Halogenation is an example of electrophillic aromatic substitution. In electrophillic aromatic substitutions, a benzene is attacked by an electrophile which results in substitution of hydrogens. However, halogens are not electrophillic enough to break the aromaticity of benzenes, which require a catalyst to activate.

**Activation of Halogen**

(where X= Br or Cl, we will discuss further in detail later why other members of the halogen family Flourine and Iodine are not used in halogenation of benzenes)

Hence, Halogen needs the help and aid of Lewis Acidic Catalysts to activate it to become a very strong electrophile. Examples of these activated halogens are Ferric Hallides (FeX$_3$) Aluminum Halides (AlX$_3$) where X= Br or Cl. In the following examples, the halogen we will look at is Bromine.

In the example of bromine, in order to make bromine electrophillic enough to react with benzene, we use the aid of an aluminum halide such as aluminum bromide.

With aluminum bromide as a Lewis acid, we can mix Br$_2$ with AlBr$_3$ to give us Br$^+$. The presence of Br$^+$ is a much better electrophile than Br$_2$ alone. Bromination is achieved with the help of AlBr$_3$ (Lewis acid catalysts) as it polarizes the Br-Br bond. The polarization causes the bromine atoms within the Br-Br bond to become more electrophilic. The presence of Br$^+$ compared to Br$_2$ alone is a much better electrophilic that can then react with benzene.
As the bromine has now become more electrophillic after activation of a catalyst, an electrophillic attack by the benzene occurs at the terminal bromine of Br-Br-AlBr₃. This allows the other bromine atom to leave with the AlBr₃ as a good leaving group, AlBr₄⁻.

After the electrophilic attack of bromide to the benzene, the hydrogen on the same carbon as bromine substitutes the carbocation in which resulted from the attack. Hence it being an electrophilic aromatic SUBSTITUTION. Since the by-product aluminum tetrabromide is a strong nucleophile, it pulls of a proton from the Hydrogen on the same carbon as bromine.
In the end, AlBr$_3$ was not consumed by the reaction and is regenerated. It serves as our catalyst in the halogenation of benzenes.

Dissociation Energies of Halogens and its Effect on Halogenation of Benzenes

The electrophillic bromination of benzenes is an exothermic reaction. Considering the exothermic rates of aromatic halogenation decreasing down the periodic table in the Halogen family, Flourination is the most exothermic and Iodination would be the least. Being so exothermic, a reaction of flourine with benzene is explosive! For iodine, electrophillic iodination is generally endothermic, hence a reaction is often not possible. Similar to bromide, chlorination would require the aid of an activating presence such as Alumnium Chloride or Ferric Chloride. The mechanism of this reaction is the same as with Bromination of benzene.

Outside links

Edit section

- http://www.chemguide.co.uk/mechanism...ogenation.html
- http://en.wikipedia.org/wiki/Electro...c_halogenation

References


Problems

1. What reagents would you need to get the given product?

2. What product would result from the given reagents?
3. What is the major product given the reagents below?

4. Draw the formatin of Cl\(^+\) from AlCl\(_3\) and Cl\(_2\)

5. Draw the mechanism of the reaction between Cl\(^+\) and a benzene.

**Solutions**

1. Cl\(_2\) and AlCl\(_3\) or Cl\(_2\) and FeCl\(_3\)

2. No Reaction

3.

4.
Contributors

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- Catherine Nguyen