

# Reactions of Benzene

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## PERSPECTIVE

Michael Faraday discovered benzene in 1825, and it is a colourless liquid.  $C_6H_6$  is the chemical formula for benzene. The organic compound is extremely unsaturated, as evidenced by the chemical formula. It is very reactive due to its high degree of unsaturation. It never participates in addition, oxidation, or reduction reactions, unlike alkenes. For example, benzene will not generate carbon-carbon double bonds when it reacts with Br, HCl, or other chemicals. Benzene undergoes a substitution process in which one or more hydrogen atoms are replaced by another atom or radical in the majority of its reactions.

Aromatic chemicals, such as benzene, fall under this category. Because of its multiple aromas or odours, the term aromatic was originally used to describe benzene and its derivatives. Later, benzene was classified based on its structure and chemical reactivity rather than its scent. As a result, aromatic compounds are now used to identify compounds that are highly unsaturated and unusually stable in the presence of chemicals that actively react with alkenes.

By analogy with alkane and alkene, the term arene is now used to refer to aromatic hydrocarbons. Parent arene is defined as benzene. If one hydrogen is removed from the arene, the combination of the aryl group with the additional atom or group is designated as ArJ, similar to how alkyl group compounds are denoted by the symbol RJ.

## Structure of Benzene

Substitution reactions are benzene's signature reactions, and it rarely experiences addition reactions. When benzene is treated with bromine in the presence of ferric chloride as a catalyst, the compound bromobenzene is produced, which is the product generated.

## Halogenation of Benzene

One hydrogen atom of the arene is replaced by one halogen atom in an electrophilic aromatic substitution process. The reactions listed above are classified as halogenation reactions. Here, we'll try to figure out how the reaction works. In the presence of a Lewis acid catalyst, this reaction takes place. The electrons in Lewis acid are essentially nonbonding ones, and the acid is nothing more than an electron pair acceptor.

## Nitration of Benzene

Benzene is treated with a mixture of concentrated nitric acid and concentrated sulfuric acid at a temperature of not more than  $50^\circ C$  in the reaction nitration of benzene. As the temperature rises, there is a greater probability of creating several nitro groups,  $-NO_2$ , which are replaced onto the ring and lead to the production of Nitrobenzene. In this reaction, concentrated sulfuric acid acts as a catalyst. The electrophile is the "nitronium ion" or "nitryl cation,"  $NO^+$ . The reaction between the nitric acid and the sulphuric acid produces this.

## Sulfonation of Benzene

### Alkylation and Acylation of Benzene

The electrophilic substitution reaction between benzene and sulfuric acid is known as sulfonation of benzene. The first method involves heating benzene for several hours at  $40^\circ C$  under reflux of intense fuming sulfuric acid. Benzenesulfonic acid is the end product. Sulfur trioxide, or  $SO_3$ , is the electrophile in this case. Depending on the type of acid employed, the sulphur trioxide electrophile can be produced in one of two methods. It can be made by dissociating concentrated sulfuric acid with traces of  $SO_3$  to make it.

### Benzylic Position and Its Impact on Benzene Reactivity

Friedel-Crafts reaction is the common name for this reaction. As you progress up the periodic table, the reactivity of haloalkanes rises, as does their polarity. This indicates that the reactivity of an RF haloalkane is highest, followed by RCl, RBr, and finally RI. This means that the Lewis acids employed as catalysts in Friedel-Crafts Alkylation reactions contain comparable halogen combinations, such as  $BF_3$ ,  $SbCl_5$ ,  $AlCl_3$ ,  $SbCl_5$ , and  $AlBr_3$ , which are all commonly utilised.

The aromaticity of benzene is responsible for its resistance to many of the processes in which alkenes generally participate. Chemists, on the other hand, have discovered ways to react benzene using a variety of methods. We begin our study of benzene reactions with reactions that take place on the carbon immediately attached to the benzene ring, more precisely known as the benzylic carbon.

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Strong oxidising agents like  $\text{H}_2\text{CrO}_4$  and  $\text{KMnO}_4$  are incapable of destroying benzene. The side-chain methyl group is oxidised to a carboxyl group when toluene is treated with these oxidising chemicals at severe circumstances, resulting in the major byproduct benzoic acid.

Again we find that the nature of the substituent influences this product ratio in a dramatic fashion. Bromination of methoxybenzene (anisole) is very fast and gives mainly the para-bromo isomer, accompanied by 10% of the ortho-isomer and only

a trace of the meta-isomer. Bromination of nitrobenzene requires strong heating and produces the meta-bromo isomer as the chief product. Once again, the type of the substituent has a significant impact on the product ratio. Bromination of methoxybenzene (anisole) occurs quickly and produces primarily the para-bromo isomer, with 10% of the ortho-isomer and barely a trace of the meta-isomer remaining. Bromination of nitrobenzene necessitates high temperatures and yields the meta-bromo isomer as the primary result.