

# Dielectric relaxation time behavior of complexed spores: A modified equation for relaxation time

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**Abstract** - A study deals with “Dielectric relaxation time behavior of complexed sporis: A modified equation for relaxation time.” The theory was determination of relaxation time of regard polar molecule gives an average effect representing that over all relaxation. The method was studied that experimental theory of dielectric relaxation behaviour of modified equation of Complexed species for relaxation time. The result was formed that individual molecules, Pyridine pyrrole, Quinaline pyrrole, and Quinaline Pyridine indole, also dielectric the experimental of thermodynamics parameter's etc.

**Keywords:** Dielectric relaxation behaviour, Complexed species, relaxation time, Individual molecules, Pyridine pyrrole, Quinaline pyrrole, and Quinaline Pyridine indole, Experimental theory etc.

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## INTRODUCTION

A single frequency mode propagating during relaxation of a rigid polar molecule displays an average effect representing the overall relaxation. However, Higashi's method is able to resolve dispersions in two separate relaxation processes linked by group and molecular rotation.

Evaluation based on the above techniques gives effective information about the qualitative behaviors of molecules under applied fields. Schlamach's investigation of binary mixtures as a function of temperature at certain frequencies shows that dielectric relaxation involves,

They are indicative of a process such as single solvation in a relatively large area liquid, provided that the polar components are associative or non-associative. 'Many workers' reports two relaxation processes in binary identical mixtures with components having relaxation times on substantially different paths.<sup>1</sup> Study of different types of H-bond complexes (N-N) inside polystrum matrix, other ones that the results are interpreted in terms of parameters on enthalpy (Shukla et. al., 2011).

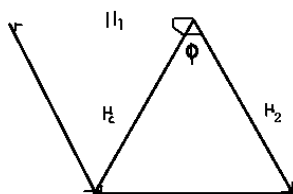
Recently Haian (2016) proposed an empirical relationship for the apparent relaxation time ( $\tau_2$ ) of non-associating binary mixtures consisting of pyridine, quinoline and quinoline molecules in n-heptane and benzoin solutions is proposed.

The calculation of the proposed relation presents a single agreement with experimental relaxation time values (1) in binary mixtures. Nadan's relation has satisfactory results for non-cooperative systems, in which interactions are neglected for small distances.

The components here are of associative nature, capable of forming complexes through H-bonding/charge transfer, this type of bonding has to be observed in the other dipoles associated with the relaxation phenomenon. Further comment and further modification.<sup>3</sup> With this view the Four types of rigid molecules, namely pyrrole, quinoline, pyridine, and indole and their complexes, were found by dielectric measurements in extended solution. A modified relation was suggested and the apparent relaxation time was found to be determined using the modified equation. Thus, a good agreement was observed between experimental and calculated relaxation times evaluated by thermodynamic parameters.

Theory- It is of great importance to study the relaxation behavior of binary mixtures capable of forming a complex as well as developing adequate models to fit the experimental and relaxation data.

Apparent relaxation time ( $\tau_2$ ).



See: Representation of bond formation in Complexes

For the binary mixture system comprising of right polar molecules in a non-polar solvent, was given by

$$1/r_s = 1_1 A_1 / r_1$$

In this,  $A_1$  represents the factors affecting size and shape, fractional volume viscosity, solvent-solute interaction and the rearrangement state on the dipole of a component.<sup>4</sup> Neglecting, the solutions ignoring the solute-solvent interactions of the probe and consider that the contribution to a different particular relaxation mechanism depends on the class's dipole moments. ( $\mu_1$ ),  $A_1$  may be given by,

$$A_1 = c_1 \mu_1^2 / (1_1 c_1 \mu_1^2)$$

Here  $C_1$  has represents the parameters involved and effects on dipole moment of  $A_1$  and solute-solvent interactions. The  $\mu_1$  and  $\mu_2$  non-associative of the simplest raiding on binary mixtures, eqn. will take the form-

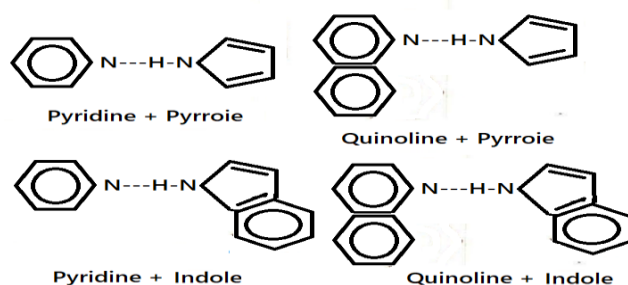
$$\frac{1}{r_a} = \frac{1}{r_1} \frac{c \mu_1^2}{c \mu_1^2} + \frac{1}{r_2} \frac{\mu_1^2}{c \mu_1^2 \mu_2^2}$$

$C$ , being the ratio of molecular concentrations ( $C_1/C_2$ ) of the 2-constituents first and second; corresponded to dipole-moment and its values-  $\mu_1$  and  $\mu_2$ , ' $C$ ' found the unities for their molecules on comparable sizes of binary mixtures.

The results of the two component vectors of dipole moments in a binary complex formed in solution by a concentration ratio of 1:1 in molar can also be represented in the vector:  $\mu_2 a = \mu_1^2, \mu_2^2 / 2 + 2 \mu_1 \mu_2 \cos \phi$   $\phi$  has been adopted and "Magee and Walker" case study 'C'-'H'-'N' bonds complexes for amine (acid) molecules towards chloroform and amine this bonds are considered to be the angle between the vectors. The units  $2 \mu_1 \mu_2 \cos \phi$  a factors of association formed between groups in a single system are represented.

**RESULTS**

Four very rigid micromolecules in binary complexes like pyridine and quinoline, pyrrole indole were investigated in dilute permittivity data)  $c''$ , dielectric constant,  $c''$ , dielectric lese) at 9.0 GHs of individual and complex molecules.



Pyridine=(.089-.168)`` , Quinoline= (.106-.230)`` ,  
Pyrrole=(.125-.210)`` , Indole=(.149-.183)`` ,

Pyridine + Pyrrole=(.084-.153)``

Quinoline + Pyrrole=(.072-.135)``

Quinoline + Indole=(.128-.149)``

Pyridine + Indole=(.068-143)``

If under ideal conditions and in the absence of any other contribution, the complex species in the binary form resulting from H-bonding between units is considered to be an approximate sum of the relaxation times of individuals, then it can be said that the relaxation times are twin moments. stacks for binary system complexes of represented equation.

solutions of non-polar solvent, cyclohexane. The binary mixtures are

- (a) Pyridine+Pyrrole
- (b) Quinoline+Pyrrole
- (c) Quinoline+Indole
- (d) Pyridine+Indole

A ratio there molar concentrations in the different component (molecules) by weight fractions has been 1:1 to this cyclohexane build up ranges of the temperature 295 to 323K. So the permittivity range ( $c'$  &  $c''$ ) has the systems to measure on ONE band 9.80GHz and another RH/76/ tech., further, modified by DW /79/.<sup>6</sup> & were measured using dipolemeter and Abbe refractometer respectively.

The permittivity data ( $c'$  and  $c''$ ) at s-band of investigated molecules and binary complexes are reported. The slopes are in relaxation parameters of individual molecules ( $10, f_y$  and  $F_{ox}$ ) has distribution to a functions and dipole the moment value on the high range and reports the experimental relaxation times and the relaxation times (52) range from propose relations. Finally, the thermodynamical parameters (APA and AS) of complexed species calculated using OH and  $2 \mu_1 \mu_2 \cos \phi$  data have been reported.

**DISCUSSION**

**Individual molecules-**The finding discussion on observed in relaxation-times also individuals the molecule was found that general agreement each substance. The observed-on values of pyridine quinoline at 303K are found to be in agreement with those of 3.5 ps and 6.3 ps respectively, reported earlier by M/125/. The relaxation time of pyrrole-4.8 ps at 303K appeared to be longer than the earlier reported values.

**Pyridine + Pyrrole-** The observed dielectric relaxation time (6.5 ps) and  $\epsilon''$  (7.7 ps) at 303 K are generally in agreement. It may be seen that these relaxation times values are higher than those of the components forming the complex. A small distribution to the dielectric  $\epsilon''$  (0-0.55) observed for the above system indicates that the main contribution to the dielectric dispersion is due to the complexed species.

The apparent relaxation time of 4.6, 6.6 and 6.0 ps evaluated using G.Krishna, Hignal and Fröhlich equations are also in good agreement except in the case of the data calculated using  $T_q$ , being slightly shorter than the other two values. These data when compared with the experimental values as indicated above exhibit a good agreement.

**Quinoline + Pyrrole-** For this system also, the observed low values of  $\epsilon''$  (0.01-0.03) indicate that the dispersion occurs mainly due to the complexed species. The average relaxation times  $T_0$  (20.5 ps),  $\tau_{OH}$  (12.6 ps) and  $\tau_p$  (12.3 ps) at 305°, are in close agreement. These experimental values may be compared with the apparent relaxation time  $\tau$  calculated using the proposed relation. The  $\tau$  of 12.5, 14.5 and 12.0 ps determined using individual values of  $T_0$ ,  $\tau_{OH}$  and  $\tau_p$  of the component molecules of 303 K, exhibit fairly good agreement with the experimental data.

**Quinoline + Indole-** Low value of  $\epsilon''$  (0.01-0.08) for this system also indicates that the dielectric absorption occurs due to only rotational motion, possibly from the dipolar rotation of the complexed species. At 303 K, the experimentally observed  $\tau_{OH}$  (19.8 ps) and  $\tau_p$  (16.6 ps) were values of  $\tau$  (18.6 ps), in excellent agreement with the apparent relaxation time parameters of 18.4, 18.6 and 16.4 ps calculated using the component values of  $T_0$  and  $\tau_p$  respectively.  $\epsilon''$  seen from table 6.4, the average relaxation times  $\tau$  observed from G. Krishna, Higasi and Fröhlich equations are also in good agreement. This indicates the validity of the proposed equation for apparent relaxation time of a complexed system formed due to hydrogen bonding. This has been found true at nearly all other temperatures.

**Pyridine + Indole-** The complexed species formed due to hydrogen bonding between the pyridine and indole molecules yielded a distribution function in the range of 0.16 to 0.23, which indicates some type of associative behaviour, perhaps exhibited by indole. The dielectric relaxation times  $\tau$ ,  $\tau_{OH}$  and  $\tau_p$  obtained from the complexed species were found to be 8.0 ps, 9.6 ps and 10.1 ps respectively, showing an

agreement under the associative behaviour of the component molecules. The apparent relaxation time values of 7.0 ps may be compared with so of 3. ps.  $\tau_{OH}$ , of 6.7 ps with  $\tau_p$  of 9.6 ps and 5 of 9.1 ps with  $\tau$  of 10.1 ps exhibits a fairly good comparison between the calculated and observed data of the relaxation time.

It may be that for all the four complexed species investigated here, the experimental and the calculated relaxation times of the complexed system are much longer than the relaxation times of the constituent components, indicating the formation of complexed species capable of exhibiting independent dispersion. It may however be noted that in general the observed relaxation times of the complexed species are not equivalent to the sum of the individual relaxation times due to the components. Relaxation time data for quinoline + indole gives a relaxation time comparable in terms of the sum of relaxation time values of individual molecules.<sup>7</sup>

**Thermodynamical parameters-** In order to test the theory for applicability of the proposed relation, so a thermodynamical parameters values. The free energy ( $\Delta F$ ) is also determined using  $\tau_{OH}$  values. enthalpy ( $\Delta H$ ) and entropy ( $\Delta S$ ) of activation for relaxation process determined using both the experimental data ( $\tau_{OH}$ ) and the calculated apparent relaxation time ( $\tau$ ) are reported that may be seen from the table that  $\Delta F$  values for complexed species vary in the order pyridine + pyrrole quinoline + pyrrole pyridines indole quinoline + < indole. This suggested that the free energy of activation varies in accordance with the shape and size of the rotating unit in almost all the complexes.  $\Delta F$  increases with temperature, giving negative entropy values.  $\Delta S$  comparison of  $\Delta H$  values evaluated using parameters may be made. For pyridine + pyrrole system All of 18.1 kJ mol<sup>-1</sup> and 18.7 kJ mol<sup>-1</sup>, determined using  $\tau_{OH}$  values<sup>8</sup> appear to be in good agreement. Relaxation time data yield enthalpies of 4.91 and 4.79 kJ mol<sup>-1</sup> and kJ mol<sup>-1</sup> 5.95 kJ mol<sup>-1</sup> respectively. All these three systems exhibit an excellent agreement which supports on range for the dielectric relaxation times of on complexed species. The enthalpies and other activation parameters determined using the two relaxation times, being in very good agreement support the valid range on propose there relation. The study has been suggested that the dielectric relaxation time behavior of complexed species: A modified equation for relaxation time behaviour on complex species.

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