INTRODUCTION

This thesis is the outcome of investigations carried out on the application of polymer immobilized reagents, particularly ion-exchange resin immobilized reagents to some organic synthesis. Polymer immobilized reagents which finds application in organic synthesis appear in two broad forms:

1. Functionalized polymers to which reactive reagents have been immobilized.

2. Ion-exchange resin to which reactive groups have been immobilized by exchanging the replaceable ions.

In the present investigation, some aspects of organic synthesis have been studied mainly by utilizing ion-exchange resin as carrier or supports for immobilizing substrates or the reagents. It is deemed appropriate at this stage to give a brief review of some of the applications of polymer and ion-exchange resin immobilized reagents in organic synthesis.

I. A REVIEW OF POLYMER IMMOBILIZED REAGENTS IN ORGANIC SYNTHESIS

Until the mid-sixty's polymers were of considerable interest as materials. The utility of these polymers as support material in organic synthesis remained virtually unknown until its applicability was demonstrated by R. B. Merrifield for the synthesis of peptides, a method popularly known as the "Merrifield peptide synthesis". Thereafter, functionalized polymers have found widespread applications in organic synthesis.

Generally, polymers have been utilized to play three important roles in organic synthesis:

(a) they have been used to immobilize substances on which reactions are carried out

(b) they have been used to serve as reagents in organic synthesis

(c) they have been used as catalysts.
A proper choice of the polymers is an important factor for carrying out a successful polymer mediated synthesis. A wide range of polymers are available, however, the most widely used are the functionalized polymers derived from styrene-DVB copolymers, although the possibility of other polymers being utilized for such purposes is wide and some aspects of their use has come to light in some of the recent works published. A few instances are, the vinyl polymers incorporating pyridinium chlorochromate has been prepared and functionalized to serve as polymeric support in organic synthesis, e.g. in the oxidation of alcohols to carbonyl compounds (1). Carbodi-imide group incorporated in polymers like polyethylene and polyhexamethylene has been used as condensing agent for peptide and anhydride synthesis (2,3).

Polyamide supports such as poly-L-lysine, polydimethylacryl- amide and polyacrylmorpholide are reported to have been used in the synthesis of oligonucleotides (4,5).

**ADVANTAGES AND DISADVANTAGES IN USING FUNCTIONALIZED POLYMERS**

The advantages of using a functionalized polymer as a reagent or a catalyst lies in the simplification of work-up procedure for separation and isolation of products formed. Automatic removal of by products in a reaction by virtue of the reagent's selective attachment to the insoluble polymer has been considered to be a major advantage. Further, reactivity of an unstable reagent or catalyst may be attenuated when supported on a resin and the corrosive action for example, of protonic acids can be minimized by effective entrapment. Finally, toxic reagents and malodourous materials, such as sulphur compounds can be rendered environmentally acceptable by immobilization.

Despite these significant advantages, use of these polymeric reagents have some important shortcomings too. The most important among these has been the additional time and cost involved in synthesizing a supported reagent and catalyst. However, this may be very well compensated by the potential advantages offered by the use of regenerable and recyclable variety. A good number of systems have been developed and considerable scope is still left for exploitation and for their utilization in synthetic organic chemistry.
POLYMERIC REAGENTS

The following are some of the useful polymeric reagents that have been utilized in organic synthesis.

(A) Polymeric Condensing Reagent:

In the synthesis of peptides and nucleotides, carbodi-imides have been used as condensing agents, and some insoluble polymer-bound carbodi-imide derivatives have been prepared and used in the synthesis of peptides(6). These polymeric supports were also used in the preparation of carboxylic acid anhydride(2) as shown in scheme 1. The anhydride thus formed can be isolated from the reaction mixture by means of simple filtration and subsequent removal of the solvent. Besides the said polymeric condensing reagent, some other polymeric reagents are also known and polymeric benzene sulphonyl chloride which happens to be a reagent of this kind finds application in peptide synthesis.

\[\text{Scheme-1}\]

\[\text{P}{-\text{NH-CO-NH-R}} \xrightarrow{\text{TsCl-Et,NH}} \text{P}{-\text{N=C=N-R}} \xrightarrow{\text{Stearic acid}} \text{P}{-\text{NH-CO-NH-R}} + \text{Stearic anhydride}\]

\[\text{P} = \text{Polymer}\]

(B) Polymeric Halogenating Reagent:

Different polymeric halogenating reagents have come to light which have been successfully prepared by introducing halogens into molecules either by electrophilic addition or by nucleophilic displacement. Polymeric analog of N-bromosuccinimide have been synthesized (7) and allylic bromination of cyclohexene could be done successfully with \(\text{O-N-bromomaleimide}\).

(C) Polymeric Alkylating and Acylating Reagents:

Different polymeric reagents have been found to act as alkylating and acylating reagents. 'Popcorn' polymer(8) obtained from styrene, p-vinyl benzoic acid and divinyl benzene has been used for preparing
insoluble anhydrides (9). These anhydrides when reacted with aniline or ethanol gave the anilides or ethyl esters in good yield. The transformation is shown in scheme 2.

**SCHEME-2**

\[ \text{P}-\text{CO}-\text{O}-\text{CO}-\text{Ph} \xrightarrow{\text{(i)PhNH}_2} \text{(i)Benzanilide/Ethyl benzoate}} \]

Alkylation or acylation of compounds containing active methylene group, invariably gives poor yields of the monoalkylated/acylated products. This is due to the formation of diacylated/dialkylated products and products obtained by self-condensation of the ester under study. However, these competing side reactions can be prevented by the introduction of insoluble polymer carriers. If the molecules of an enolizable ester are bound to a polymer by covalent linkage at sufficiently low level of loading, the molecules should be essentially well separated from one another. And if the polymer used is absolutely rigid and does not undergo any conformational change to bring the anchored molecules very close to each other, the statistical chances for self-condensation to take place is reduced to a large extent. The substrate is then said to exist in an environment of 'infinite dilution'. One equivalent of a suitable base followed by one equivalent of the alkylhalides or acylhalides gives preferably monosubstituted product (10-13). The reaction sequence is shown in scheme 3.

**SCHEME-3**

\[ \text{P}-\text{CH}_2\text{CO}-\text{CH}_2\text{R} \xrightarrow{\text{Base}} \text{P}-\text{CH}_2\text{O}\text{C}-\text{CHR} \]

\[ \begin{align*}
\text{P}-\text{CH}_2\text{O}\text{C}-\text{CHR} &
\xrightarrow{\text{R'}\text{COCl}} \text{P}-\text{CH}_2\text{O}\text{C}-\text{CHR} \\
\xrightarrow{\text{H}^+} \text{RCH}_2\text{COR'} &
\end{align*} \]

\[ \begin{align*}
\text{P}-\text{CH}_2\text{O}\text{C}-\text{CHR} &
\xrightarrow{\text{R''CH}_2\text{Cl}} \text{P}-\text{CH}_2\text{O}\text{C}-\text{CHR} \\
\xrightarrow{\text{H}^+} \text{R-CH-CH}_2\text{R''} &
\end{align*} \]
Selective mono- and di-C-alkylation of 1,3-dicarbonyl compounds having two active hydrogen atoms through a simple and mild operation remains as a formidable problem in organic synthesis and this can be eliminated by a simple and controlled procedure through a solvent-free reaction on the surface of alumina impregnated with sodium or potassium alkoxide(14), as shown in scheme 4.


(D) Polymeric Protecting Groups:

In a completely symmetrical bifunctional compound, there is no group capable of reacting selectively with only one functionality. However, successful use of the functionalized insoluble polymer made it possible. When a large excess of a symmetrical bifunctional compound reacts with a functionalized insoluble polymer, it will provide an environment of 'infinite dilution' which will ensure the reaction of only one functional group with the polymer. Thus the hyperentropic efficacy (infinite dilution effect) of the reaction will result in a monoblocked symmetrical bifunctional compound which can be separated from the excess of symmetrical bifunctional compound by simple filtration.

Where, \( R = \text{Tf (Tol) Of Thp (Tetrahydropyran)} \)

and \( n = 2, 4, 6, 8, 10 \)
Symmetrical diols can be bound to a polymer (acid chloride) via one of the hydroxyl groups leaving the other hydroxyl group free for derivatization(15,16), which is represented in scheme 5. The original polymer in this case could however be regenerated for reuse. Similarly, symmetrical dialdehydes have been shown to react exclusively at one aldehyde function with a cross-linked polystyrene polymer containing a diol functional group(17) according to the scheme 6.

Symmetrical diacid chlorides have also been monoblocked utilizing hydroxymethylated polymer(18). Monofunctionalization of symmetrical diamines has also been reported (19,20).
(E) Polymeric Redox Reagents:

Polymeric redox systems were one of the earliest examples of polymeric reagents. Many of the redox polymers prepared are known to have incorporated the quinone or aminoquinone groups in the polymer matrix. In most of the quinone-based redox polymers electron-withdrawing substituents are introduced so as to increase the hydrogen acceptor property which in turn increase the redox potential of the quinone-hydroquinone system. Such polymeric systems have been employed for dehydrogenation and oxidation of organic compounds. Other such important systems are thiol-disulphide system, pyridine-hydropyridine system, polymeric dyes and polymeric metal complex systems.

Insoluble peracid reagent has been one of the oldest known polymeric reagent used in epoxidation of olefines(21). Report of synthesis of unsymmetrical disulphides with thiol sulphonates immobilized on a polystyrene support (22) has received much attention as it enables one to eliminate the cumbersome and time-consuming procedure of separation of by product (sulphinic acid) from reaction mixture.

Reduction of organic compounds with polymer-supported reagents includes the reduction of disulphides to thiols(23). Insoluble polymeric organotin dihydride(24) has been prepared and used as a selective reducing agent for carbonyl compound and alkylhalides.

(F) Polymeric Phosphine Reagents:

These have been used as a modification to the important Wittig reaction of olefin synthesis. The disadvantage of the ordinary Wittig reaction lies in the difficulty in separating the desired product from the by products, specially the triphenyl phosphine oxide. As a modification to

\[
\text{Scheme 7}
\]

\[
\text{Base} \quad \begin{array}{c}
\text{Ph} \\
\text{Ph}
\end{array}
\xrightarrow{\text{I}}
\begin{array}{c}
\text{P} \\
\text{P=CH-X}
\end{array}
\xrightarrow{\text{I}}
\begin{array}{c}
\text{Ph} \\
\text{Ph}
\end{array}
\]
the Wittig reaction a phosphine reagent was attached to the polymer backbone. After the reaction, the byproducts remained with the polymer and the product, olefin, was virtually free from contamination. The reaction is shown in scheme 7.

Besides its use in Wittig reaction, utilization of polymeric phosphine reagents is manifold. The reductive cleavage of aromatic disulphides to afford the corresponding thiols by the application of this polymeric support reagent (25) as shown in scheme 8, is one such example.

\[ \text{SCHEME-8} \]

\[
\begin{align*}
\text{Ar-S-S-Ar} + (\text{PVPPh})_2 & \rightarrow \text{Ar-S-PPh}_2(P) + \text{Ar-S} \\
\text{Ar-S-PPh}_2(P) + \text{H}_2\text{O} & \rightarrow 2\text{Ar-S} + 2\text{H}^+ + \text{Ph}_2\text{PO} \\
2\text{Ar-S} + 2\text{H}^+ & \rightarrow \text{Ar-SH}
\end{align*}
\]

(G) Miscellaneous:

There are some other polymer immobilized reagents which could not be categorized. One such synthetically important reagent has been the polymer-bound tosyl azide (26) which is used as a diazo group transfer reagent as per scheme 9 in the synthesis of diazoketones from \( \beta \)-diketones.

\[ \text{SCHEME-9} \]

\[
\begin{align*}
\text{P-SO}_2\text{N}_3 + \text{Et}_3\text{N} & \rightarrow \text{R-CO-CH}_2\text{-CO-R} \\
\text{Solid phase} & \rightarrow \text{in solution} \\
\text{R-CO-C-COR} + (\text{P})\text{-SO}_2\text{NH}_2 & \rightarrow \text{R-CO-C-COR}
\end{align*}
\]
Some of the recently reported polymer mediated organic synthesis which may have significant importance are -

(1) Application of Stille reaction for efficient carbon-carbon bond formation on solid support by coupling polymer-bound aryl iodides with vinyl aryl stannanes (27) (scheme 10).

![Scheme 10]


(2) The solid phase condensation of an amine with an aldehyde or ketone giving imines using specially the Sasrin bound 13C-labeled amino acids at room temperature appears to be having significant applicability (28).

(3) Preparation of a solid-phase CBZ chloride equivalent grafted onto Tenta gel S-resin is important because of its ready conversion to polymer bound amides and esters (29).

(4) The synthesis of macrocyclic ring system using polymer immobilized \( \omega \)-hydroxy dodecanoic acid and a linear dimer of \( \epsilon \)-hydroxy caproic acid is of considerable interest because this report is one of the very few instances of synthesis of macrocycles on polymer support (30).

II. A REVIEW OF ION-EXCHANGE RESIN AS SUPPORT IN ORGANIC SYNTHESIS

In addition to the conventional polymers, the ion-exchange resins, both anionic and cationic, have also been used for the variety of organic synthesis. It is well known that the acid and the base form of ion-exchange resin represents the earliest example of synthetic polymeric catalyst (31,32) and several review on the subject is presently available (33,34). The commercial availability of a series of resin which are functionalized polystyrenes both in the form of anion and cation exchangers have led to their utility in a variety of organic synthetic methods. Although the ion-exchange
resins are historically the earliest example of the polymer-support reagents, this aspect of synthetic organic chemistry have remained relatively underutilized although they provide similar advantages in terms of simple reaction work-up, easy product isolation and mild reaction conditions. Ion-exchange resins can be considered as potential substitute for tetraalkylammonium salts used as catalyst in the ever popular phase-transfer techniques. One additional feature of the ion-exchangers is the fact that they can be thoroughly dried by several methods including azeotropic distillation. This feature provides the additional advantage of undertaking a high degree of dehydration of the anions/cations linked to the resin which eventually can be used to avoid hydrolytic side reactions or for immobilizing ions which are prone to hydrolytic decomposition. Further, better yield may be achieved by increasing the reaction rates using reagents far in excess of the stoichiometric requirements. However, choice of solvent remains critical and is often being determined by the desired reaction temperature. In case of highly reactive species, protic solvent such as alcohols and even water have been used. Barring a few exceptions, the resins used can be regenerated by washing with an appropriate reagent. A detail discussion on the utilization of the ion-exchange resin for immobilizing organic reagents is being presented herein.

(1) Halogenating Agents:

Polymeric reagents have been used to introduce halogens into molecules either by nucleophilic displacement or by electrophilic addition. Anion exchange resins carrying fluorine, chlorine, bromine and iodine anions have been used to exchange one halide for another in various alkylhalide substrates (35) according to scheme 11.

\[ \text{SF\text{\textendash}11} \]

Where, \( X = \text{Cl, Br, I} \)
The preparation of alkyl fluorides has been the point of much interest from the synthetic point of view.

By the use of standard amine anion exchange resin loaded with fluoride ions, sulphonyl fluorides have been prepared and was used to exchange halogen anions with various sulphonyl halides (36).

Fluorine transfer from Amberlyst A-26 was used to prepare compounds containing $^{18}$F (37,38). This route was exploited in preparing various labeled alkyl and acyl fluorides.

Anion exchange resins have also found its use in the synthesis of halogenated organic compounds. The ion-exchange resin in the bromide or iodide form were treated with an excess of bromine or chlorine in CCl$_4$ to give respectively the Br$_3^-$, BrCl$_2^-$ and ICl$_2^-$ anions linked to the polymer. By means of the polymer-supported perbromide reagent direct bromination of aldehydes and ketones were effected whereas corresponding chlorination of the same substrates were effected by using ICl$_2^-$ resins (39).

(2) Alkylation:

It was shown that the anion exchange resins containing fluoride ions are powerful bases for promoting many base catalyzed organic reactions under mild condition. With the aid of fluoride ions immobilized on strongly basic anion exchange resin like Amberlyst A-26, A-27 or Dowex MSA-1, alkylation of $\beta$-diketones can be carried out(40). Applying the same technique sulphenylation of $\beta$-diketones, Michael addition of a thiol to an $\alpha,\beta$-unsaturated ketone and $\alpha$-alkylation of phenols were also made possible.

Alkylation of $\beta$-diketones using polymers as supports for the intermediate enolate anion has also been reported (41). The said report also includes a discussion on the polymer mediated alkylation of phenoxide anion.

(3) Oxidizing Agent:

Polymer-supported chromic acid (Amberlyst A-26, HCrO$_4^-$ form) has been prepared by washing chloride form of the resin with aqueous solution of chromic acid as shown in the scheme 12 and it finds applications in oxidation of 1° and 2° alcohols to carbonyl compounds (42). The same polymer supported reagent has been used in the preparation of aldehydes and
ketones from allylic and benzylic halides\cite{43}. In either of the cases regeneration of the resin was done effectively.

\textbf{SCHEME-12}

\[
\begin{align*}
\text{P} - \text{C}_6\text{H}_4\text{N}^+ & + \text{CrO}_3\text{(aq.)} \rightarrow \text{P} - \text{C}_6\text{H}_4\text{N}^+ + \text{HCl} \\
& \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad 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Periodates immobilized on to Amberlite IRA 904 resin (Cl\textsuperscript{-} form) and iodoses immobilized on to Amberlyst A-26 resin (hydroxide form) were used for oxidation of chloroquinol to chlorobenzoquinone and dibenzylsulphide to dibenzyl sulphoxide\cite{44}.

\textbf{(4) Polymeric nucleophiles :}

A good number of reactions have been identified where anion exchange resins act as polymeric nucleophiles. One such reaction is the preparation of esters from carboxylic acids and alkyl halides according to the scheme 13 on ion-exchange resin support \cite{45}.

\textbf{SCHEME-13}

Preparation of polymer supported cyano compounds is of significance. Benzyl cyanide can be obtained by the reaction of benzyl bromide with an anion exchange resin, CN\textsuperscript{-} form\cite{46,47}. When sodium or potassium cyanide is used as a source of nucleophiles(CN\textsuperscript{-}), the reaction product had to be isolated from the inorganic material but with the resin-bound nucleophile, the reaction was carried out in column and the product was simply eluted out while the by products remained in the column (scheme 14).
Sulphonates are generally observed to be less prone to the elimination reactions compared to the corresponding alkylhalides. However, preparation of secondary alkyl fluorides starting from sulphonates in the ion-exchange resin support has been reported (48) and forms an interesting procedure of indirect removal of sulphonates to give alkenes.

In yet another report the use of anion exchange resin provides an improvised way of obtaining phenyl sulphones from polymer-supported benzene sulphinate according to the scheme 15 (49).

So far the discussion has been restricted to some reactions performed with simple nucleophiles attached to the anion exchanger. The same kind of support, however, finds use in the preparation of a variety of different reagents. Use of anion exchange resin in the synthesis of benzyl ethers of phenols(50) is one such example. Benzyl ethers of phenols are usually synthesized by coupling an alkali phenolate with benzyl halide in an appropriate solvent with the aid of heat. But interestingly the resin-supported synthesis could be carried out conveniently at room temperature by the use of phenolates immobilized onto an anion exchange resin according to the scheme 16.
Synthesis of aldehydes from alkylhalides by a polymer-supported iron carbonyl complex (51) was done by supporting the reagents on a polymer matrix using Amberlyst A-26 (Cl\(^+\)). The tetra-carbonylhydridoferrate anion, rapidly and quantitatively exchanges under an inert atmosphere, with the chloride ion simply on stirring the resin[Y] (scheme 17) with the solution of the hydride[X]. Resin[Z] prepared in this way can be utilized to convert alkylhalides to homologous aldehydes in tetrahydrofuran solution under reflux(52). The report is, however, silent about the regeneration of the resin. This hydride resin was found to behave as a useful reducing agent and was utilized in converting aromatic nitro compounds to amines under mild conditions.
Phosphonates substituted with electron withdrawing groups like -CN and -COO.Me have been supported on a macroreticular ion-exchange resin, Amberlyst A-26 by simple neutralization process according to the scheme 18 (53). Treatment of carbonyl compounds with the polymer bound Horner-Wittig reagent in various solvents gave olefins in high yield at room temperature (54).

Synthesis of acyl azide on ion-exchange resin, Amberlite IRA 400, Cl form, support has been reported (55).

Use of the anion exchange resin, Amberlite 400, hydroxide form in immobilizing carbanion from methyl nitroacetate and its subsequent use to effect Michael addition has also been reported (56).

Sodium salt of hippuric acid when treated with Amberlite IRA 400, chloride form, affords the polymer-supported hippuric acid anion which can be alkylated by treatment with alkylhalides in ethanol. Easy regeneration of the resin to its initial activity has also been reported.

Reports are also available of immobilization of biomolecules such as enzymes and utilizing these biomolecules in synthetic organic chemistry. The above review is by no means exhaustive but is expected to emphasize the importance of polymer immobilized reagents in organic synthesis.

III. SUMMARY OF CHAPTERS

In the present study, ion-exchange resins have been used for the preparation of some immobilized reagents and their synthetic utility studied. The overall study included the applicability of three types of resin immobilized reagents, namely:

1. resin immobilized diazonium ions with which diazocoupling reactions were carried out in solid phase
(2) utility of resin immobilized borohydride as a useful reducing agent

(3) synthetic utility of resin immobilized papain.

The reason for taking three different reagents was to emphasize the widespread utility of these reagents in organic synthesis. The study of diazocoupling reaction on ion-exchange resin support indicates the usefulness of such techniques in carrying out nucleophilic and electrophilic substitution reactions. Resin immobilized borohydride was utilized to carry out reduction reactions and finally the utilization of resin immobilized papain for the hydrolysis of anilides emphasized the applicability of resin immobilized enzymes in organic synthesis.

Summary of different chapters appearing in this thesis is as follows:

DIAZOCOUPPING REACTIONS ON ION-EXCHANGE RESIN SUPPORT

In the initial stages of the present study a procedure was found out to immobilize aryldiazonium ions onto a cation exchanger for its application as a solid phase 'arylazo' group transfer reagent. In the study, the diazonium ions were formed by the usual reactions of an aromatic amine with nitrous acid. Thereafter, diazonium ions were immobilized on a cation exchanger to give the resin immobilized aryldiazonium ions. Resin immobilized diazonium ions could indeed be utilized to give the diazocoupling reactions in the solid phase, details of which is given in chapter I.

One important fact observed was that by using resin immobilized diazonium ions the diazocoupling reactions could be carried out in organic solvents which was hitherto not possible. Another important fact that came to light was the fact that by immobilization, aryldiazonium ions could be stabilized and could be stored under ordinary conditions.

SYNTHESIS OF 1,2,3-TRIAZENES ON SOLID SUPPORT

1,2,3-triazenes are useful synthetic intermediates and these compounds find application as cytotoxic agents. In the classical synthetic methods triazenes were synthesized by N-coupling of amines with diazonium ions in acidic or alkaline medium. The method has been found unsatisfactory, however, in the present study, triazenes have been synthesized in a solid phase reaction by first immobilizing the diazonium ions onto a cation
exchanger and subsequently brought into reaction with suitable amines in an appropriate solvent. Details of the synthetic procedures are given in chapter-II.

**SOLID PHASE DIAZOCOUPLING REACTIONS OF INDOLE AND INDOLE DERIVATIVES**

The diazocoupling reactions of indole and its derivatives which are \( \pi \)-excessive heteroaromatics was first investigated by Fischer in 1886 and subsequently by other authors. It has been observed that the diazocoupling reactions of indole to give 3-arylazoindole suffers from the inherent disadvantages of the fact that the primary reaction is accompanied by several competitive side reactions. It has also been observed that the azo product obtained undergoes decomposition in the presence of acids in the usual reaction conditions. However, it has been found in this study that resin immobilized aryldiazonium ions can be successfully utilized to carry out the diazocoupling reactions of indole to give 3-arylazoindole in high yields with no by product formation. Similar reactions have also been carried out with 3-methyl indole (skatole) to give the desired 2-arylazoskatoles in good yield. The diazocoupling reactions could be carried out in organic solvents and details of which is presented in chapter-III.

**SYNTHESIS OF N-ARYLAZO PRODUCTS OF INDOLE AND PYRROLE ON POLYMERIC SUPPORT**

The diazocoupling reactions of indole and pyrrole have earlier been carried out either in acidic or alkaline medium. The electron density measurement reveals the C-3 be the ideal position in indole for the diazocoupling reaction to occur. Under no condition, the N-arylazoindole could be prepared. One method which was unsuccessfully utilized was by converting indole to its N- sodio derivative followed by reaction of the latter with diazonium ion solutions. This method also could not give the N-arylazoindole for the obvious reason that in the presence of acids diazocoupling reactions at the N-position was impossible as the proton, being a stronger electrophile, replaced the Na-metal in preference to the weak electrophile, namely the diazonium ion.

In this study, diazonium ions were immobilized onto a cation exchanger and the resin immobilized diazonium ions thus obtained were subsequently brought into reaction with a solution of sodio indole/sodio pyrrole, prepared in anhydrous tetrahydrofuran to give N-arylazoindole / N-arylazopyrrole in good yield without the formation of by products.
A reverse procedure was also followed wherein indole and pyrrole were converted into their sodium salt in anhydrous tetrahydrofuran and the indolyl and pyrryl anions were subsequently grafted onto an anion exchanger. The indolyl and pyrryl anions were brought into reaction with diazonium ion in solutions, the product obtained were the N-arylazoindoles and N-arylazopyrroles. Elaborate discussion is given in chapter-IV.

**REDUCTION BY BOROHYDRIDE EXCHANGE RESIN (BER)**

In a subsequent study, borohydride exchange resins were prepared and utilized to reduce the azo compounds to their hydrazo analogs. Studies were also carried out on the utility of BER for the reduction of the exocyclic double bond of oxazolones in the 4-position. Details of the experimental methods are given in chapter-V.

**HYDROLYSIS OF ANILIDES BY RESIN IMMOBILIZED PAPAIN**

In yet another study, the ion-exchange resins were utilized to immobilize a hydrolytic enzyme, namely papain. It has been observed that papain can be utilized under proper condition to hydrolyze anilides. It has also been observed that by carefully controlling the condition of pH, papain can be immobilized onto a cation exchanger and subsequently the hydrolysis of anilides in a biphasic condition can be studied, experimental detail is given in chapter-VI.

From the review given herein, it has been observed that anion exchange resins have been the materials of choice as an immobilizing matrix. However, very few instances are available on the utilization of cation exchangers. In the present study, the cation exchanger have been utilized especially for immobilizing aryldiazonium ions and subsequently used as "polymeric arylazo group transfer reagents". Similarly, anion exchangers were used in preparation of "Borohydride Exchange Resin" and subsequently utilized in some organic synthesis.