

M.Sc Sem – 1 (Chemistry)

Lecture – 2 ; Vilsmeier reaction

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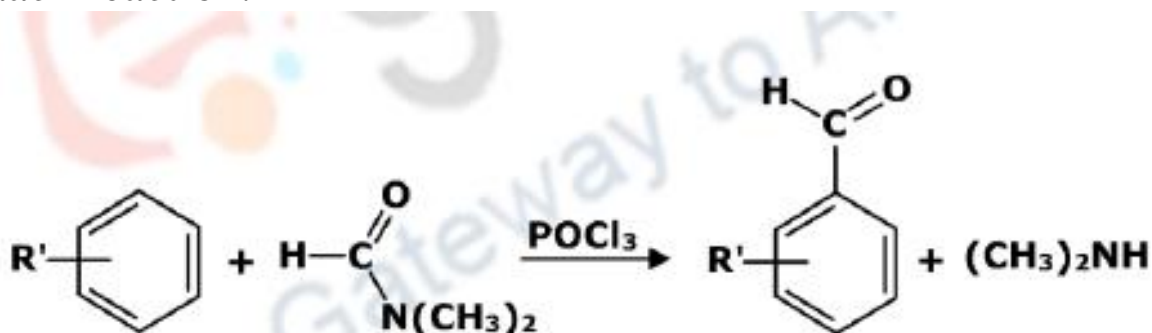
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Vilsmeier-Haack Reaction : -

The reaction of electron-rich aromatic compounds with N,N-dimethylformamide (DMF) and phosphorus oxychloride (POCl_3) to yield an aromatic aldehyde is called the Vilsmeier–Haack reaction.



Reagents used in Vilsmeier–Haack reaction :-

The Vilsmeier complexes employed in the formylation reactions are usually derived from N,N-disubstituted amide and POCl_3 .

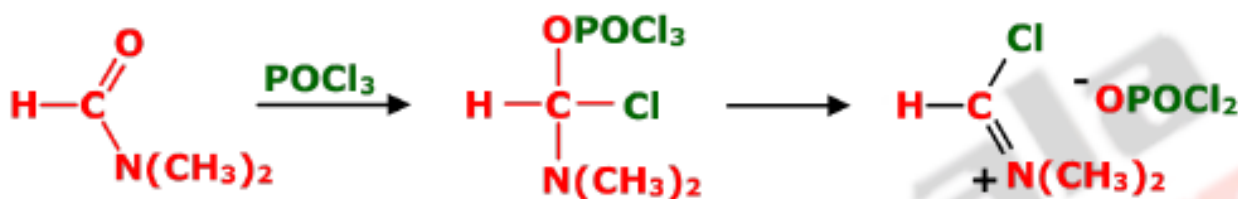
(1) N,N-disubstituted amides :- N-Methyl formanilide, N,N-dimethyl formamide, N-formylpiperidine and N-formylindoline have also been used other than DMF. Other amides such as N,N-dimethyl acetamide, N-methyl acetamide, N, N-dimethyl benzamide, etc. have been employed in the presence of POCl_3 but these amides are prone to undergo self condensation.

(2) Acid chlorides:- Acid chlorides other than POCl_3 have also been used in carrying out the Vilsmeier reactions. Some of these are PCl_5 , SOCl_2 , COCl_2 , R/ArCOCl , ArSO_2Cl , , $\text{Me}_2\text{NSO}_2\text{Cl}$.

(3)Solvents:- When liquid amides are used as solvents, excess can be used, e.g DMF, dimethyl acetamide, N-methyl pyrrolidone, etc. Other solvents have also been used like benzene, toluene, chloroform, methylchloride, o-dichlorobenzene, dioxane and tetrahydrofuran.

Structure of the Vilsmeier-Haack Complex :-

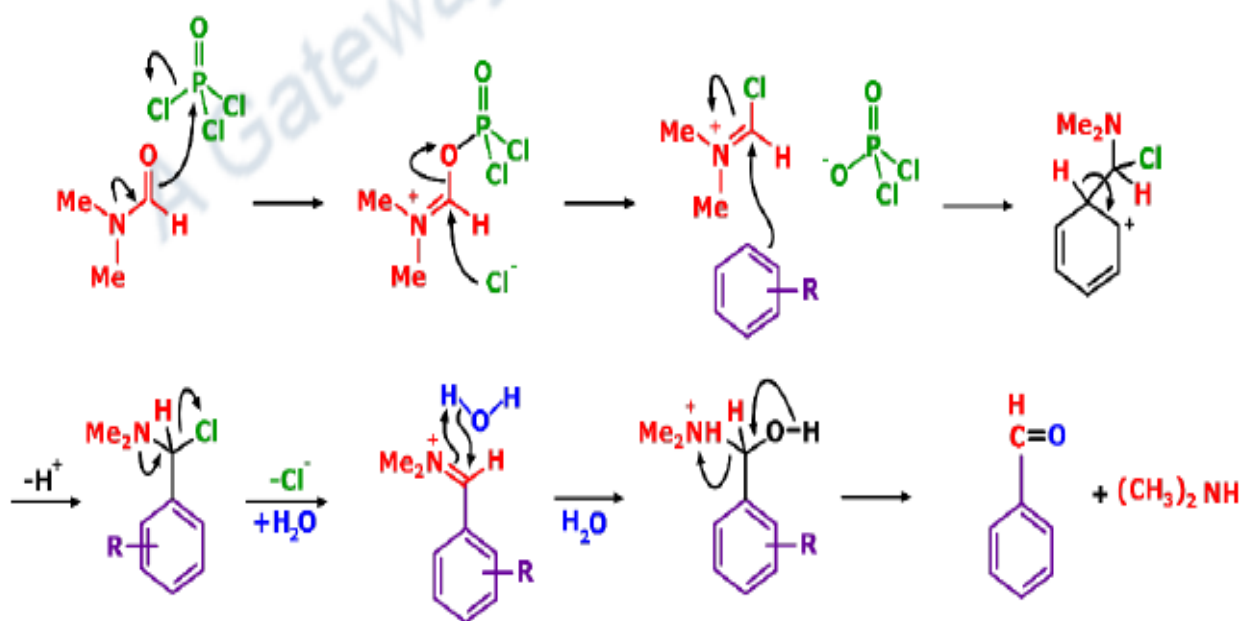
Phosphorous oxychloride reacts with tertiary amides to give adduct which exhibits salt like properties. These adducts so obtained are called as the **Vilsmeier complexes**.



Mechanism of Vilsmeier-Haack reaction :-

The formylating agent is a chloromethyl iminium salt, also called the Vilsmeier complex that acts as the electrophile in an electrophilic substitution reaction with the aromatic substrate.

The initial product of the electrophilic aromatic substitution step is unstable and easily hydrolyzes to yield the aromatic aldehyde as the final reaction product. With *mono*-substituted aromatic substrates the *para*-substituted aldehyde is formed preferentially.



Vilsmeier-Haack reaction is applicable only to electron rich aromatic compounds such as amines and phenols. Benzene and naphthalene are unreactive but anthracene gives 1-aldehyde (85%). N, N-dimethyl aniline gives 4-dimethyl amino benzaldehyde (80%). The method is particularly effective for compounds such as pyrroles which are not formylated by other procedures.

