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Discovery

Synthesis and Characterization: Ln(III) Polychelates of phenolic resins

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ABSTRACT

The polymeric ligand (resin) was prepared from 2,4-dihydroxy benzophenone with 1,2-propylene glycol in presence of polyphosphoric acid as a catalyst at 160ºC for 13 h. The poly[(2,4-dihydroxybenzophenone) 1,2- propylene glycol] (DHBP-1,2-PD) form 1:2 metal: ligand chelates with La(III), Pr(III), Nd(III), Sm(III), Gd(III), Tb(III) and Dy(III). The polymeric ligand and its polychelates were characterized on the basis of elemental analyses, electronic spectra, magnetic susceptibilities, IR spectroscopy, NMR and thermogravimetric analyses. The molecular weight was determined using number average molecular weight ($\overline{Mn}$) by vapour pressure osmometry method. All the polychelates are paramagnetic in nature except La(III) which is diamagnetic.

Key words:
Polychelates, thermal study, ion exchange study.

Abbreviation:

B.M.-Bohr magneton; DHBP- 2,4-dihydroxybenzophenone; [DHBP-ED]n- poly[(2,4-dihydroxybenzophenone)ethylene]; DMF- Dimethyl formamide; DMSO- dimethyl sulphoxide; IR-infrared; MHz- megahertz; NMR- nuclear magnetic resonance; $[\overline{Mn}]$ number average molecular weight; THF- tetrahydrofuran; UV- ultraviolet; VPO- vapour pressure osmometry.

1. INTRODUCTION

Ion-exchange is a process where, an ion from solution is exchanged for a similarly charged ion attached to an immobile solid particle (Shepherd, 2000). These solid ion exchange particles are either naturally occurring or synthetically prepared. Synthetic resins are being predominantly used as ion-exchangers; their characteristics can be tailored to specific applications such as water purification and selective removal of waste materials in nuclear plants (Kopylova, 1998, Popat et al. 1994, Tusa et al. 2001). An ion-exchange resin comprises high molecular-weight polyelectrolytes, which can exchange their mobile ions for ions of similar charge from the surrounding medium. Each resin has a distinct number of mobile ion sites that set the maximum quantity of exchanges per unit of resin. These mobile ion sites occur not only on the surface but also within the volume (on all molecules) of ion exchangers. Recently, several coordination polymers have been prepared from aromatic and aliphatic polymers containing pendant functional groups which act as chelating groups in binding polyvalent metal ions (Joshi et al. 2006). Chelating polymers have attracted more interest, due to their applications in waste water treatment, metal recovery from dilute solutions, as protective coatings on metal surfaces or as priming layers, paper coatings, fiber and fabrics, selective binding of enzymes (Alelah and Moet, 1990, Mathew and Pillai, 1994). Polymeric coordinating reagents are novel type of substances possessing a combination of physical properties of a polymer and chemical properties of the attached reagent. Cation-exchanger resins can also be used as fillers. In general it helps to increase the ion-exchange capacity of the basic material and also some specific properties such as alkali resistance, mechanical and chemical properties. It is also found that ion-exchanger has positive effects on the water absorption. Therefore, it is recommended to produce more durable and weather-resistant products (Soroushian et al. 2005). Work has been undertaken to understand the interaction between resin and f electrons and to find out the efficiency and effectiveness of the resin to exchange lanthanide (III) metal ions. Polychelates of poly[(2,4-dihydroxy benzophenone)1,2- propylene glycol] with lanthanide (III) metal ions were synthesized and characterized. It is observed, that the polychelates are thermally less stable than the polymeric ligand. Resins show good ion-exchange capacity towards the lanthanides (III) metal ions.

2. MATERIALS AND METHODS

2,4-diHydroxybenzophenone (DHBP, Aldrich), 1,2-propylene glycol (PG, Aldrich), polyphosphoric acid (Lancaster) (PPA), methanol, (ARGrade), hydrated metal acetates of lanthanum, praseodymium, neodymium, samarium, gadolinium, terbium and dysprosium (Merck), DMSO, DMF, $NaNO_3$, NaCl, Na_2SO_4 and $NaClO_4$ (AR-Grade).

2.1. Synthesis of Resin

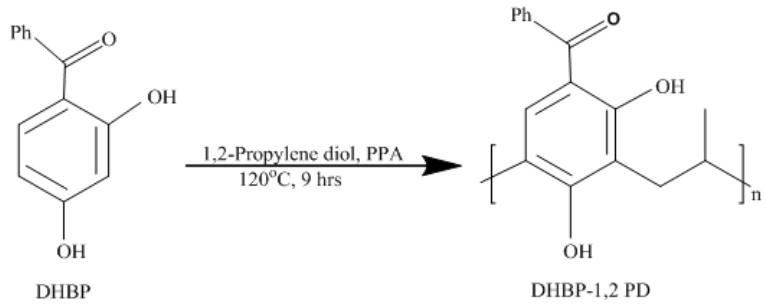
Polycondensation of 2,4, dihydroxy benzophenone with 1,2 Propylene Diol

To a well stirred and ice-cooled mixture of 2,4 dihydroxy benzophenone (12.84 gm, 0.06 mol) and 1,2 propylene diol (2.21 mL, 0.06 mol), polyphosphoric acid (PPA) (20gm) was added slowly with stirring as a catalyst (Scheme 1). The reaction mixture was left at room temperature for half an hour and condensed an an oil bath at 120°C for 9 hrs. The reaction mixture was then cooled, poured on crushed ice and left overnight. A reddish-brown solid was separated out and collected, Synthesized resin was further purified by reprecipitation from dimethyl formamide with water for three times and dried at 60°C temperature. The purified resin was reddish brown in Color. D.P.> 270°C, Yield 43.30%.

2.2. Synthesis of Polychelates

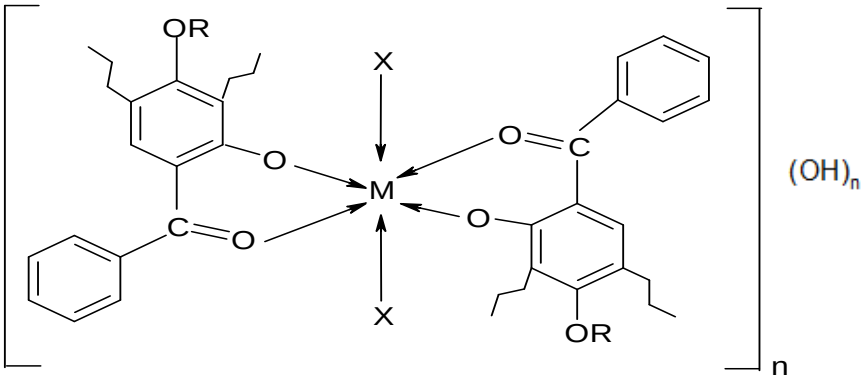
All polychelates were synthesized by following the same general method. Lanthanum, praseodymium, neodymium, samarium, gadolinium, terbium and dysprosium acetates were used in preparation of the polychelates. The polymeric ligand (0.01 mol) was dissolved in DMSO (50 mL). The metal acetate (0.005 mol) was also dissolved in DMSO (25 mL). The hot and clear solution of the metal acetate was added with constant stirring to the hot and clear solution of ligand. A reddish- brown coloured product separated out immediately. The suspension was digested on a water bath for 2 h and then filtered. The solid was washed with hot DMSO to remove unreacted metal acetate. Finally, the product was washed with acetone and dried at 60°C for 24 h. The yield of each

polyehelate was between 60% to 70%. Decomposition point of all the polychelates was >300°C. The proposed geometry of the polychelates is given in scheme 2.



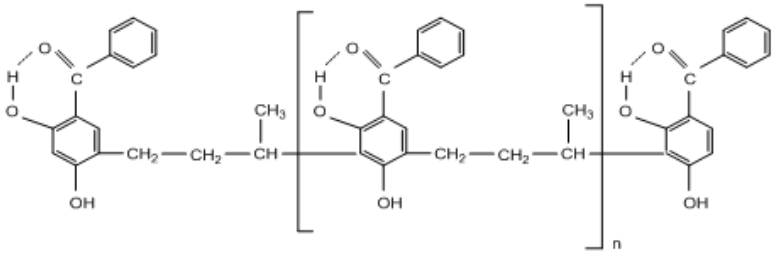
Scheme 1

Synthesis of DHBP-1,2 PD resin



Scheme 2

Proposed geometry of polychelates M=La^{III}, Pr^{III}, Nd^{III}, Sm^{III}, Gd^{III}, Tb^{III}, Dy^{III}; X=H_2O; R=H



Scheme 3

Proposed structure of the polymeric ligand

2.3. Analytical Procedures

Carbon and hydrogen were analyzed with a Coleman C, H, N analyzer (Table 1). The metal content was determined by titration with standard Na_2EDTA after decomposing the polychelates with a mixture of concentrated hydrochloric acid, sulphuric acid and perchloric acid in a 5:2:3 mL ratio, respectively. Magnetic susceptibilities were measured by the Gouy method at room temperature. The IR spectra of the samples in KBr pellets were recorded on a model 938 Perkin Elmer Spectrophotometer. ^{1}H NMR Spectra were determined in DMSO-d6 with FT NMR spectrophotometer using TMS as an internal reference. The number average molecular weight ($\overline{Mn}$) of polymeric ligand (resin) sample was measured with a Knaur Germany (VPO) using DMF as a solvent at 90°C and polystyrene (PS) as a calibrant.

3. RESULTS AND DISCUSSION

3.1. Infrared Spectra

In the polymeric resin the broad band appears in the range of 3300-3650 cm^{-1} and it is due to -O-H stretching. The -O-H group originates from the phenolic hydroxyl group and water absorbed by resins. The band due to -O-H stretching is less broad in the IR spectra of the polymer, which suggests the absence of absorbed water. Hence, this band would have been largely due to the presence of hydroxyl groups. The strong band of -C=O around 1635-1655 cm^{-1} and weak band at 2650-2900 cm^{-1} indicates an intramolecular hydrogen bond. The phenolic O-H in plane bending and stretching are observed in the range of 1230±20 cm^{-1} and 1340±10 cm^{-1}, respectively. The bands observed around 1480-1600 cm^{-1} region are attributed to -C=C stretching (aromatic) vibrations. The band in the region of 2920 cm^{-1} and 2890 cm^{-1} are attributed to the $-CH_2-$ and -CH(R)- bridge, respectively, which is absent in DHBP and confirms the presence of propylene bridge in resin (DHBP-1,2-PD). The band in the region 1020-1170 cm^{-1} is attributed to -C-H in plane bending. In the spectra of each resin, a band observed around 890±10 cm^{-1} is due to isolated hydrogen on the phenolic moiety repeating unit of the polymer chain. The band around 860-880 cm^{-1} may be attributed to the l, 2, 3, 4, 5-penta substituted phenyl ring, having only one isolated H atom. The medium intensity band at 830±10 cm^{-1} shows the 1, 2, 4, 5-tetra substituted phenyl ring, having two H on the phenyl ring. The presence of a band around 895 ± 10 cm^{-1} suggests that the linkage in the resin chain occurs through 3 and 5 positions of the monomer. The -C=O stretching frequency in the resin is observed around 1635-1655 cm^{-1}, appearing at a lower frequency of 20 to 30 cm^{-1} in all the polychelates, which suggests -C=O→ M coordination (Sari et al. 2006) as shown in Figure 1. In the polychelates the bands observed around 450-470 cm-1 and 565 cm^{-1} indicating the M-O bond suggest that phenolic and carbonyl groups are involved in bond formation with the metal ion. The proposed structure of the polymeric ligand is shown in Scheme 3.

3.2. ^{1}H NMR Spectra

The ^{1}H NMR spectra of 2,4-dihydroxybenzophenone, poly[(2,4-dihydroxy benzophenone) - 1,2-propylene glycol] shows the signals at δ = 12.72, 3.85 and 6.3-7.9 ppm that are due to -OH group ortho to (Ar-C=O), respectively (Silverstein R.M., Webster F.X.,1998) as shown in Figure 2. In all the polychelates the signal of the -OH group is completely disappeared, suggesting that the bond formation takes place through the -OH ortho to (Ar- C=O). Also, aromatic protons are shifted downfield by 0.14-1.32 ppm in the NMR spectra of the polychelates due to the deshielding effect of the metal ion on the ligand proton, as shown in Figure 2.

3.3. Vapour Pressure Osmometry

The number average molecular weight ($\overline{Mn}$) of the polymeric ligand (resin) samples were estimated by vapour pressure osmometry (Eliassi and Modarress, 2001). Dilute solutions of polymer samples were prepared to determine ($\overline{Mn}$). Four concentrations of 2.21, 4.42, 6.63 and 8.84 g.kg-1 were prepared in DMF. The VPO experiment was carried out for each concentration and the corresponding bridge output reading in millivolts was noted as 24.0, 48.0, 72.0 and 101.0, respectively. The plot of millivolts versus concentration is obtained. With the help of the slope (10.84) and the VPO constant K (1.15× 104), the ($\overline{Mn}$) = 1095 g.mol-1 value of the polymer was calculated.

3.4. Thermogravimetric Analyses

Thermogravimetric analyses (TGA) data of the polymeric resin and polychelates were performed in the temperature range of 0 to 800ºC. The data revealed that the rate of decomposition of the polychelate is higher than that of the parent resin, suggesting that there may be strong intramolecular hydrogen bonding in the polymer. The absence of such hydrogen bonding in polychelate favours the reduction in thermal stability of polychelates compared to the parent resin (Misra and Tewari, 2002). It seems that metal ions accelerate the decomposition of the polychelates. The thermal stability of the ligand and metal chelates is in the order: ligand >

polychelates. The presence of water molecules is considered as water of co-ordination. According to (Nikolaev et al. 1969) water eliminated above 150°C may be due to coordination to the metal ion. The nature of the water molecules observed in the complexes is water of coordination, which is supported by cumulative weight loss percentage and thermal data. The thermogram of [Tb(2,4-dihydroxybenzophenone)- 1,2-propylene glycol] polychelate is shown in Figure 3.

3.5. Electronic Spectra and Magnetic Measurements

The electronic spectra of all the polychelates exhibited two additional bands in the region 270-310 nm and 440-460 nm. The first band occurs in the spectra of the polymeric ligand, is assigned to the type π→ π1* and π→ π2* (Kriza et al. 2000). The second band is assigned to the polymeric ligand →Ln(III) transitions in all the polychelates. The La(III) polychelates were found diamagnetic in nature as expected for six coordinated octahedral geometry. The electronic spectra of Pr(III), f3, polychelates exhibit absorptions at 22,514, 21,253, 20,687 and 16,870 cm-1, assigned to $^3H_4 \rightarrow {}^3p_2$, $^3H_4 \rightarrow {}^3p_1$, $^3H_4 \rightarrow {}^3p_0$ and $^3H_4 \rightarrow {}^1D_2$ transitions of Pr(III) in a octahedral environment, due to large crystal field with magnetic moment 3.73 BM. The Nd(III) polychelates are paramagnetic as expected for f4 system. Bands were obtained at 17,644, 18,789, 15,023 and 10,690 cm-I for $^4I_{9/2} \rightarrow {}^2G_{9/2}$, $^4I_{9/2} \rightarrow {}^2G_{5/2}$, $^4I_{9/2} \rightarrow {}^2S_{3/2}$, and $^4I_{9/2} \rightarrow {}^2S_{3/2}$, and $^4I_{9/2} \rightarrow {}^4F_{5/2}$ transitions of Nd(III) in octahedral geometry. In addition the bands at 22,245, 21,788 and 24,924 cm-1 for polychelates are assigned to $^4H_{5/2} \rightarrow {}^4F_{9/2}$, $^4H_{5/2} \rightarrow {}^6p_5$ and $^4H_{5/2} \rightarrow {}^4I_{11/2}$transitions of Sm(III) in octahedral geometry due to large crystal field splitting and all the polychelates are paramagnetic in nature. The magnetic moment 1.77 BM is obtained as expected. The Gd(III) and Tb(III) polychelates were found paramagnetic in nature 7.82 BM and 9.50 BM as expected for six coordinated octahedral polychelates. The electronic spectra of Dy(III) f10 polychelates exhibit absorption at 26,890 cm-I assigned to $^6H_{15/2} \rightarrow {}^6H_{13/2}$ transition of Dy(III) in octahedral geometry due to large crystal field splitting. From above study the proposed geometry of polychelates is as shown in Scheme 2.

3.6. Ion-exchange Study

The purified resin sample DHBP-1,2-PD was finally powdered to pass a 300 mesh screen and used in all experiments for ion-exchange study. The batch equilibration method was used. The details of the procedure for selectivity of the lanthanides (III) metal ions by the resin, is similar as reported earlier (Joshi et al. 2006). The selectivity of resin DHBP-1,2-PD towards lanthanides (III) metal ions was studied under the influence of various factors, such as the influence of different electrolytes at various concentrations on uptake of metal ion, effect of p^H of the medium on metal binding capacity, evaluation of the rate of metal uptake and evaluation of distribution ratio (K_D) of metal ions over the wide p^H range. The results are shown in Tables 2-5.

3.7. Influence of an Electrolyte on Uptake of Metal Ion

The influence of Cl^-, $N0_3^-$, ClO^- and SO_4^{2-} at various concentrations on the equilibrium state of the metal resin interaction has been studied (Figure 4). The results are presented in Table 4. It reveals that, the amount of metal ion taken up by the resin increases with an increase in concentration of NO_3^-, ClO_4^-, and decreases, with Cl^-.

3.8. Effect of p^H of the Medium on Metal Binding Capacity

The results of selected metals uptake have been presented in Table 3. The rate of metal ion uptake depends on the nature of metal ion. The study was restricted up to maximum p^H = 6, due to hydrolysis of metal ion at higher p^H. The formation of metal hydroxide interferes the ion-exchange process. It is found that the relative amount of metal adsorbed by the resin increases with increasing p^H of the medium as it is shown in Figure 5.

3.9. Evaluation of the Rate of Metal Uptake

To determine the time required to reach the state of equilibrium under given experimental conditions, a series of experiments have been carried out, in which the metal uptake by the chelating resin was estimated from time to time. It is assumed that at 25°C and under given conditions, the state of equilibrium is established in 24 h. The rate of metal uptake is expressed as percentage of the attainment at state of equilibrium. If "X" mg of metal ions were adsorbed, after 1 h and "Y" mg of metal ions were adsorbed at equilibrium, i.e. after 24 h, X×100/Y would be the measure of percentage of equilibrium attained after 1 h. It can be observed that the rate increases for first 3-4 h for La(III), Nd(III) and Sm(III) and the state of equilibrium is attained after 24 h for all metal ions (Figure 6).

3.10. Evaluation of Distribution Ratio (K_D) of Metal Ions over a Wide Range of p^H

The distribution of each of the metal ions [La^{3+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, Gd^{3+}, Tb^{3+} and Dy^{3+}] between the resin phase (solid) and aqueous phase (liquid) is estimated at appropriate p^H, using 1.0 M $NaNO_3$ solution. The experiments were carried out from 3 to 5.5 p^H. The amount of the metal ion which remained in the aqueous phase was estimated. The original metal ion concentration is known, and the metal ion adsorbed by the resin was estimated. The results are shown in Figure 7. The distribution ratio, K_D, has been calculated from the following equation:

$$K_D = \frac{\text{Amount of metal ion adsorded by resin}}{\text{Amount of metal ion in solution}} \text{ X } \frac{\text{Volume of solution}}{\text{Weight of resin}}$$

The effect of p^H on the amount of metal ions distributed between two phases can be explained by using the results shown in Table 5. It can be observed that the distribution ratio increases for [La^{3+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, Gd^{3+}, Tb^{3+} and Dy^{3+}] metal ions as the p^H of the medium increases as it is shown in Figure 7. Also the value of distribution ratio for given p^H depends upon the nature of the polymeric ligand (resin).

Table 1

Analytical data of DHBP-1,2 PD resin and its Polychelates

Compound	Formula weight of Repeating unit	% Found (Calculated)			μ_{eff} (B.M)
		M	C	H	
$(DHBP\text{-}1,2\ PD)_n$ $[C_{16}H_{14}O_3]_n$	254	---	75.40 (75.57)	5.48 (5.54)	---
$\{[La(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9La]_n$	698	19.93 (19.88)	55.00 (55.02)	4.44 (4.47)	Diamagnetic
$\{[Pr(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Pr]_n$	700	20.10 (20.11)	54.79 (54.86)	4.41 (4.46)	3.71
$\{[Nd(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Nd]_n$	703	20.41 (20.49)	54.57 (54.60)	4.45 (4.43)	3.61
$\{[Sm(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Sm]_n$	709	21.12 (21.17)	54.08 (54.13)	4.44 (4.40)	1.77
$\{[Gd(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Gd]_n$	716	21.95 (21.93)	53.71 (53.61)	4.31 (4.35)	7.91
$\{[Tb(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Tb]_n$	718	22.06 (22.11)	54.00 (53.49)	4.37 (4.34)	9.47
$\{[Dy(DHBP\ -1,2\ PG)_2(H_2O)_2].OH\}_n$ $[C_{32}H_{31}O_9Dy]_n$	722	22.45 (22.50)	53.30 (53.22)	4.35 (4.32)	10.67

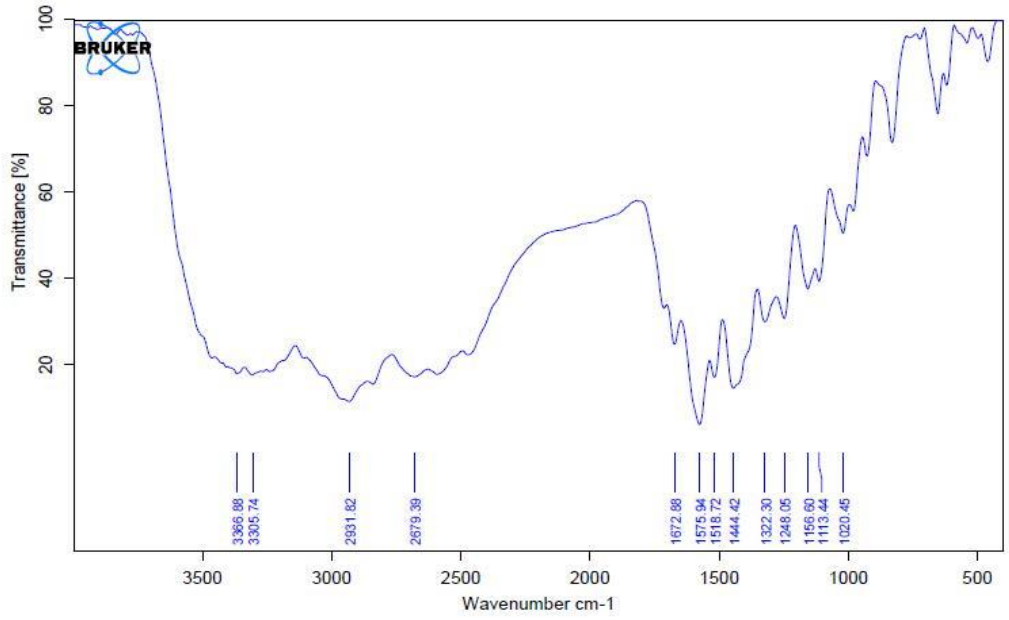


Figure 1

FTIR Spectrum of DHBP-1,2-Propane diol Resin

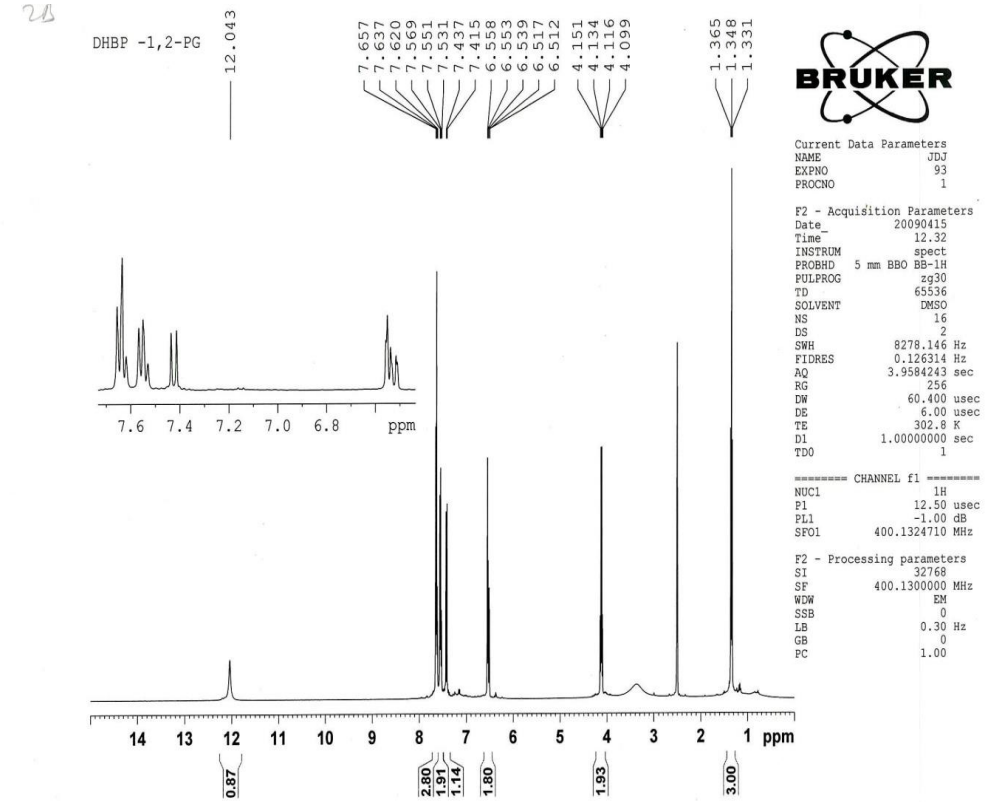


Figure 2

[1]HNMR Spectrum of DHBP-1,2 PD Resins

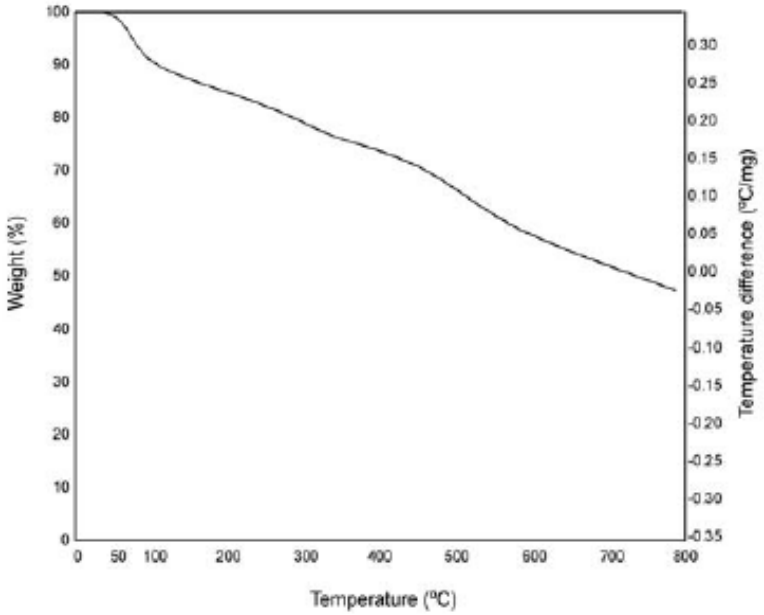


Figure 3

Thermogram of [Tb (2,4-dihydroxybenzophenone)- 1,2-propyleneglycol] polychelate

Table 2

Effect of electrolyte concentration on metal ion adsorption capacity of DHBP-1,2-PD resin

Metal ions	Electrolyte (Mol. lit^{-1})	Metal ion uptake (meq.g^{-1}) in presence of electrolyte			
		$NaNO_3$	NaCl	Na_2SO_4	$NaClO_4$
	0.05	0.40	0.38	0.40	0.41
La^{3+}	0.10	0.49	0.47	0.38	0.47
	0.50	0.71	0.65	0.33	0.67
	1.00	0.75	0.70	0.31	0.73
	0.05	0.39	0.39	0.40	0.40
Pr^{3+}	0.10	0.48	0.46	0.37	0.48
	0.50	0.71	0.68	0.32	0.67
	1.00	0.77	0.74	0.30	0.74
	0.05	0.41	0.40	0.39	0.42
Nd^{3+}	0.10	0.49	0.47	0.36	0.49
	0.50	0.74	0.69	0.32	0.72
	1.00	0.77	0.74	0.29	0.75
	0.05	0.42	0.42	0.38	0.43
Sm^{3+}	0.10	0.50	0.48	0.34	0.50
	0.50	0.75	0.73	0.30	0.73

	1.00	0.79	0.76	0.29	0.76
	0.05	0.43	0.43	0.36	0.42
Gd^{3+}	0.10	0.51	0.50	0.31	0.53
	0.50	0.75	0.75	0.30	0.74
	1.00	0.80	0.79	0.28	0.79
	0.05	0.44	0.44	0.35	0.43
Tb^{3+}	0.10	0.53	0.52	0.33	0.53
	0.50	0.76	0.78	0.29	0.75
	1.00	0.81	0.80	0.27	0.80
	0.05	0.45	0.45	0.35	0.45
Dy^{3+}	0.10	0.54	0.53	0.32	0.54
	0.50	0.77	0.79	0.29	0.77
	1.00	0.83	0.82	0.27	0.81

Resin, DHBP-1,2 PD = 50 mg; $M(NO_3)_2$ = 2mL, 0.1 M; Volume of electrolyte solution = 40 mL; Time = 24 hrs; Temperature = 30°C; pH of the medium = 5.6

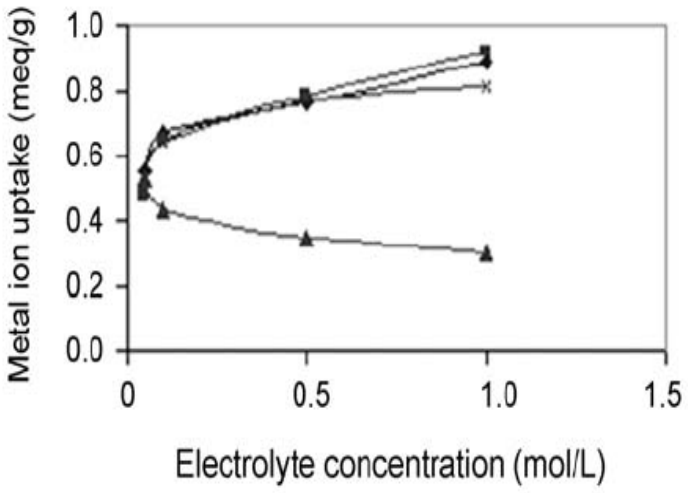


Figure 4

Metal ion uptake as a function of electrolyte concentration

(♦) $NaNO_3$, (■) NaCl, (▲) Na_2SO_4, (x) $NaClO_4$

Table 3

Effect of p^H on metal ion binding capacity with DHBP-1,2-PD resin.

Metal ions	Metal ion uptake ($meq.g^{-1}$)				
	pH of the medium				
	3.0	3.5	4.0	5.0	5.5
La^{3+}	0.45	0.56	0.60	0.75	0.82
Pr^{3+}	0.46	0.54	0.61	0.76	0.83
Nd^{3+}	0.48	0.55	0.63	0.77	0.84
Sm^{3+}	0.47	0.56	0.65	0.74	0.79
Gd^{3+}	0.46	0.57	0.64	0.73	0.78
Tb^{3+}	0.48	0.56	0.63	0.74	0.77
Dy^{3+}	0.46	0.57	0.64	0.73	0.80

Resin, DHBP-1,2-PD=50 mg; $Mt(NO_3)_2$ = 2 mL, 0.1 M; volume of electrolyte solution= 40 mL; time= 24 h; temperature=30ºC.

Table 4

Rate of metal ion uptake by resins as a function of time*

Time (h)	Metal Ion uptake ($meq.g^{-1}$)						
	pH of medium (3.0-5.5)						
	La^{3+}	Pr^{3+}	Nd^{3+}	Sm^{3+}	Gd^{3+}	Tb^{3+}	Dy^{3+}
1.0	41.40	26.90	42.90	43.16	40.19	41.30	39.90
2.0	49.98	31.67	48.93	49.17	48.30	45.90	47.53
3.0	57.28	44.70	56.60	55.19	54.45	54.89	56.90
4.0	68.89	53.90	66.16	69.17	68.29	65.60	67.90
5.0	82.91	67.98	81.19	80.17	78.90	76.90	77.89
6.0	89.27	76.64	89.30	90.29	88.87	87.30	86.90
7.0	94.30	87.78	93.98	95.90	92.90	90.91	91.90

Resin, DHBP-1,2-PD= 50 mg; $Mt(NO_3)_2$= 2 mL, 0.1 M; volume of electrolyte solution= 40 mL; time= 24 h; temperature = 30ºC, (*) Assuming 100% equilibrium is established after 2 hrs.

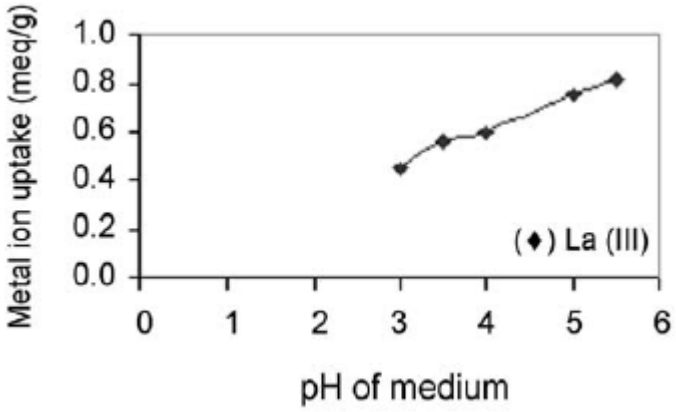


Figure 5

Metal ion uptake as a function of p^H of medium

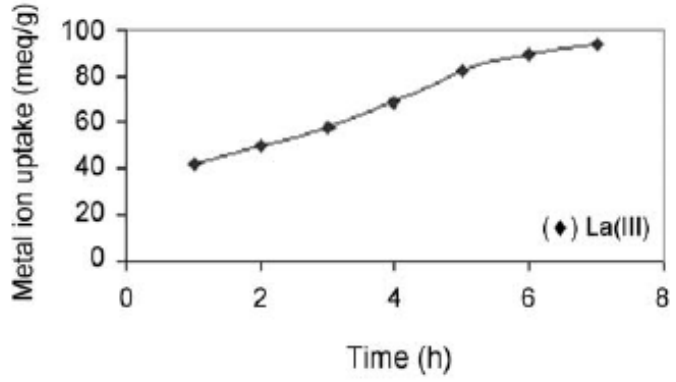


Figure 6

Metal ion uptake as a function of time

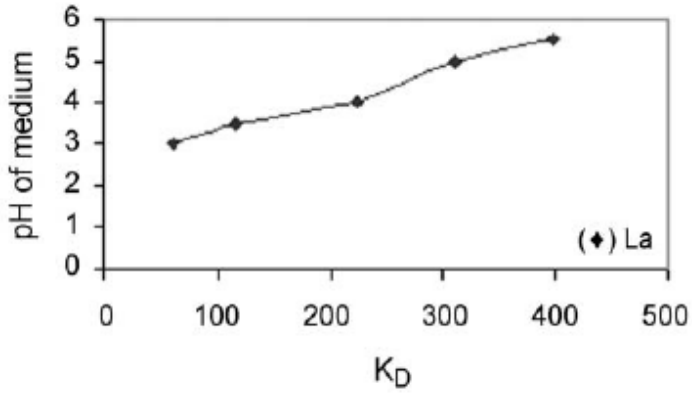


Figure 7

Distribution ratio (K_D) of metal ion as a function of p^H

Table 5

Distribution ratio of ions adsorbed by the resin (DHBP-1,2-PD) and remained in the solution at equilibrium

Metal ions	Distribution ratio (K_D)				
	pH of the medium				
	3.0	3.5	4.0	5.0	5.5
La^{3+}	60.20	115.78	224.32	310.54	397.66
Pr^{3+}	74.35	145.86	244.10	387.61	420.88
Nd^{3+}	30.40	100.92	210.76	292.56	375.44
Sn^{3+}	22.38	104.98	188.14	260.83	390.24
Gd^{3+}	38.25	116.96	234.65	330.28	416.31
Tb^{3+}	45.21	102.54	196.62	274.33	340.97
Dy^{3+}	53.41	126.42	218.56	305.45	400.37

Resin, DHBP-1,2-PD= 50 mg; $Mt(NO_3)_3$= 2 mL, 0.1 M; volume of electrolyte solution= 40 mL; time= 24 h; temperature= 30ºC

4. CONCLUSION

On the basis of elemental analyses, IR, thermogravimetric analyses, ^1H NMR spectra, magnetic properties and vapour pressure osmometry the proposed geometry of the complex is given in scheme 2. The resin has good binding capacity for the lanthanides (III) at various conditions employed for the ion-exchange study. On the basis of results, it is found that resin can be used as an effective and efficient ion exchanger.

SUMMARY OF RESEARCH

1. A novel phenolic polymeric resin was prepared from 2,4-dihydroxybenzophenone, an benzophenone derived monomer, which was used to synthesize polychelates of lanthanide(III) elements.
2. The resultant polychelates were characterized using IR, NMR, VPO, TGA, Ion exchange study, electronic and magnetic measurement were carried out to define the proposed geometry and resin has been used as an ion exchanger for lanthanides.

FUTURE ISSUES

It would be definitely beneficial investigate the physicochemical of the prepared polychelates, which may help to explore their potential for a variety of fields in Chemistry.

DISCLOSURE STATEMENT

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