CHAPTER - I

General introduction and literature survey
Introduction

p- Alkoxy alkyl benzoates and bisphenols have attracted great interest because of their importance in synthetic organic chemistry. The versatile application of p-hydroxy alkyl benzoates, p-alkoxy alkyl benzoates and bisphenols compound has made this area of extensive research by synthetic chemists. p-alkoxy alkyl benzoates are an important component in the catalyst system for the production of polypropylene. They are used as inside electron donor in the connection with solid particulate catalyst precursor. The global market for polypropylene had a volume of 45, 1 million tons which leads to a turnover of about 65 billion US dollar. There are many chemical industries which are manufacture polypropylene. Similarly the importance of bisphenols has increased continually with the growth of the plastics industry from about the end of the 1930s. bisphenol is an important chemical intermediate for the preparation of industrially important epoxy resin and polycarbonates that are used in molding, casting, sealing, coating, encapsulating, adhesives and laminating, in the preparation of reinforced plastic, paints, varnishes and additives. Most of the bisphenol showed significant antiviral activity. From literature review it is quite clear that bisphenols are one of the extensively studied molecules and still there is scope for the development of improved methodology for its synthesis. With the present growing concern about controlling environmental pollution and protecting future resources, the design of environmentally friendly chemical processes has attracted considerable interest in organic synthesis. Several applications of p-alkoxy alkyl benzoates as catalysts for synthesis of polypropylene and starting materials in the synthesis of
various medicinal compounds have been reported in literature but very little attention is being given on its synthesis.

These finding prompted us to synthesize series of p-alkoxy alkyl benzoates and bisphenols with simple synthetic procedure, safe, economical, extremely high purity product and it should be commercial viable process taking care of environmental aspects.

General survey on esterification, etherification and condensation

Esterification:

bipyridyl-6-6-ylhexanoate / CSF [20], 4, 5-dichoro-1, 2, 3-
dithiazoliumchloride[21]1-hydroxybenzotriazole /trichloromethy-
carbonochloridate [22] N-hydroxysuccin-imide/DDC [23] 4 -
(4,6-dimethoxy - 1, 3 ,5-triazine-2-y1) - 4 - ethyl morforiumchloride
/ N -methylnorpholline [24] diiodotributlyphosphorane and
diodotriphenylphophorane/HMPTA [25] organocatalytic
mitsunobu reaction. [26] Fluorous DEAD reagent. [27].
Ph$_3$PBr$_3$/K$_2$CO$_3$ [28].

Ishihara K. et al. [29] have shown that bulky diarylamonium
arenesulfonates as selective esterification catalyst. [Fig.1.1]

![Fig. 1.1](image1.png)

Chakraborti A.K. et al. [30] successfully demonstrated that direct
atom efficient esterification between carboxylic acid and alcohol
catalyzed by protic acid immobilized recyclable catalyst [Fig. 1.2]

![Fig.1.2](image2.png)
Srinivas K.V.N.S. et al. [31] reported silica chloride a versatile heterogeneous catalyst for esterification and transesterification [Fig.1.3]

\[
\text{R OH} \quad \text{(solvent)} \quad \text{silica chloride (150 mg/mmol substrate)} \quad \text{reflux, 5 -10 h} \quad \text{R OR'}
\]

**Fig. 1.3**

Sara P. Morcillon et al. [32] reported mild method for the selective esterification of carboxy acid based on the Gareggsamuelsson reaction using different phosphine, iodine and imidazole allow one wide variety of acids with good to excellent results [Fig.1.4]

\[
\text{R OH} \quad \text{PPh}_3 \quad \text{I}_2, \text{imidazole, CH}_2\text{Cl}_2 \quad \text{R OR'}
\]

**Fig. 1.4**

Brinchi L. et al. [33] demonstrated that ionic liquid based on 1,3-dialkylimidazolinum methane sulphonates have been used as efficient reusable reaction media in the esterification of several carboxylic acid with alkyl halides catalyzed by fluoride ions.[Fig. 1.5]

\[
\text{R OH} \quad \text{KF} \quad \text{R -Cl} \quad \text{ionic liquid} \quad 90^\circ \text{c} \quad \text{R OR'}
\]

**Fig. 1.5**
**o-Alkylation (ether formation)**

Literature surveys on general o-alkylation methodology are described.

Phenols are converted into ether by reaction in alkaline solution with alkyl halides. In alkaline solution a phenol exists as the phenoxide ion which acts as a nucleophilic reagent, attacks the halide or the sulphate displacing it. This is known as **Williamson synthesis**.

Various phenols are transformed into corresponding phenol methyl ethers with betian such as trimethyl glycin, trimethyl ammonium acetate, carboxyl N,N,N-trimethyl methane ammonium using CaO at 200°C gives ether with 71-72% purity [34]. Sun L. et al.[35] demonstrated that an efficient method chemoselectively converts benzyl alcohol into their methyl ether in the presence of aliphatic or phenolic hydroxy group using 2,4,6-trichloro -1,3,5 triazine and dimethyl sulfoxide in methanol or ethanol *[Fig.1.6]*

![Fig. 1.6](image)

Jana K.K. et al. [36] reported the o-alkylation of 2-hydroxy benzoic acid by dimethyl sulphate using acetone solvent, triethylamine and ethylene dibromide gives 90% yield *[Fig. 1.7]*
Ganpati et al. [37] demonstrated selective o-alkylation of aromatic product from substituted phenol using phosphonium based ionic liquid such as Trihexyl (tetra decyl) phosphonium chloride, trihexyl(tetradecyl) phosphonium bromide and trihexyl (tetradecyl) phosphonium hexafluoro phosphate. Ishizaki et al. [38] demonstrated o-alkylation by alkyl halide using NaH (60 %) and acetone at reflux temperature gives moderate yield.[Fig.1.8]

Rajaram Bal and S. Sivasankar [39] studied Vapour phase selective o-alkylation of phenol with methanol, ethanol, n-propanol and n-butanol in presences of alkali loaded silica catalyst in the vapor phase [Fig.1.9].

Dariusz Bogdal et al. [40] reported o-alkylation of substituted phenol under microwave radiation using alkylation agents in
presence of phase transfer catalyst and the mixture of K₂CO₃ & KOH gives 64\% Yield[Fig.1.10].

\[
\begin{align*}
\text{Y: H,Cl,Br,NH}_2,\text{CH}_3,\text{Ar} \quad & \quad \text{64-92\%} \\
\end{align*}
\]

Deshmukh et al. [41] reported o-alkylation of phenolic aryl ester using Amberlyst A-26 resin as catalyst with corresponding alcohol [Fig.1.11].

\[
\begin{align*}
\text{OH} + \text{R-OH} \quad & \quad \text{CS-SiO}_2 \quad \rightarrow \quad \text{R-O} + \text{H}_2\text{O} \\
\end{align*}
\]

Pierantozzi and A.F. Nordquist [42] reported selective o-alkylation of phenol with Methanol using La₂(HPO₄)₃, BaSO₄ & SrSO₄ catalyst in batch liquid phase reactor and in continuous flow reactor. Selectivity for Anisole formation were up to 94\% over La₂(HPO₄)₃ & 90\% over BaSO₄ at 573°C.[Fig.1.12]

\[
\begin{align*}
\text{OH} + \text{CH}_3\text{OH} \quad & \quad \text{La}_2(\text{HPO}_4)_3 \quad \rightarrow \quad \text{CH}_3\text{O} + \text{H}_2\text{O} \\
\end{align*}
\]

Xiuli Bu and et al. [43] studied the organic phase catalysed o-alkylation of phenol under solvent free condition. Simply grinding the mixture of relevant Phenol, Alkyl Bromide, anhydrous K₂CO₃ & organic based as catalyst in a mortar at room temperature with good to excellent yields. [Fig.1.13]
Jyoti Pandey et al. [44] reported efficient chemo selective etherification of Phenol in polyfunctional aromatic compounds with different alkyl halide in presence of K$_2$CO$_3$/TBAB [Fig.1.14]

Condensation reaction

Condensation reaction is a chemical reaction in which two molecules or moieties (functional group) combine to form one single molecule, together with the loss of a small molecule of water.

Bisphenol have been synthesized by the condensation of phenol with cyclic ketone or aliphatic ketone using borontrifluoride. [45] Polyyphosphoric acid [46, 47] dry hydrochloric acid [48, 49] and acetic acid [50] Yadav et al. [51] have used solid catalyst like hetopolyacid H$_3$PO$_{12}$O$_{40}$ supported on K10 clay for synthesis of bisphenols. Zeolites have been increasingly used in the synthesis of fine chemical and bisphenols due to their high surface area and uniform pore diameter [52-55] However, pore diameter of zeolites are in the micropore region (less than 20 Å) and their suitability for the conversion of large substrates has been limited[56] compared the
activity of zeolites like ZSM-5, H-modenite and HY with Amberlyst-15 and showed that Zeolites with large pore opening are more selective for the synthesis of bisphenols. Tanev and Zhao [57-58] reported ion exchange resin is a powerful catalyst for bisphenol synthesis. Recently Pandurangan P [59] investigated condensation of a ketone or aldehyde with phenol in the presence of a heteropolyacid and supported heteropolyacid catalyst.

From the literature review it has been observed that for the synthesis of bisphenol huge amount of chlorinated solvent such as methylene dichloride, ethylenedichloride and chloro benzene are reported. The toxicity and volatile nature of chlorinated solvent have posed a serious threat to the environment [60,61].

One of the challenges to research workers during the recent years that to develop green procedures which are both environmentally desirable and economically acceptable. Green chemistry is considered as integral part of a comprehensive program to protect human health and environment most of organic solvent used in industry are toxic, costly and problematic to use carrying out reaction with lesser amount or no solvent will lead to clean, efficient and economical processes. With the increasing environmental concern and the regulatory constraints faced by the chemical and pharmaceutical industries, development of environmentally benign organic reaction has become crucial and demanding research area in modern organic chemical research. Therefore more and more chemists are devoted to the researching “green synthesis” which means the reagent; solvent and catalyst are environmentally friendly in the organic chemical reaction.
To realize this goal, some of the methodology, which are used in organic synthesis are,

1) Use catalyst in organic synthesis
2) Use safer catalyst and reaction condition.
3) Increase energy efficiency.
4) Design less hazardous chemical synthesis.
5) Prevent waste.
6) Avoid unwanted chemical derivatives
7) Solvent recovery and recycled in the process
8) Minimum unit operation.
9) Maximize efficiency.
10) Design for separation.

Phase transfer catalysis is one of the promising methods, in organic synthesis of speciality chemicals in the last 20 years a steadily increasing number of published papers and patents dealing with phase transfer catalysis and their applications. Phase transfer catalysis is not merely important for substitution reaction but, nowadays, it is being extensively applied in Polymer chemistry, heterocyclic chemistry, organometallic synthesis, agrochemicals, dyes, flavours, perfumes and pharmaceutical manufacture [62-64]

The technique of phase transfer catalysis has extensively, been applied in the organic synthesis via substitution, displacement, condensation, elimination. Ylide -mediated reactions redox and polymerization.

The most advantage of using phase transfer catalysis technique to synthesize organic chemicals are the enhancement of reaction rate carrying out reaction at moderate condition, obtaining high conversion of the reaction [65-66]
The present work entitled, “studies and synthesis of p-alkoxy alkyl benzoates and bisphenols as potential polymer catalyst and additive” describes a novel, highly efficient azeotropic method of esterification, and use of selective phase transfer catalyst, carrying out reactions with lesser amount or solvent free process, charcoal free process. Keeping in mind, the environmental concern in research and industries, we have focused up on improvements in the existing reaction paths by the use of mild, economical easily available catalyst, mild purification reagents, short reaction time, simple procedure extremely high purity compound with commercial viable process.

Industries are a major cause for environmental pollution, reduce, reuse and recycle is the Mantra for modern day waste disposal. Method to reduce industrial pollution at source is very essential to maintain its ISO 14001 accreditation.

We have successfully demonstrated solvent recycle study in the synthesis without hampering yield and purityalong with the stability of p-alkoxy alkyl benzoate of synthesized compound.

Considering serious threat of chlorinated solvent to the environment and human health, we have successfully developed free of halogenated hydrocarbon solvent bisphenol synthesis process.

In recent years, the search for environmentally benign chemical processes or methodologies has received much attention from chemists, because they are essential for the conservation of the global ecosystem. From this viewpoint, we have focused on reduction of chemical oxygen demand at source and improve
process performance by recovering methanol from bisphenol aqueous and make process environmentally safe.

We have also developed simple, safe reproducible and highly efficient analytical method for p-alkoxy alkyl benzoates and bisphenols characterization as a view of polymer catalyst and additives. Chemical industries rely up on qualitative and quantitative analysis to ensure that the used raw material meets certain specification and also to check the quality of the final product.
References

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