GENERAL INTRODUCTION

Number of useful, important organic reactions take place only in the presence of transition metal complexes.

Ziegler - Natta polymerisation:
\[ \text{CH}_2=\text{CH}_2 + [\text{Ti}] \rightarrow \text{[CH}_2\text{CH}_2]_n \]

Wacker process:
\[ \text{CH}_2 = \text{CH}_2 + \text{O}_2 \rightarrow \text{CH}_3\text{CHO} \]

Fischer - Tropsch synthesis:
\[ \text{CO} + \text{H}_2 \rightarrow \text{C}_n \text{ compounds} \]

Homogeneous hydrogenations using Wilkinson's catalyst:
\[ \text{C}=\text{C} + \text{[\{(Ph}_3\text{P)}_3\text{RhCl}\}] \rightarrow \text{C}-\text{C}-\text{H} \]

Hydroformylation: Oxo process:
\[ \text{CH}_3\text{CH} = \text{CH}_2 + \text{[Co]}/\text{CO}/\text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CHO} \]
Hydrocarboxylation: Reppe Reaction\textsuperscript{15,16}

\[
\ce{\overset{\text{Ni(CO)}_4}{\mathrm{C} = \mathrm{C} + \mathrm{CO} + \mathrm{H}_2O} \rightarrow \mathrm{H - C - C - COOH}}
\]

Hydrocyanation\textsuperscript{17}:

\[
\ce{\mathrm{\overset{[\text{Ni}]}{=\mathrm{C} - \mathrm{C} - \mathrm{CN}}} + 2\text{HCN} \rightarrow \mathrm{CN - \mathrm{C} - \mathrm{CN}}}
\]

Epoxidation\textsuperscript{18}:

\[
\ce{\mathrm{\overset{[\text{Mo}]}{\mathrm{CH}_3\mathrm{CH} = \mathrm{CH}_2 + \text{Ph - CH} - \mathrm{CH}_3 \rightarrow \mathrm{H}_3\mathrm{CCH} - \mathrm{CH}_2 + \text{Ph - CH} - \mathrm{CH}_3}}}
\]

Oxychlorination\textsuperscript{19}:

\[
\ce{\mathrm{\overset{[\text{Cu}]}{\mathrm{CH}_2 = \mathrm{CH}_2 + \mathrm{HCl} + \mathrm{O}_2 \rightarrow \mathrm{CH}_2 = \mathrm{CHCl} + \mathrm{H}_2\mathrm{O}}}
\]

Oligomerization\textsuperscript{20,21}:

\[
\ce{\overset{[\text{Ni}]}{4(\text{HC} \equiv \text{CH}) \rightarrow \text{Octane}}}
\]

\[
\ce{\overset{[\text{Ti}]}{3 \overset{\text{[Ti]}}{=\mathrm{C} - \mathrm{C}} \rightarrow \text{Indane}}}
\]
Metathesis Reaction$^{22-24}$:

$$\begin{align*}
\text{R}_1 \text{C} & \quad \text{R}_2 \quad \text{C} \\
\text{C} & \quad \text{R}_4 \\
\text{R}_3 & \quad \text{R}_5 \quad \text{C} \\
\quad & \quad \text{R}_6
\end{align*}$$

These transformations and many other catalytic processes involving transition metal complexes have been put into industrial applications. Research and development of these industrial reactions required understanding of the mechanisms and intermediates involved in these processes. It was realized that these processes involve the intermediacy of an organometallic intermediate at least in one of the steps and hence there is immense interest in studying the structure and reactions of organometallic compounds.

Studies on the structure and reactivities of the transition metal organometallic compounds constitute the major part of the organometallic chemistry which has been developing rapidly over the past 30 years. In recent years, there is immense interest among organic chemists to exploit this type of chemistry in synthesis. Many useful reactions and applications of organocupper$^{25-27}$ and organopalladium$^{28}$ reagents have been uncovered. Several other transition metal complexes
have been found to give transformations hitherto unknown to organic chemists. Many reagent systems involving organometallic compounds of titanium and zirconium compounds have been developed.29-31

Interesting cyclization reactions utilizing chromium carbene complexes have been observed.32

\[
\begin{align*}
\text{(CO)}_5\text{Cr}=C&:(R_1)C=CR_2 \to \begin{array}{c}
\text{OH} \\
R_1 \\
\text{R} \\
\end{array} \\
\text{R} \\
\text{R} \\
\end{align*}
\]

Organoiron reagents have been found to give many interesting applications.33 Several interesting transformations have been realised with \(\text{Fe}_2(\text{CO})_9\).33-35

\[
\begin{align*}
\text{Br} & \quad \text{O} & \quad \text{Br} & \quad \text{Br} & \quad \text{Br} \\
\text{Br} & \quad \text{O} & \quad \text{Br} & \quad \text{Br} & \quad \text{Br} \\
\end{align*}
\]

A new method of constructing five membered rings via cooligomerization of an alkyne and alkene with carbon monoxide utilizing \(\text{Co}_2(\text{CO})_8\).
has been discovered by Pauson and Khand.\textsuperscript{36} This reaction has been already extensively utilized for the synthesis of many cyclopentanoid natural products.\textsuperscript{36}

Several cobalt catalysed (2+2+2) cycloadditions and cyclizations utilizing CpCo(CO)\textsubscript{2} and their applications in the synthesis of natural products have been reported by Vollhardt and his coworkers.\textsuperscript{37}
Organonickel complexes have been found to give many interesting reactions and an excellent compilation has appeared.\textsuperscript{38}

Despite the availability of several excellent review articles on the interesting synthetic methods utilizing transition metal complexes, still there is hesitation among synthetic chemists in utilizing these methods. This may be due to complexities involved in the synthesis of the transition metal organometallic reagents required for these transformations. Our objective is to investigate the reactions of transition metal hydrides and low-valent transition metal complexes, generated by reduction of transition metal halides utilizing simple reducing agents such as NaBH\textsubscript{4} with organic substrates. We have selected the cobalt(II) chloride for the present investigation. The relevant literature reports are discussed in the introductory, and results and discussion sections of chapters 1-3.