Cyanohydrins have the structural formula of $R_2C(OH)CN$. The “R” on the formula represents an alkyl, aryl, or hydrogen. In order to form a cyanohydrin, a hydrogen cyanide adds reversibly to the carbonyl group of an organic compound thus forming a hydroxyalkanenitrile adducts (commonly known and called as cyanohydrins).

Introduction

Cyanohydrin reactions occurs when an aldehyde or ketone gets treated by a cyanide anion (such as HCN) or a nitrile forming a cyanohydrin product. This special reaction is a nucleophilic addition, where the nucleophilic $CN^-$ attacks the electrophilic carbonyl carbon on the ketone, following a protonation by HCN, thereby the cyanide anion being regenerated. This reaction is also reversible.

Cyanohydrins are also intermediates for the Strecker amino acid synthesis. The preparation of displacements of sulfite by cyanide salts are also followed under cyanohydrins.

Mechanism of Cyanohydrin Formation

Acid-catalysed hydrolysis of silylated cyanohydrins has recently been shown to give cyanohydrins instead of ketones; thus an efficient synthesis of cyanohydrins has been found which works with even highly hindered ketones.

Acetone Cyanohydrins
Acetone cyanohydrins (ACH) have the structural formula of \((\text{CH}_3)\text{C(OH)CN}\) and are extremely hazardous substances, since they rapidly decomposes in contact with water. In ACH, sulfuric acid is treated to give the sulfate ester of the methacrylamid. Preparations of other cyanohydrins are also used from ACH: for HACN to Michael acceptors and for the formylation of arenas. The treatment with lithium hydride affords anhydrous lithium cyanide.

Other Cyanohydrins

Other cyanohydrins, excluding acetone cyanohydrins, are: mandelonitrile and glycolonitrile.

Mandelonitrile have a structural formula of \(\text{C}_6\text{H}_5\text{CH(OH)CN}\) and occur in pits of some fruits. Glycolonitrile is an organic compound with the structural formula of \(\text{HOCH}_2\text{CN}\), which is the simplest cyanohydrin that is derived by formaldehydes.

References


Problems

Complete the following reactions for cyanohydrins:
1.)

\[
\text{cyclcopentanone} + \text{Na}^+ \cdot \text{CN} \xrightarrow{\text{Conc. HCl}} \text{HCN} + \text{NaCl}
\]

2.)

\[
\text{CH}_3\text{CCN} \rightleftharpoons \text{CH}_2\text{CH} + \text{HCN} \xrightarrow{\text{HO}^-} \text{shifts equilibrium}
\]

3.) True or False: For a cyanohydrin to form, a \textit{fast addition} of strong acid to cyanide salt is carried out to convert the salt into HCN.

4.) True or False: Cyanohydrin reactions are \textit{irreversible}.

5.) What is the product for the overall reaction?

\[
\text{Mes}_3\text{SiCN}, \text{ZnI}_2 \xrightarrow{\text{aq. HCl}, 45^\circ\text{C}} \?
\]

\underline{Answers}

1.)

2.)

3.) False, slow addition

4.) False, reversible

5.)
Contributors

- Kathy Wong (UCD)