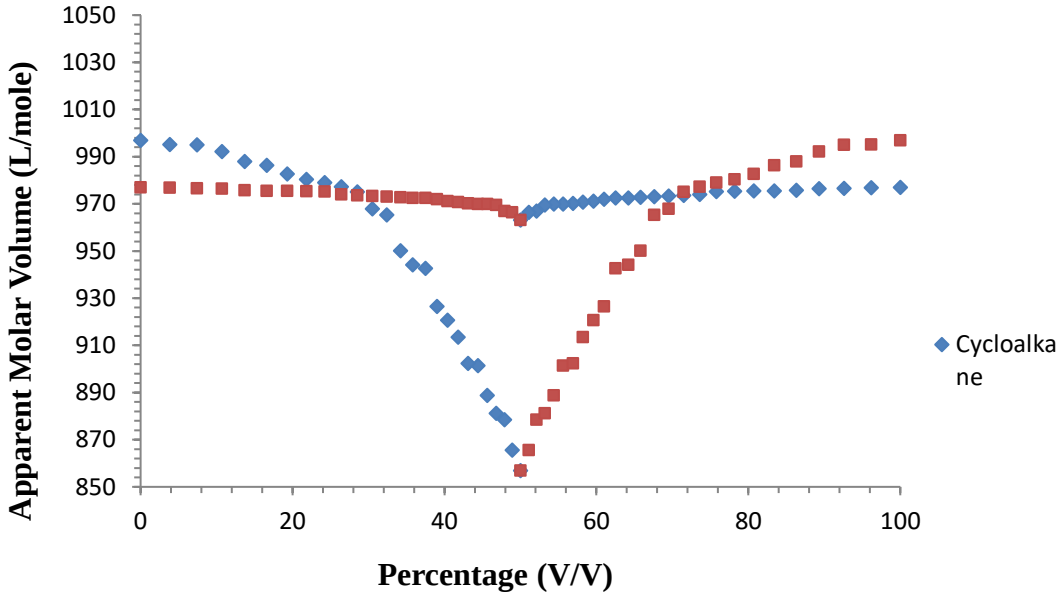

Figure 3.4 Graph showing change in Density of cycloalkane-alcohol based non-aqueous systems (cyclohexane-cyclohexanol) with respect to Percentage (V/V) of components of the systems at temperature 303K, 307K, and 310K

Figure 4.4 Graph illustrating the relationship between the percentage (V/V) of the system's components and the change in apparent molar volume at 303K for mixed solvent systems At 303K, with no alcohol present, the apparent molar volume was 976.91 L/mole, as shown in Figure 4.9. However, the apparent molar volume kept going down until it reached 963.10 (L/mole) as the alcohol percentage was raised. When there was only alcohol (zero cycloalkane), a similar pattern emerged. As the proportion of cycloalkane in the mixtures increased, the apparent molar volume dropped from 996.91 (L/mole) to 856.86 (L/mole). One possible explanation is that the number of intermolecular interactions has increased.

with the gradual increase of the components in the systems. So, because of these interactions density was may be increased that resulted in the decrease of the apparent molar volume.

2) 4.3.2 Change in Apparent molar Volume of Mixed Solvent Systems with Percentage (V/V) of the Components of the Systems at 307K

Graphical Representation of the Change in Density of the Mixed Systems with Mole Fraction of the Components of the Systems at 303K

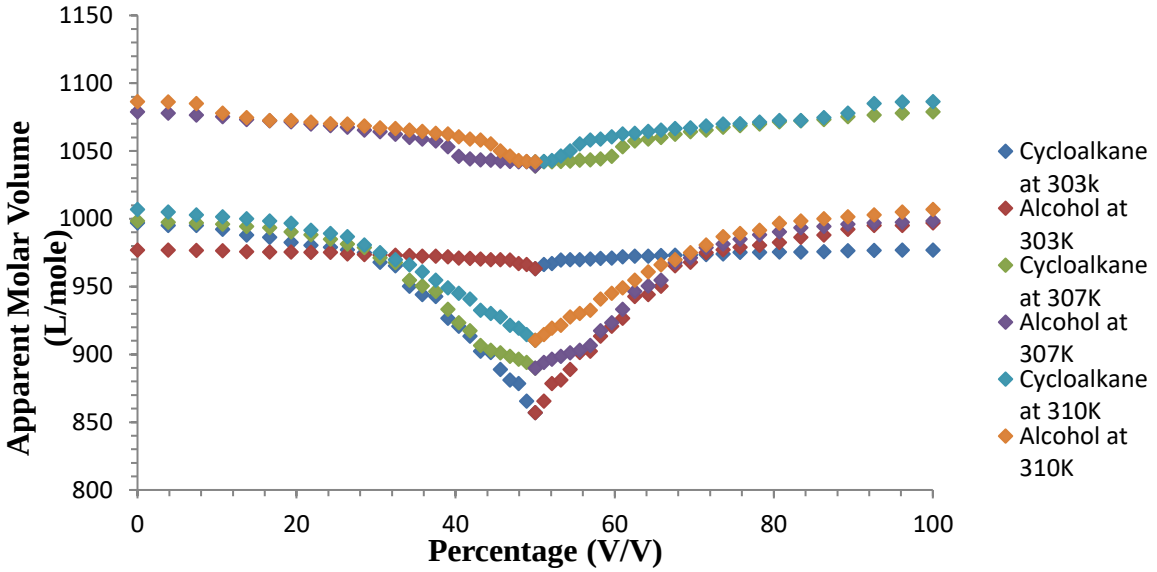

Figure 4.5Graph showing the change in the density of the mixed solvent systems with the Mole Fraction of the Components of the Systems at 303K

Figure 4.5 shows that at 303K when mole fraction of cycloalkane was 1 and that of alcohol was 0 then the density of the systems was 0.7980 g/mL. It indicates that with the increase in the mole fraction of alcohol into the mixed systems, the density of the systems continued to increase upto 0.8095 g/mL. But with the further increase in the mole fraction of alcohol into mixed systems, density of the systems was observed to be decreased. It further illustrates that when the mole fraction of alcohol was 1 and that of cycloalkane was 0, density of the systems was 0.8072 g/mL. It shows that with the increase in the mole fraction of cycloalkane into the mixed systems, the density continued to increase upto 0.9440 g/mL. but after that point the density of the systems continued to decrease upto 0.7980 g/mL. The increase in the density could be because of some intermolecular interactions between the molecules of cycloalkanes and alcohol. Because of these forces there could be the formation of some stable structures which has increased the density of the systems.

Graphical Representation of the Change in Density of the Mixed Systems with Mole Fraction of Components of the Systems at 307K

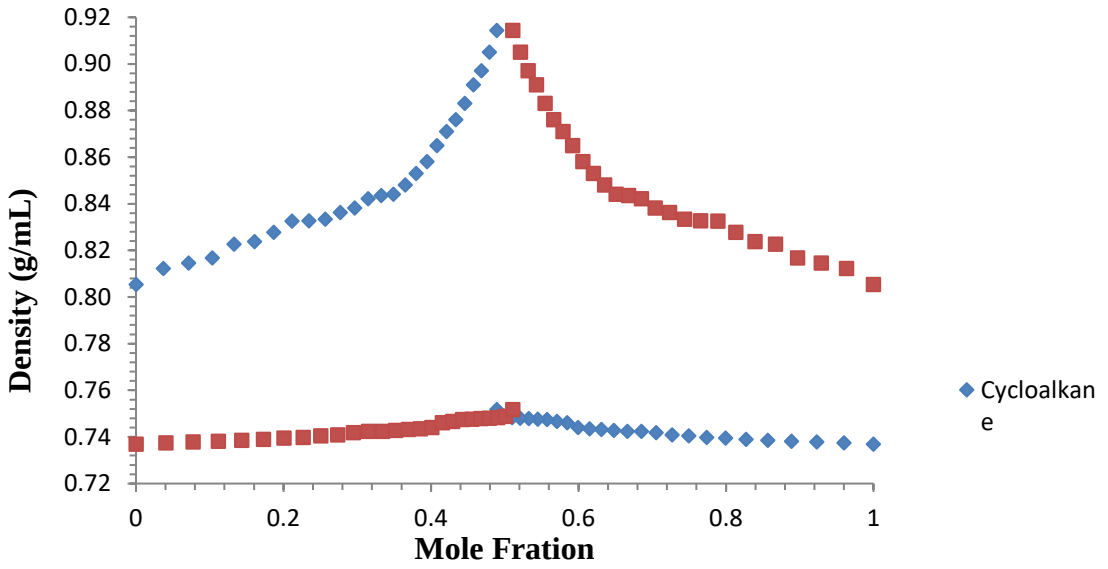

Figure 4.6 Graph showing the change in the density of the mixed solvent systems with the Mole Fraction of the Components of the Systems at 307K

Figure 4.6 show that at 307K when mole fraction of cycloalkane was 1 and that of alcohol was 0 then the density of the systems was 0.7369 g/mL. It indicates that with the increase in the mole fraction of alcohol into the mixed systems, the density of the systems continued to increase upto 0.7517 g/mL. But with the further increase in the mole fraction of alcohol into mixed systems, density of the systems was observed to be decreased. It further illustrates that when the mole fraction of alcohol was 1 and that of cycloalkane was 0, density of the systems was 0.8053 g/mL. It indicates that with the increase in the mole fraction of cycloalkane into the mixed systems, the density continued to increase upto 0.9144 g/mL. but after that point the density of the systems continued to decrease upto 0.7369 g/mL. The increase in the density could be because of some intermolecular interactions between the molecules of cycloalkanes and alcohol. Because of these forces there could be the formation of some stable structures which has increased the density of the systems.

Graphical Representation of the Change in Density of the Mixed Systems with Mole Fraction of Components of the Systems at 310K

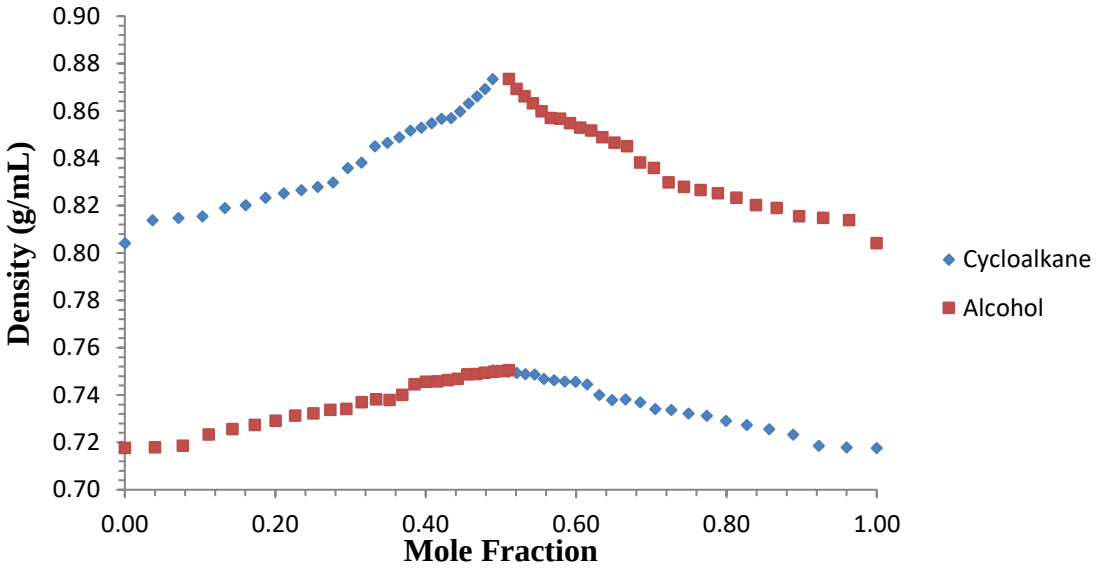

Figure 4.7 Graph showing the change in the density of the mixed solvent systems with the Mole Fraction of the components of the systems at 310K

Figure 4.7 illustrates that at 310K there is similar trend in the change of density with the mole fraction of the components. When mole fraction of cycloalkane was 1 and that of alcohol was 0 then the density of the systems was 0.7176 g/mL. It indicates that with the increase in the mole fraction of alcohol into the mixed systems, the density of the systems continued to increase upto 0.7504 g/mL. But with the further increase in the mole fraction of alcohol into mixed systems, density of the systems was observed to be decreased. It further illustrates that when the mole fraction of alcohol was 1 and that of cycloalkane was 0, density of the systems was 0.8040 g/mL. It indicates that with the increase in the mole fraction of cycloalkane into the mixed systems, the density continued to increase upto 0.8734g/mL. But after that point the density of the systems continued to decrease upto 0.7176 g/mL. The increase in the density could be because of the formation of some stable structures which has increased the density of the systems as discussed before in Figure 4.5 and 4.6.

Graphical Representation of the Comparison of the Change of Density of the Mixed Systems with Mole Fraction of Components of the Systems at 303, 307 and 310K

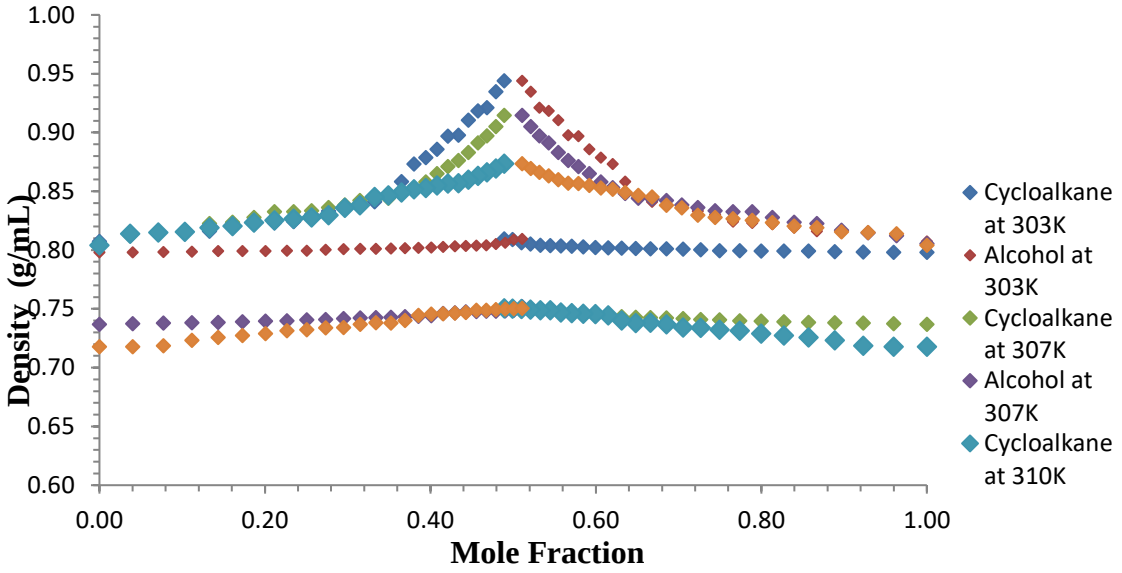

Figure 4.8 Graph showing the change in the density of the mixed solvent systems with the Mole Fraction of the Components of the systems at 303, 307 and 310K

Figure 4.8 shows that at low temperature the density of the mixed systems is maximum as compared to the high temperature. It indicates that at 303K the density of the mixed systems was high but at 307 and 310K density was low respectively. It could be because of volume expansion at the high temperature.

Graphical Representation of the Change in Apparent molar Volume of Mixed Solvent Systems with Percentage (V/V) of the Components of the Systems at 303K

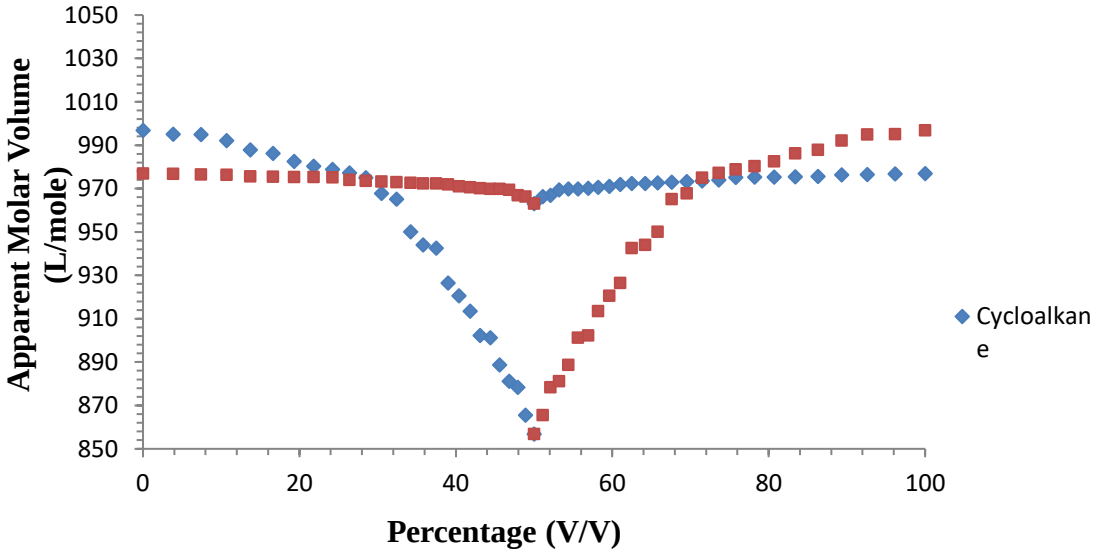

Figure 4.9 Graph showing change in Apparent Molar Volume of mixed solvent systems with Percentage (V/V) of the components of the systems at 303K

Figure 4.9 illustrates that at 303K when there was pure cycloalkane (with 0% alcohol), the apparent molar volume was 976.91 (L/mole). But as the percentage of alcohol was gradually increased, the apparent molar volume

continued to decrease upto 963.10 (L/mole). Similar trend was observed when there was pure alcohol (with 0% cycloalkane). The value of apparent molar volume at that point was 996.91 (L/mole), which continued to decrease upto 856.86 (L/mole) with the increasing percentage of cycloalkane in the mixed systems. This could be because of increase in the intermolecular interactions with the gradual increase of the components in the systems. So, because of these interactions density was may be increased that resulted in the decrease of the apparent molar volume.

Graphical Representation of the Change in Apparent molar Volume of Mixed Solvent Systems with Percentage (V/V) of the Components of the Systems at 307K

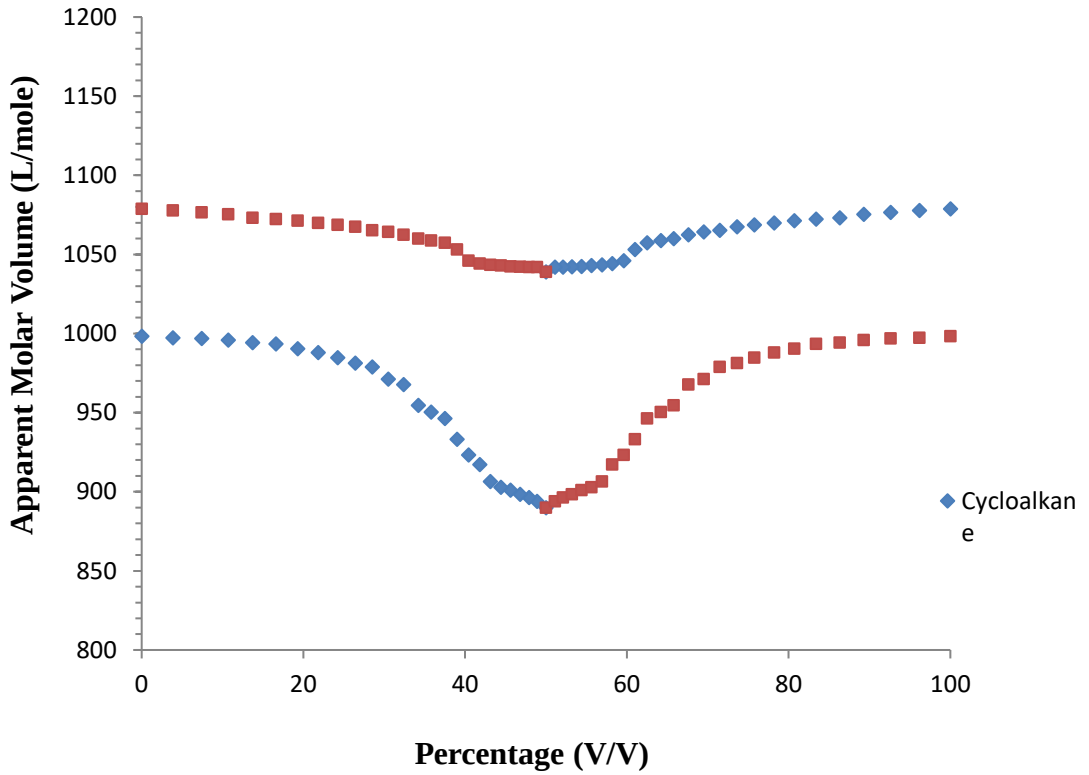

Figure 4.10 Graph showing change in Apparent Molar Volume of mixed solvent systems with Percentage (V/V) of the components of the systems at 307K

Figure 4.10 illustrates that at 307K when there was pure cycloalkane (with 0% alcohol), the apparent molar volume was 1078.86 (L/mole). But as the percentage of alcohol was gradually increased, the apparent molar volume continued to decrease upto 1039.05 (L/mole). Similar trend was observed when there was pure alcohol (with 0% cycloalkane). The value of apparent molar volume at that point was 998.28 (L/mole), which continued to decrease upto 889.89 (L/mole) with the increasing percentage of cycloalkane in the mixed systems. The reason for their increase has been already discussed in Figure 4.9.

Graphical Representation of the Change in Apparent molar Volume of Mixed Solvent Systems with Percentage (V/V) of the Components of the Systems at 310K

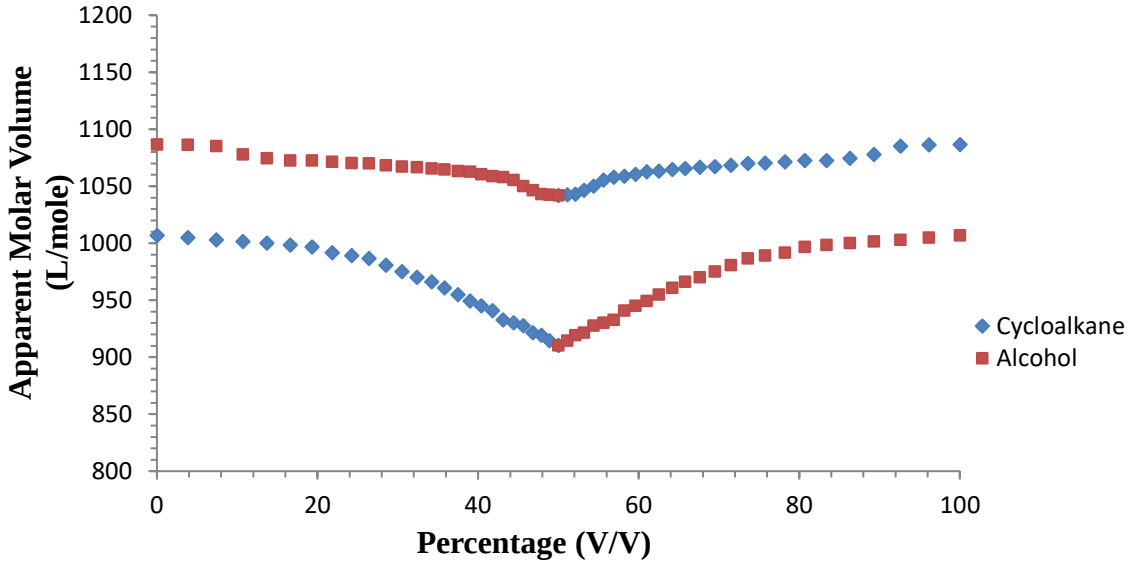

Figure 4.11 Graph showing change in Apparent Molar Volume of mixed solvent systems with Percentage (V/V) of components of the systems at 310K

Figure 4.11 indicates the similar results as were observed in Figure 4.9 and in Figure 4.10. It shows that when there was pure cycloalkane (with 0% alcohol) then the apparent molar volume was 1086.37 (L/mole). But as the percentage of alcohol was gradually increased, the apparent molar volume of the mixed systems was decreased that continued to decrease upto 1041.98 (L/mole). Same trend was observed when there was only pure alcohol and the percentage of cycloalkane was gradually increased which in turn decreased the apparent molar volume. The reason for this decrease has already been discussed above in Figure 4.9.

Graphical Representation of the Change in Apparent molar Volume of Mixed Solvent Systems with Percentage (V/V) of the Components of the Systems at 303, 307 and at 310K

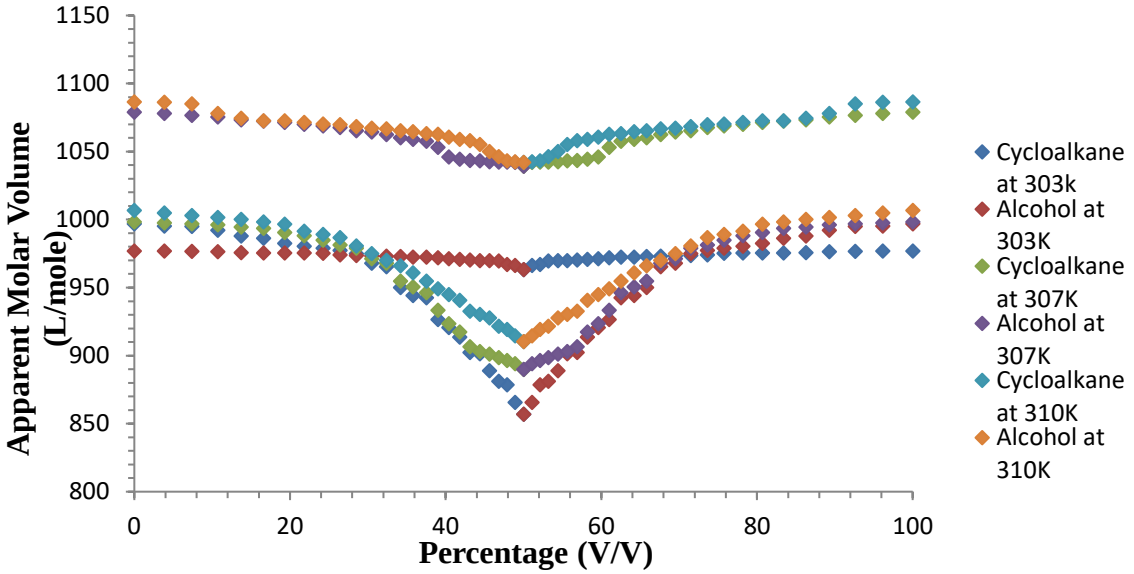

Figure 4.12 Graph showing change in Apparent Molar Volume of mixed solvent systems with Percentage (V/V) of components of the systems at 303, 307 and at 310K

Figure 4.12 indicates that apparent molar volume goes on increasing with the increasing temperature. It can be seen that apparent molar volume was high at 310K as compared to 307 and 303K respectively. It could be because of volume expansion at the high temperature.

IV. Conclusion

The study of density and apparent molar volume changes in mixed cycloalkane-alcohol systems at temperatures of 303K, 307K, and 310K reveals several important insights. As the percentage of alcohol increases in the cycloalkane-alcohol mixtures, density generally increases until a peak is reached at 50% alcohol, after which it decreases. This trend is consistent across all temperatures studied. The maximum density is observed at 303K, indicating that higher temperatures lead to a decrease in density due to volume expansion. Apparent molar volume decreases with increasing alcohol or cycloalkane concentration at all temperatures, with the most significant changes occurring at 307K and 310K. This pattern reflects the interplay of intermolecular interactions and volume changes. Overall, the results underscore the temperature dependence of these properties and highlight the complex relationship between component concentration and system density and volume.

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