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Measurement of Conductance of $FeCl_3$ in Distilled Water at Different Temperature and Concentration

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Abstract

Precise measurement of the conductivity of $FeCl_3$ in distilled water at 303.15 and 308.15 K temperature were measured. The specific conductivities exhibited a sharp increase with increase in concentration within the concentration range investigated (0.001 to 0.100 mol per liter. The decrease in the conductance with decrease in concentration is due to decrease in the number of ion per unit volume of the solution. Also decrease in conductance with decrease increase in temperature due to decrease in the speed of the ions.

Key Words: conductivity, $FeCl_{3,}$ distilled water, temperature

Introduction

$FeCl_3$ is the iron (lll) chloride. It is the inorganic compound called ferric chloride. It is the anhydrous compound, crystalline solid, having the melting point 307.6^{0}C. It is slightly soluble in water. It is noncombustible it is a common compound of iron in the +3 oxidation state. The color depends on the viewing angle: by reflected light the crystals appear dark green, but by transmitted light they appear purple-red. When wet it is corrosive to aluminum and most metals. Pick up and remove spilled solid before adding water.It is also used as a leaching agent in chloride hydrometallurgy (park et al. 2006) for example in the production of Si from FeSi (Silgrain process, Duenas, et al. 2006) Another important application of iron (III) chloride is etching copper in two-step redox reaction to copper (I) chloride and then to copper (II) chloride in the production of printed circuit boards (Greenwood et al. 1997). Iron (III) chloride is used as catalyst for the reaction of ethylene with chlorine, forming ethylene dichloride (1,2-dichloroethane), an important commodity chemical, which is mainly used for the industrial production of vinyl chloride, the monomer for making PVC.

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Iron (III) chloride is harmful, highly corrosive and acidic. The anhydrous material is a powerful dehydrating agent. Although reports of poisoning in humans are rare, ingestion of ferric chloride can result in serious morbidity and mortality. Inappropriate labeling and storage lead to accidental swallowing or misdiagnosis. Early diagnosis is important, especially in seriously poisoned patients.

The ferric chloride test is a traditional colorimetric test for phenols, which uses a 1% iron (III) c.hloride solution that has been neutralised with sodium hydroxide until a slight precipitate of FeO (OH) is formed (Furniss et al. 1989) The mixture is filtered before use. The organic substance is dissolved in water, methanol or ethanol, then the neutralised iron (III) chloride solution is added—a transient or permanent coloration (usually purple, green or blue) indicates the presence of a phenol or enol. This reaction is exploited in the Trinder spot test, which is used to indicate the presence of salicylates, particularly salicylic acid, which contains a phenolic OH group. This test can be used to detect the presence of gamma-hydroxybutyric acid and gamma-butyrolacton (Zhang et al. 2006) which cause it to turn red-brown.

In solvent of low dielectric constant, having the low ionizing effect on the salt, the electrostatic force between oppositely charged ions would be appreciable and conductance value will have small value. However, solvent have high dielectric constants yield more conducting solutions, the conductivity of $FeCl_3$ increases with increasing temperature of distilled water. The rise in conductance with temperature is due to the decrease in the viscosity of the solution, increases in the speed of the ions and an increase in the degree of ionization. In other word, the fall in conductance with temperature is due to the increase in the viscosity of the solution, decrease in the speed of the ions and an decrease in the degree of ionization.

In solvent media (at 303.5K) of low dielectric constants, having small ionizing effect on the electrolyte, the electrostatic force between oppositely charged ions would be appreciable and conductance value will have small value. However, In solvent media (308.5K) have high dielectric constants yield more conducting solutions, the conductivity of $FeCl_3$ increases with increasing temperature.

Earlier, the transport properties of have been investigated (Bhattarai et. al. 2007) for a poly electrolyte in methanol-water mixed solvent media. The experimental data was analyzed by manning model and found the lower value than experimental ones. Later on (Bhattarai 2008) used the scaling theory approach and obtaining good fitting with experimental data.

It is used to treat sewage, industrial waste, to purify water, as an etching agent for engraving circuit boards, and in the manufacture of other chemicals.

Methods and Materials

$FeCl_3$ employed in these investigations was purchased from Ranbaxy Chemical Company, Inc,, India. Conductance measurements were carried out on a Pye-Unicam PW 9509 conductivity meter at a frequency of 2000 Hz using a dip-type cell with a cell constant of 1.15 cm^{-1} and having an uncertainty of 0.01%. The cell was calibrated by the method of Lind and co-workers, 1959 using aqueous potassium chloride solution. The measurements were made in a water bath maintained within ± 0.005 K of the desired temperature. Several independent solutions were prepared and runs were performed to ensure the reproducibility of the results. Recorrection was made for the specific conductance of the solvent by subtracting the specific conductance of the relevant solvent medium from those of the electrolyte solutions.

In order to avoid moisture pickup, all solutions were prepared in a dehumidified room with utmost care. In all cases, the experiments were performed in same ways.

Fig 1 : *Arrangement of instrument in Lab*

Data analysis

The experimental data of specific conductance and concentration of $FeCl_3$ salt solution at 303. 15K and 308.15 k in distilled water were measured in chemistry lab in Dhankuta multiple campus Dhankuta, Nepal.

At 30^0C temperature		At 35^0C temperature	
Concentration/M	Sp.Conductance ($S.cm^{-1}$)	Concentration/M	Sp. Conductance ($S.cm^{-1}$)
0.05	13.1	0.05	15.2
0.045	11.4	0.045	13.2
0.041	9.9	0.041	11.6

0.038	8.6	0.038	10.2
0.035	7.5	0.035	8.9
0.033	6.5	0.033	7.8
0.031	5.7	0.031	6.7
0.029	4.9	0.029	5.9
0.027	4.2	0.027	5.1
0.026	3.6	0.026	4.4
0.025	3.1	0.025	3.8
0.023	2.7	0.023	3.3
0.022	2.3	0.022	2.8
0.021	1.9	0.021	2.4
0.02	1.7	0.02	2.1
0.019	1.1	0.019	1.8
0.018	0.9	0.018	1.5
0.017	0.8	0.017	1.2
0.016	0.5	0.016	1

Results and Discussion

The experimental specific conductivity of $FeCl_3$ as a function of salt concentration (C_s) at 303.15 and 308.15 K in distilled water are depicted in figures. 2-3. From these figures it is evident that the specific conductivity exhibited a sharp decrease with decrease in concentration within the concentration range investigated here. The increase in the conductance with increase in concentration due to an increase in the number of ions per unit volume of the solution.

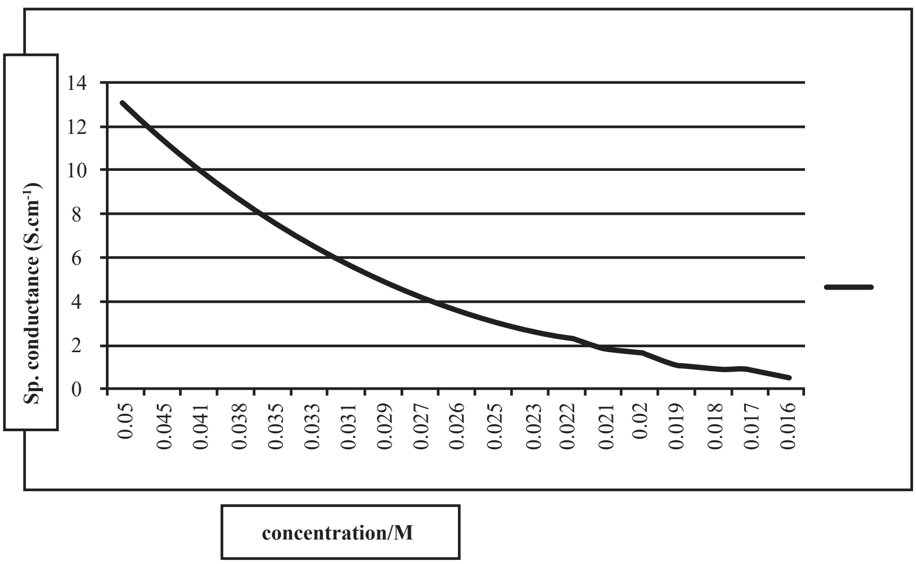

Fig. 2: *Specific conductivities of, as a f $FeCl_3$ function of salt concentration (C_s) in 303.15 K in distilled*

Fig. 2 indicates that variation of specific conductivity with dilution at 303.15K. Specific conductivity of $FeCl_3$ in distilled water is the conductance due to all the ions present in one centimeter cube of the solution. As the solution is diluted, the number of ions per centimeter cube decrease. So specific conductivity decrease with dilution.

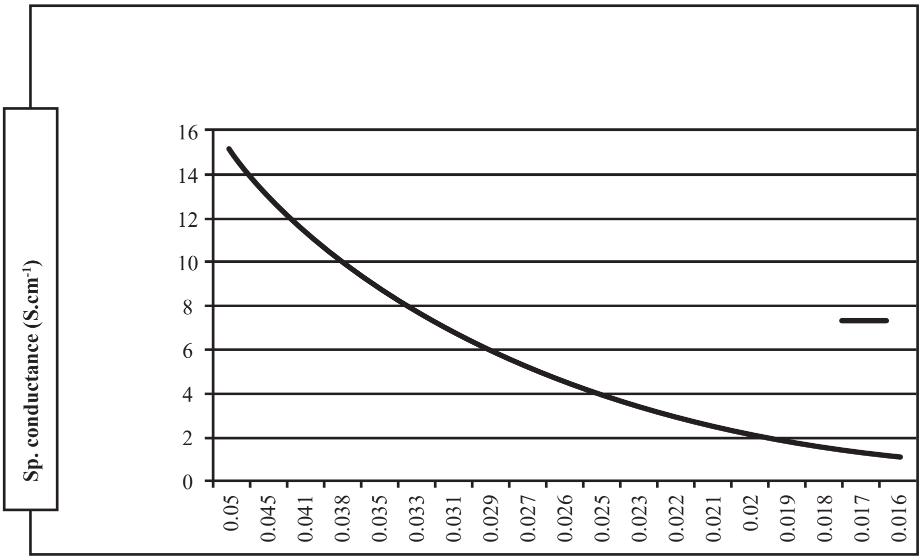

Fig. 3: *Specific conductivities of f $FeCl_3$ function of salt concentration (C_s) in 308.15 K in distilled water*

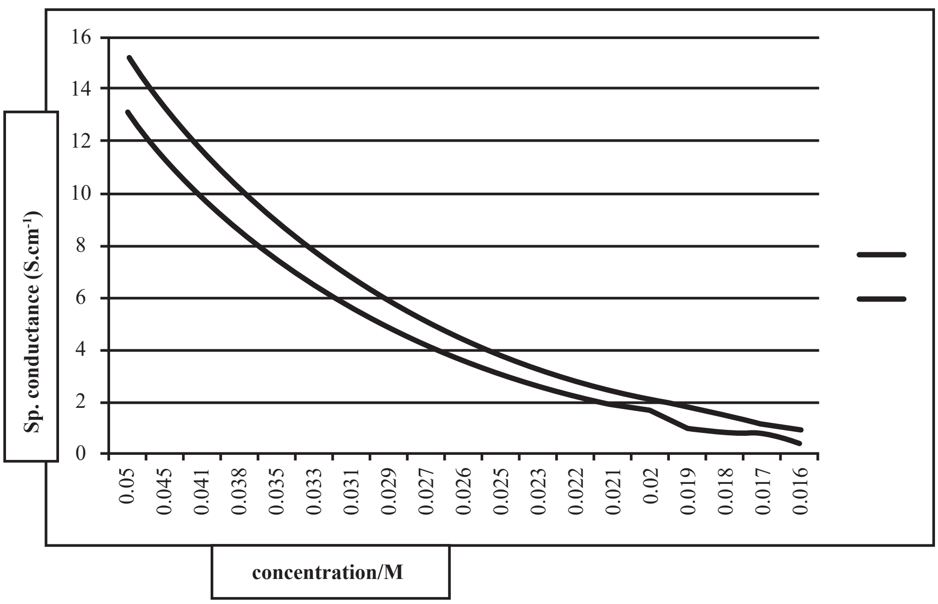

Fig. 4: *Variation of specific conductivities of $FeCl_3$ in different temperature*

Variation of specific conductivities of $FeCl_3$ in different temperature **(red colour or lower**) line at 303.15K and **(blue colour or upper**) line at 308.15K). Fig. 4 indicates that Specific conductivity of decreases $FeCl_3$ with decreasing temperature of distilled water. The fall in Specific conductivity valu with decreasing temperature is due to the increase in viscosity of the solutions, decrease in speed of the ions. Specific conductance of $FeCl_3$ decreases with decrease in the concentration of electrolyte solution at particular temperature as shown figures 2 and 3 . This is due to the decrease in the number of ions of electrolyte per unit volume of solution. It is also observed that **(Figure 4)** the specific conductance values decrease with the decrease in the temperature of the solution. This may be attributed due to decrease in the kinetic energy of ions on decrease in the temperature.

Conclusion

Effect of concentration and different temperature in distilled water have been study by measuring the specific conductance through conductrometric method. The following conclusions have been drawn from above result and discussion. The conductance decrease with decrease in concentration and conductance decrease with decrease in temperature or vice versa.

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