

## Thermal and Kinetics Analysis of the Decomposition of Hydrated tris (Indole-3-Acetato) Nd(III)

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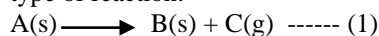
**Abstract:** There is an upsurge of interest towards the study of the interaction of plant auxins with metals present in the soil. Different researchers carried out solution and solid state studies on the complexing behaviour of the plant auxins. This note added to the existing knowledge of the chelating nature of auxins and highlights the thermal stability and kinetics of the non-isothermal decomposition of tris (indole-3-acetato) Nd(III).2H<sub>2</sub>O using techniques of Dave & Chopra [13].

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### I. Introduction

Co-ordination chemistry has assumed the huge importance in medicine, industry and analytical chemistry have been well attended [1-8] and addressed in line with the human progress upon this planet. The solid state reactions on the thermal profiles of solid complexes of Indole-3-acetic acid (IAA) resembling the type of reaction.



recommended for kinetic study by Freeman and Carrol [9] and follow first order kinetics.

Thermogravimetry has been widely used to study kinetics of thermal decomposition of reactions. As pointed out by Doyle [10], one mass-loss curve is equivalent to a large number of mass-loss curves. The determination of kinetic parameter by non-isothermal methods in advantages as compared to upon the various solid state reactions identified and examined on the conventional isothermal studies. The kinetics of solid reactions is entirely dependent upon the slope of the sigmoid of the reaction.

The kinetic analysis of the derivative a thermogravimetric data of the chelates in reference using the Dave-Chopra equations eg. (2) are made here

$$K = \frac{(A/m_0)^{n-1} \cdot (-dx/dt)}{(A - a)^n} \text{ -----(2)}$$

Equation 2 simplifies for n = 1

$$K = (-dx/dt)/A-a \text{ -----(3)}$$

which on fusion with Arrhenius equation yield

$$K = Z \cdot e^{-E/RT}$$

$$\log K = \log z - E/2.303 RT \text{ -----(4)}$$

where, 'A' is the total area under the DTG curve, 'a' is the area for the reaction curve at time t, d<sub>x</sub>/d<sub>t</sub> is the height of the curve at time t, m<sub>0</sub> is the initial mole fraction of the reactant and 'n' is the order of reaction with respect to the reaction.

### II. Experimental

The ligating molecules and the metal salts used were of analytical grade. The plant auxins (IAA) and metal salt [Nd(NO<sub>3</sub>)<sub>6</sub>.6H<sub>2</sub>O] were obtained from Aldrich Chemical Co. Inc. (USA).

The metal complex isolation involved the conversion of plant auxins in reference to sodium salt first, and then the replacement of sodium attached to carboxylic group by the metal by adding slowly, but with constant stirring, the metal salt to the aqueous solution of the sodium salt of plant auxin. The precipitate so appeared was allowed to settle, filter and washed with distilled water and dried at the temperature below the p<sub>dt</sub> (procedural decomposition temperature), value of the individual metal complex.

The Perkin Elmer (Pyris Diamond) was applied to register thermal profiling of these plant auxin complexes under the accompanying instrumental conditions.

Heating rate : 10<sup>0</sup>C min<sup>-1</sup>

Atmosphere : Nitrogen, 200ml min<sup>-1</sup>

Reference : Alumina powder

Temperature programme : Cel      Cel      Cel/min   min      s  
    26      1000      10      0      0.5

Charge (mg): IAA-Nd Complex 4.43 mg

### III. Results And Discussion

For Kinetic studies of the non-isothermal decomposition reactions, the TG trace(s) on the different metal-ligand complexes were applied following: Horowitz and Metzger [ ] and Coats and Redfern method [12]. The differentially drawn DTG traces from the TG traces were based upon for the Kinetic study applying Dave and Chopra method [13].

#### Tris (Indole-3-Acetato), Nd(III).2H<sub>2</sub>O

(Nd.R<sub>3</sub>.2H<sub>2</sub>O) where R = An anion of IAA

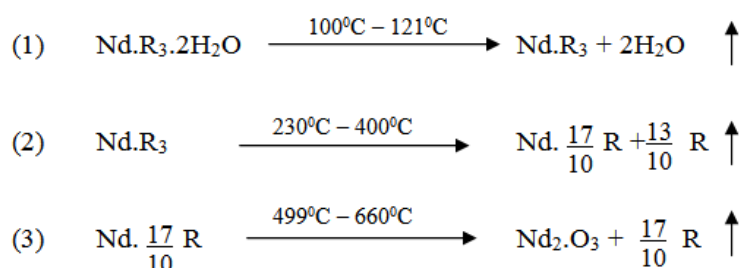
The thermal profiling of tris (indole-3-acetato) Nd(III).2H<sub>2</sub>O displayed 04 plateaus and 03 sigmoids over the stretch of ambient to 1000<sup>0</sup>C. The pdt value stood at 100<sup>0</sup>C after which the loss of lattice water(s) began and ended at 121<sup>0</sup>C. Calculations had a tally to the two molecules of lattice water. The plateau with a spread of temperature range. : 121<sup>0</sup>C-230<sup>0</sup>C corresponded to anhydrous chelate of IAA; NdR<sub>3</sub>. With the supply of more energy, the NdR<sub>3</sub> started departing the organic matter slowly till 304<sup>0</sup>C, but after it, the rate of loss speeded up and the trace nearly levelled off after 400<sup>0</sup>C till 499<sup>0</sup>C. The third plateau described the birth of a new intermediate with composition as Nd.17/10 R which could not tolerate the more supply of energy and lost all the organic matter attached leaving behind probably metal oxide : Nd<sub>2</sub>O<sub>3</sub>.

Non-isothermal decomposition of NdR<sub>3</sub>.2H<sub>2</sub>O is systematically arranged in Table 1 and in Fig. 1

The thermally defined events on TG trace had the correspondence on DTG trace. The lattice water loss (2H<sub>2</sub>O) was described by a peak with ΔTmax at 118<sup>0</sup>C whereas the loss of 13/10 R had been found corresponding to two peaks continuum with ΔTmax at 246<sup>0</sup>C and 333<sup>0</sup>C. The last sigmoid : 499<sup>0</sup>C-660<sup>0</sup>C on TG trace showed agreement to another peak with ΔTmax at 532<sup>0</sup>C sans sharpness like those of the earlier peaks observed.

DTA trace(s) described these thermal decomposition on TG/DTG traces as endotherm and 03 exotherms. The endotherm with ΔTmin at 119<sup>0</sup>C tallied to a loss of lattice water molecules whereas the 02 exotherms with ΔTmax at 247<sup>0</sup>C and 342<sup>0</sup>C showed correspondence to the losses of 13/10 R as observed as the second sigmoid at TG traces and the 02 peaks continuum (with ΔTmax at 246<sup>0</sup>C and 333<sup>0</sup>C). The exotherm with ΔTmax at 524<sup>0</sup>C correspondingly agreed to the loss of 17/10R molecule of organic chelate.

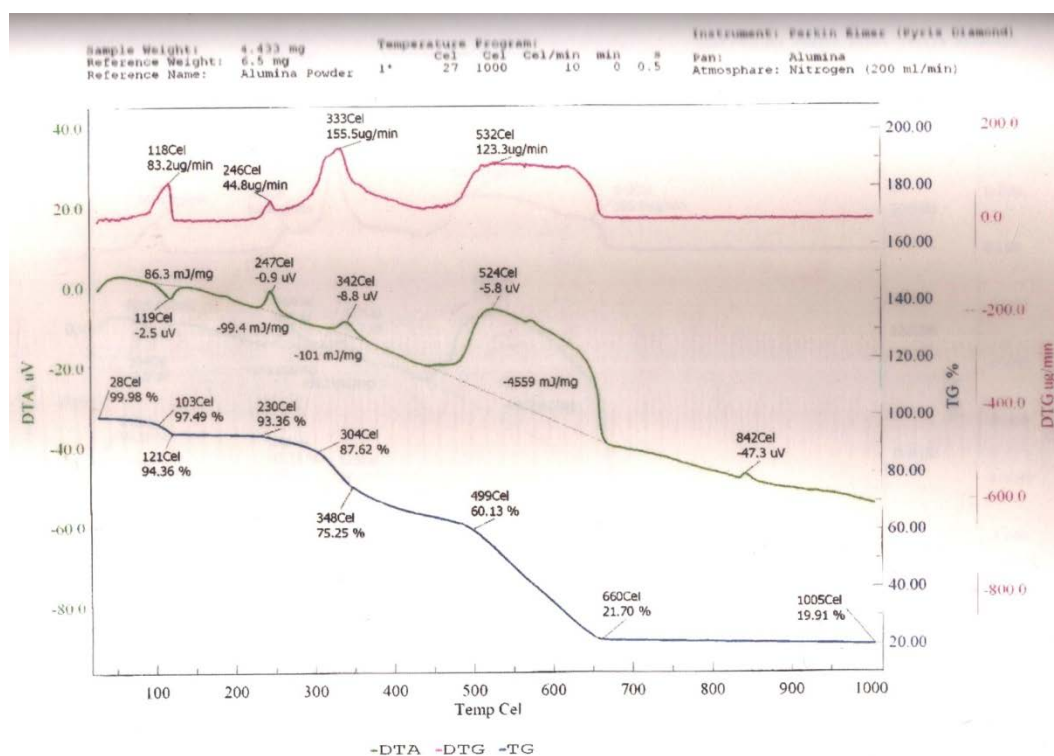
The solid-state reactions as ascertained on its thermal profile includes:



**Table 1**  
**Thermal Data on Decomposition of Tris (Indole-3-acetato) Nd(III).2H<sub>2</sub>O**

Reaction	Loss	Found	% oxide	
			Calc.	Found
T <sub>i</sub> , first stage, °C	-	100		
T <sub>f</sub> , first stage, °C	-	121		
Loss to Nd.R <sub>3</sub> , %	2H <sub>2</sub> O		5.13	5.64
T <sub>i</sub> , second stage, °C	-	230		
T <sub>f</sub> , second stage, °C	-	400		
Loss to Nd.17/10R, %	13/10R		33.96	32.86
T <sub>i</sub> , third stage, °C	-	499		
T <sub>f</sub> , third stage, °C	-	660		
Loss to Nd <sub>2</sub> O <sub>3</sub> , %	17/10R		78.33	61.88
Nd <sub>2</sub> O <sub>3</sub>			23.93	19.91

R = An Anion of IAA



**Tris (indole-3-acetato) Nd(III) Complex**  
**Fig -1**

The Dave and Chopra [3] equation for n = 1 was used to represent kinetics of non-isothermal decomposition of a metal complex as chosen by Freeman and Corroll [9] for Kinetic Study. Plots of log K against 1/T gave straight line, supporting the assumption that reaction (1-3) follow first order kinetics. The slopes and intercepts give activation energy E and collision number of reaction (1-3). Table 2 contains the kinetic data.

**Table 2**  
**Kinetic parameter for the non-isothermal decomposition of metal complexes of IAA using Dave & Chopra method**

Reaction	Temp. Range (°C)	n	E (KCal.mol <sup>-1</sup> )	log 2
Nd.R <sub>3</sub> .2H <sub>2</sub> O $\xrightarrow{100^{\circ}\text{C}-121^{\circ}\text{C}}$ Nd.R <sub>3</sub> + 2H <sub>2</sub> O	100-121	1	14.82	+0.26
Nd.R <sub>3</sub> $\xrightarrow{230^{\circ}\text{C}-400^{\circ}\text{C}}$ Nd.17/10R + 13/10 R	230-400	1	24.70	+0.64
Nd. 17/10R $\xrightarrow{499^{\circ}\text{C}-660^{\circ}\text{C}}$ Nd <sub>2</sub> O <sub>3</sub> + 17/10 R	499-660	1	36.60	+0.26

R= An anion of IAA

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