Oxidation Reactions of Alkenes (Addition Reactions)

Potassium Permanganate: KMnO₄

Purple crystals in H₂O and H₂SO₄

General Scheme:

\[
\begin{align*}
\text{C}=\text{O} & \quad \text{O}=\text{C} \\
\text{C}=\text{C} & \quad \text{C}=\text{C} \\
\text{C} & \quad \text{C} \\
\text{OH} & \quad \text{OH} \\
\text{OH} & \quad \text{OH}
\end{align*}
\]

KMnO₄

H₂O, H₂SO₄

“Hot” (100 °C)

Cis Addition

KMnO₄

H₂O, H₂SO₄

“Cold” (20 °C)

A diol
Reaction with aldehydes:

\[
\begin{align*}
\text{HCHO} & \xrightarrow{\text{KMnO}_4} \text{CH}_3\text{COOH} \\
\text{H} & \text{C} & \text{OH} & \quad & \text{H} & \text{C} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H}
\end{align*}
\]

Example 2:

\[
\begin{align*}
\text{H}_2\text{O} + \text{CO}_2 & \xrightarrow{\text{KMnO}_4} \text{H} & \text{C} & \text{O} & \xrightarrow{\text{KMnO}_4} \text{H} & \text{C} & \text{O} & \text{H} & \text{H} & \text{O} & \therefore \text{H} & \text{C} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H}
\end{align*}
\]

Unstable in these conditions.
Mechanism:

Example 1:

Acetaldehyde (Unstable in these conditions)
**Example 3:**

\[ \text{trans-2-Butene} \xrightarrow{\text{Kmno}_4} \text{cis-2-Butene} \xrightarrow{\text{Kmno}_4} \]

**Example 4:**

\[ \text{Acetic acid} \]

\[ \text{Same as above} \]

**Example 5:**

\[ \text{Meso Compound} \]

\[ \text{Adipic acid} \]
**Osmium Tetraoxide: OsO₄**

\[ \text{O}_2\text{OsO}_2\text{O}_2 \]

Toxic, Volatile

**General Scheme:**

\[
\text{C} = \text{C} \quad \overset{\text{OsO}_4}{\longrightarrow} \quad \begin{array}{c}
\text{C} \\
\downarrow\quad \downarrow
\end{array}
\quad \begin{array}{c}
\text{C} \\
\downarrow\quad \downarrow
\end{array}
\quad \begin{array}{c}
\text{OH} \\
\text{OH}
\end{array}
\]

Syn/Cis Addition

**Example 1:**

\[
\text{C} \quad \overset{\text{OsO}_4}{\longrightarrow} \quad \text{C}
\quad \begin{array}{c}
\text{OH} \\
\text{OH}
\end{array}
\]