Two mechanisms have been proposed for nucleophilic aromatic substitution: one of which is known as the $S_{N}Ar$ mechanism and involves a resonance-stabilized anionic intermediate called the **Meisenheimer complex**.

**eg:**

```latex
\begin{align*}
\text{Cl} & \quad \text{NaOH} \\
\text{\begin{tikzpicture}
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\end{tikzpicture}} & \quad \text{OH} \\
\text{NO}_2 & \quad \text{solvent: H}_2\text{O}
\end{align*}
```

**mechanism:**

**Step 1:**

```
\begin{align*}
\text{OH}^- & \quad \text{\begin{tikzpicture}
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\end{tikzpicture}} \\
\text{\begin{tikzpicture}
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\draw (0,0) circle (0.5cm);
\end{tikzpicture}} & \quad \text{OH}^- \\
\text{Meisenheimer complex}
\end{align*}
```

**Step 2:**
Step 1 is an addition, Step 2 an elimination. Thus, the overall mechanism is an addition-elimination mechanism.

For the $S_{N}Ar$ mechanism to be operant, the aromatic ring in the substrate must bear, on ortho and/or para positions with respect to the leaving group, one or more ligands that withdraw electrons by resonance. For example, when 1 or 2 is treated with sodium hydroxide in water, no reaction occurs, indicating that the Meisenheimer complex is stable enough to form only if an electron-withdrawing group therein can stabilize the negative charge by resonance.

In the Meisenheimer complex (1a) resulting from the reaction of 1 and the hydroxide ion, there are no electron-withdrawing groups on the ring besides the leaving group and the nucleophile to stabilize the negative charge.

In the Meisenheimer complex (2a) resulting from the reaction of 2 and the hydroxide ion, there is an electron-withdrawing group on the ring besides the leaving group and the nucleophile, but, due to its position, it can stabilize the negative charge only inductively, not by resonance.
see also benzyne mechanism

Contributors

- Gamini Gunawardena from the OChemPal site (Utah Valley University)