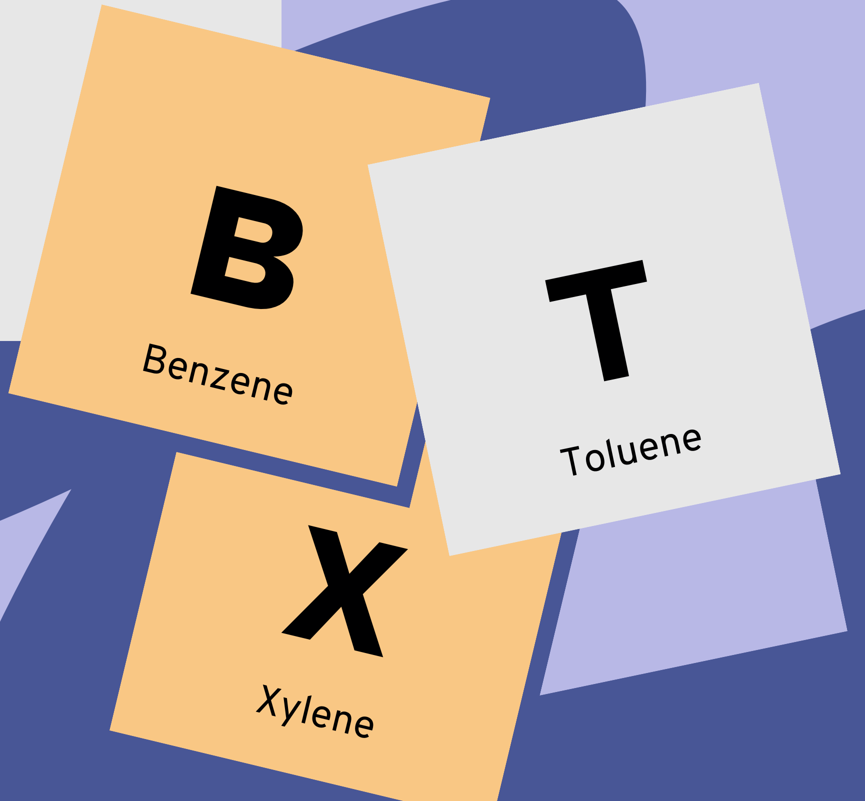
Production of BTX (Benzene, Toluene & Xylene)

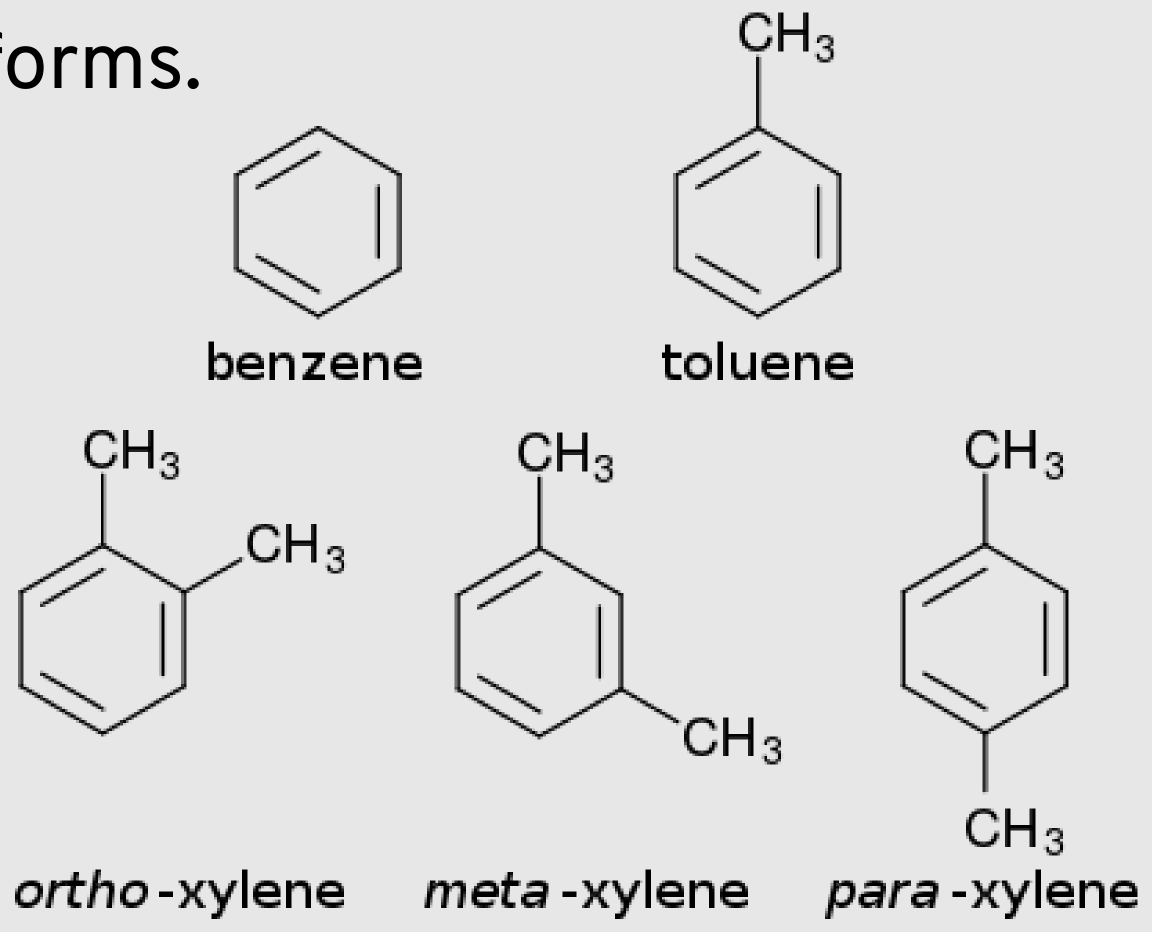
CL304 Chemical Process Technology

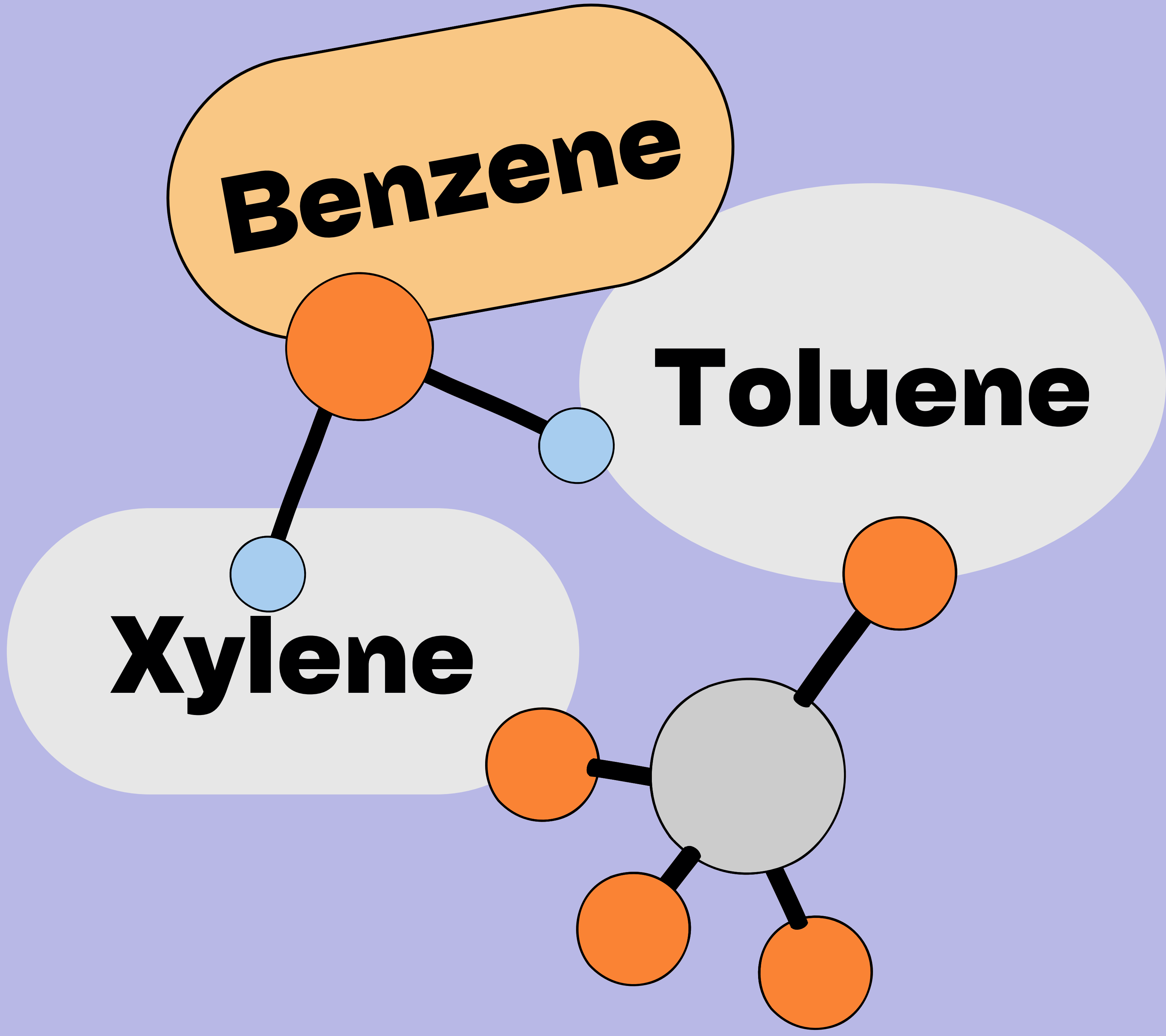
Mrityunjay Sharma 210107054
Nandini Priya 210107055
Naresh Namdeo Thakare 210107056



What is BTX?

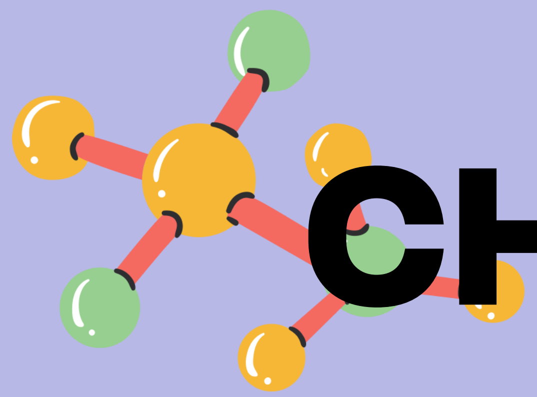
BTX, which stands for a blend of aromatic hydrocarbons including benzene, toluene, and the trio of xylene isomers, finds application in both petroleum refining and petrochemical sectors. These xylene isomers are identified by their respective ortho (o-), meta (m-), and para (p-) forms.





PHYSICAL PROPERTIES OF BTX

	Benzene	Toluene	Xylene
Appearance & Volatility	Colourless and Volatile	Colourless and Volatile	Colourless and Volatile
Density(g/cm^3)	0.879	0.867	0.86-0.88
Melting Point	5.5°C	-93°C	meta - 13.3°C ortho - 47.4°C para - 51°C
Boiling Point	80.09 °C	110.6 °C	meta - 144.4°C ortho - 139.1°C para - 138.3°C
	C_6H_6	C_7H_8	C_8H_{10}



CHEMICAL PROPERTIES OF BTX

1

All components of BTX exhibit **aromaticity**, characterized by a ring of conjugated pi electrons, which imparts stability and reactivity.

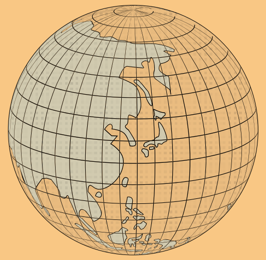
2

BTX components are sparingly soluble in water but highly soluble in organic solvents due to their **nonpolar** nature.

3

They undergo typical **aromatic substitution reactions** such as electrophilic aromatic substitution and nitration..

Did You Know?

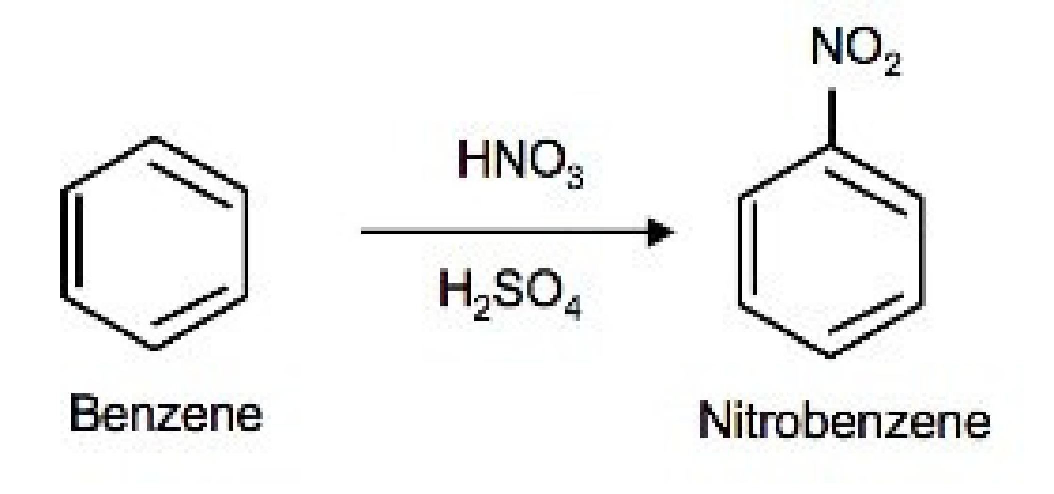


Xylene was used as a tear gas agent in **World War I**

Some Common Substitution Reactions of BENZENE

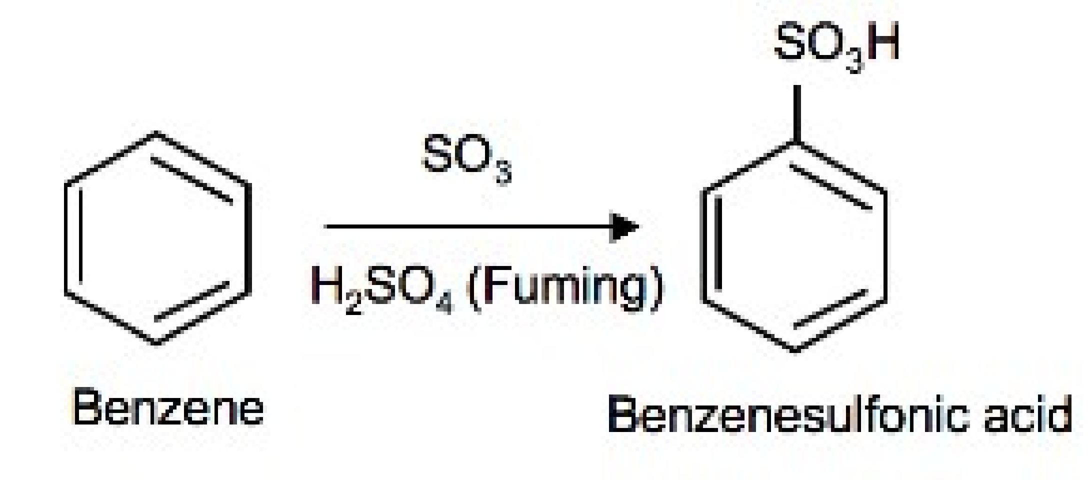
N

NITRATION



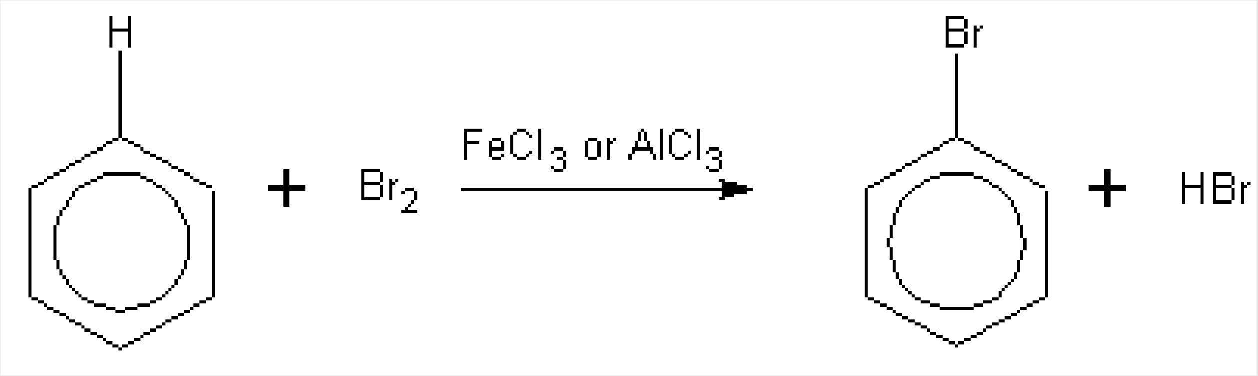
S

SULFONATION

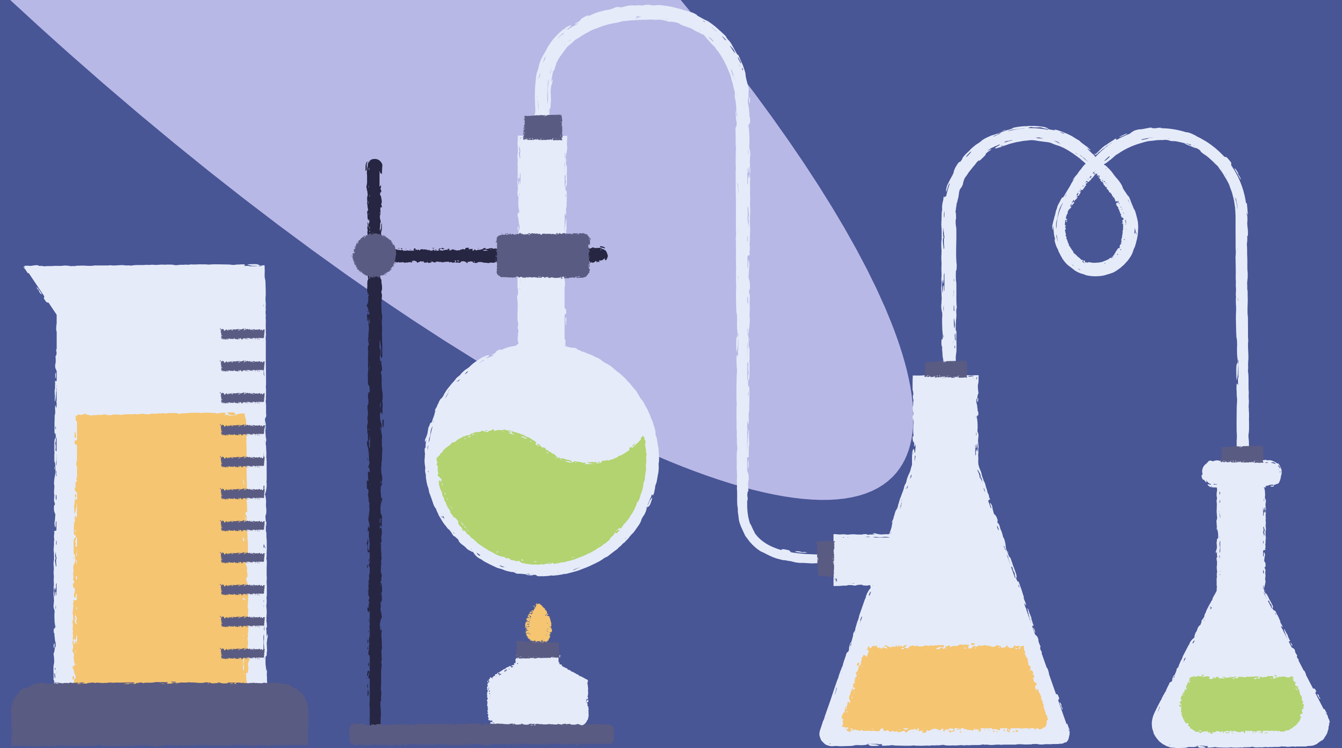


H

HALOGENATION

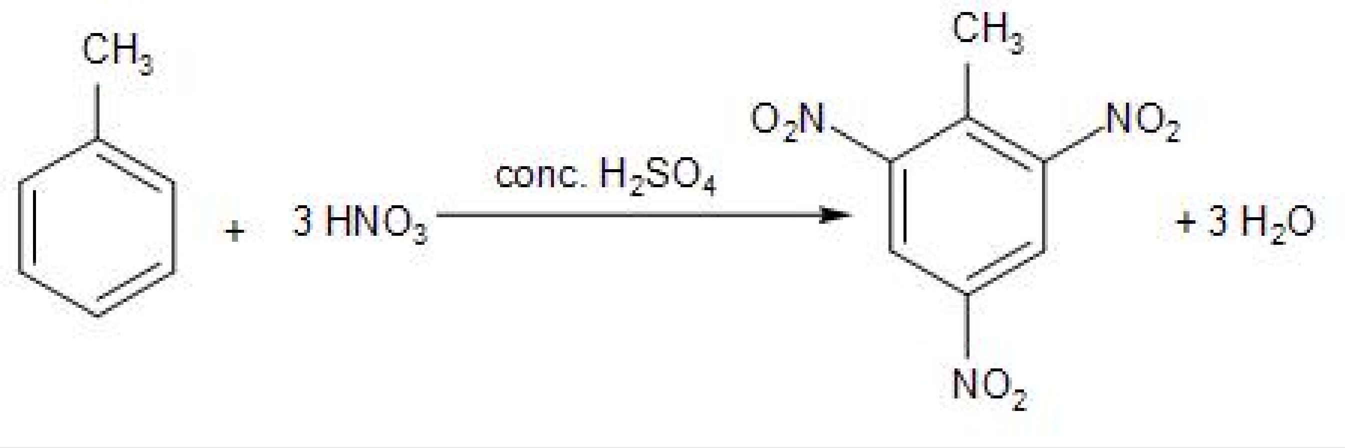


Some Common Substitution Reactions of TOLUENE



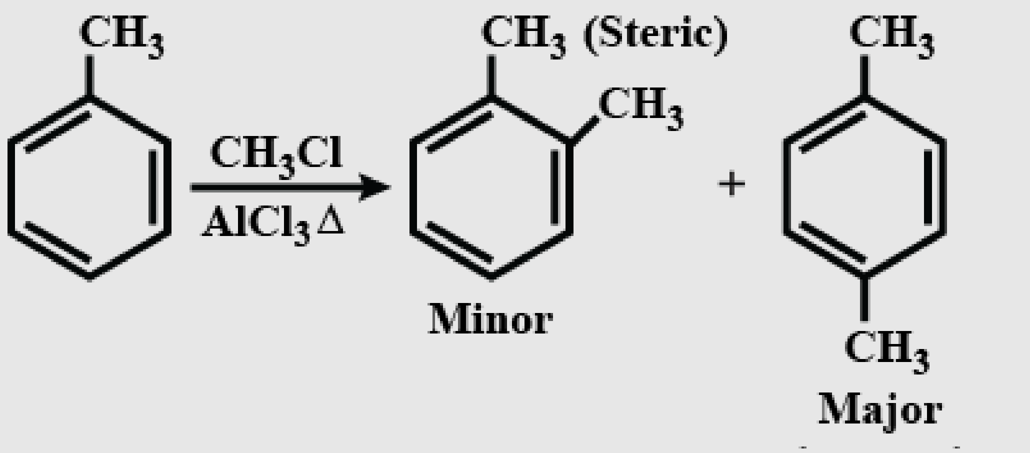
N

NITRATION



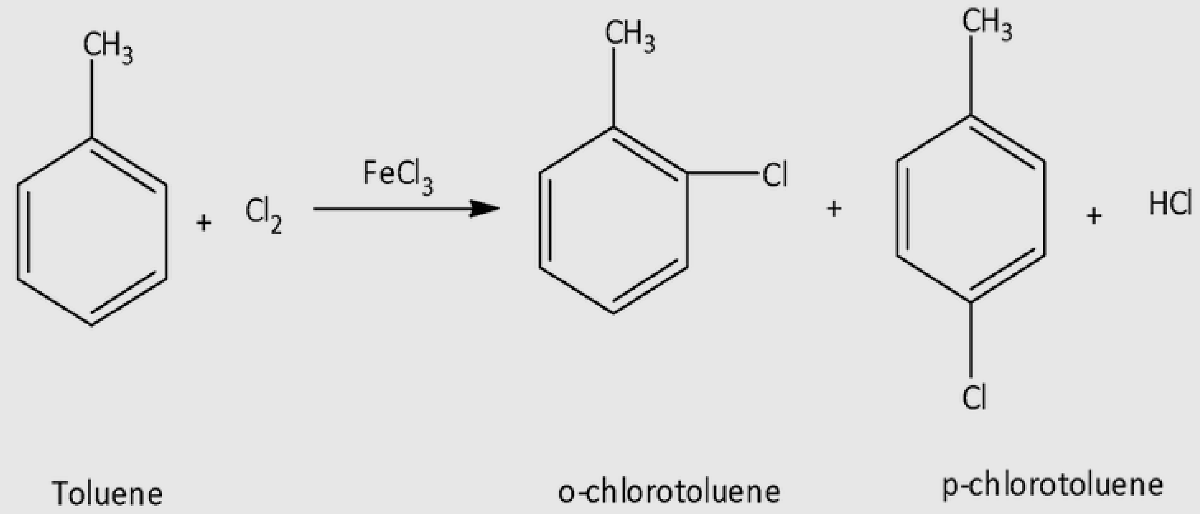
A

ALKYLATION

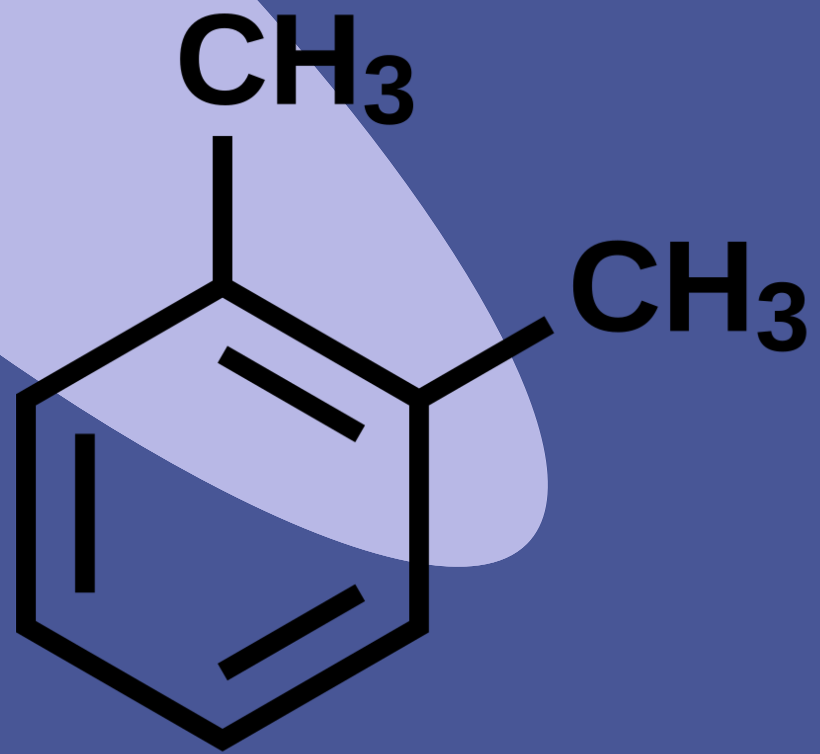


H

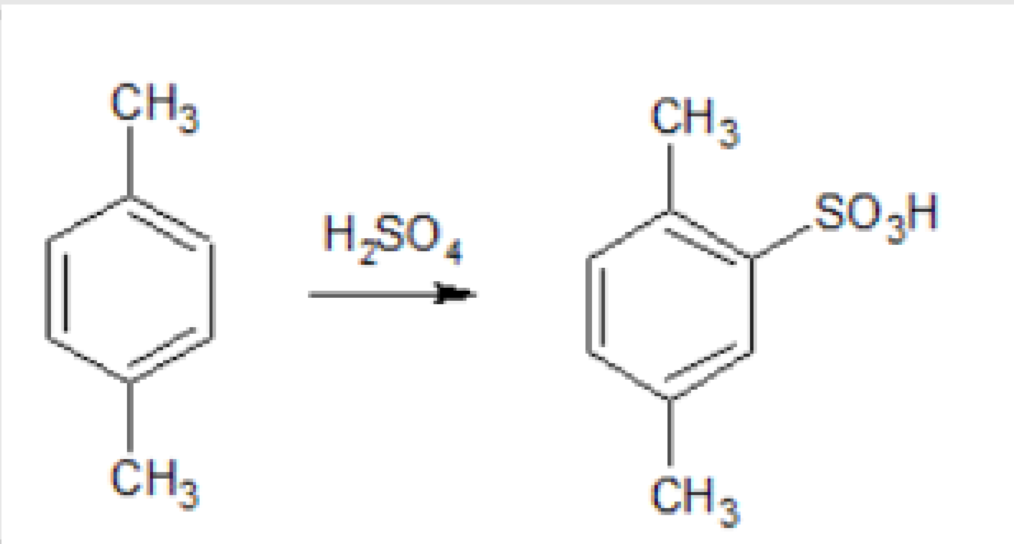
HALOGENATION



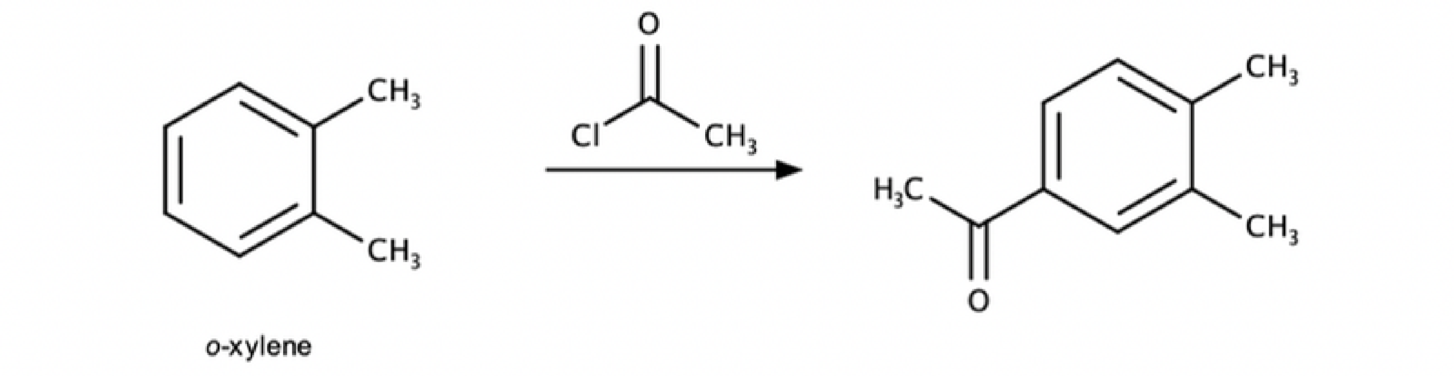
Some Common Substitution Reactions of XYLENE



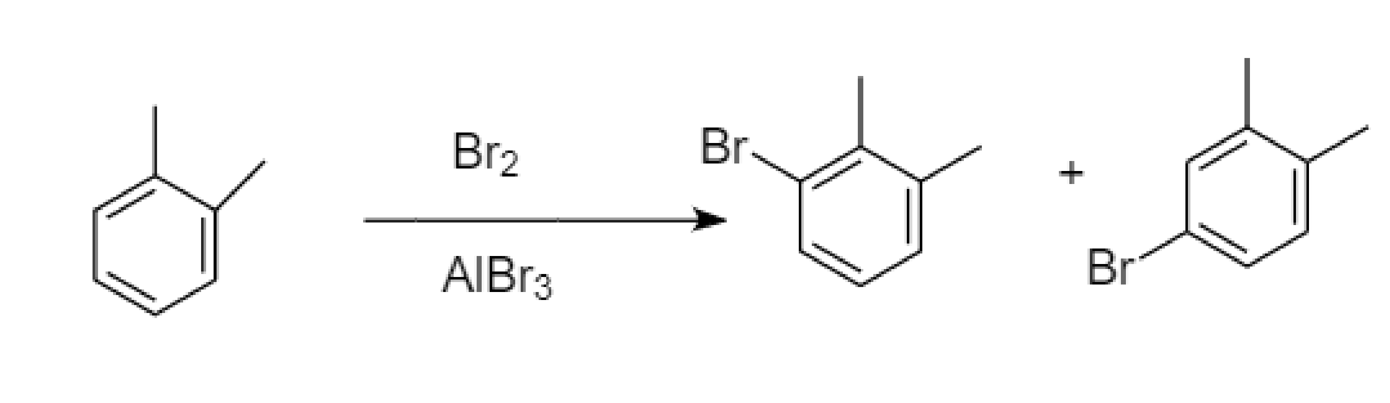
S
SULFONATION



A
ACYLATION



H
HALOGENATION



PRODUCTION OF BTX

CATALYTIC REFORMING OF PETROLEUM NAPHTHA

- Catalytic reforming of petroleum naphtha is a refining process aimed at **converting low-octane naphtha fractions into high-octane** gasoline blending components and valuable aromatic compounds like benzene, toluene, and xylene (BTX).

- The process involves subjecting the naphtha feedstock to **complex chemical reactions over a catalyst at elevated temperature and pressure.**

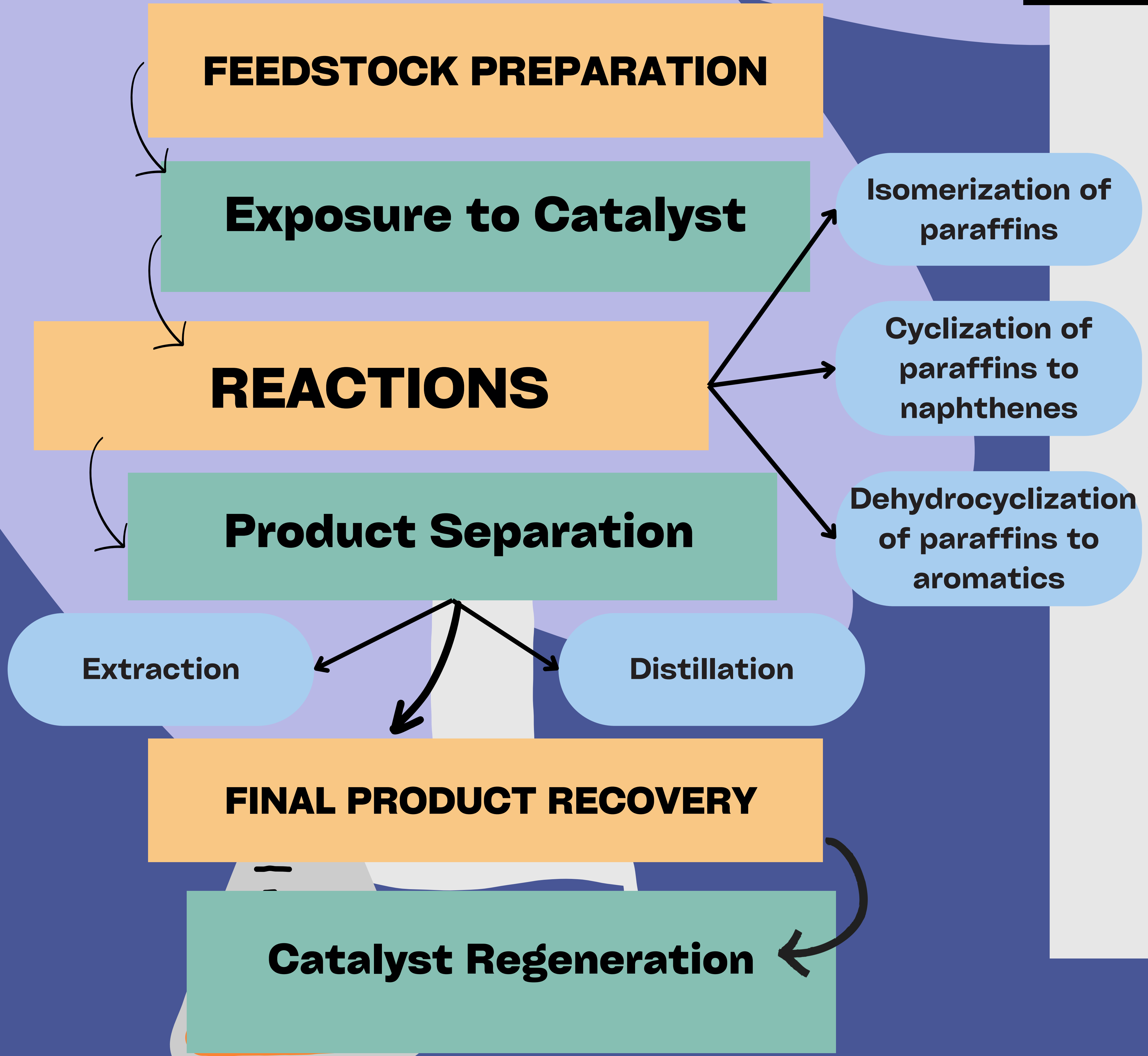
- Reactions such as **dehydrogenation, isomerization, and cyclization** occur, transforming hydrocarbons into higher-octane compounds.

- The catalyst, typically a **platinum or platinum-rhenium alloy** supported on alumina, facilitates these reactions.

- The output of catalytic reforming includes high-octane gasoline components and BTX compounds, which are separated and further processed for various industrial applications.

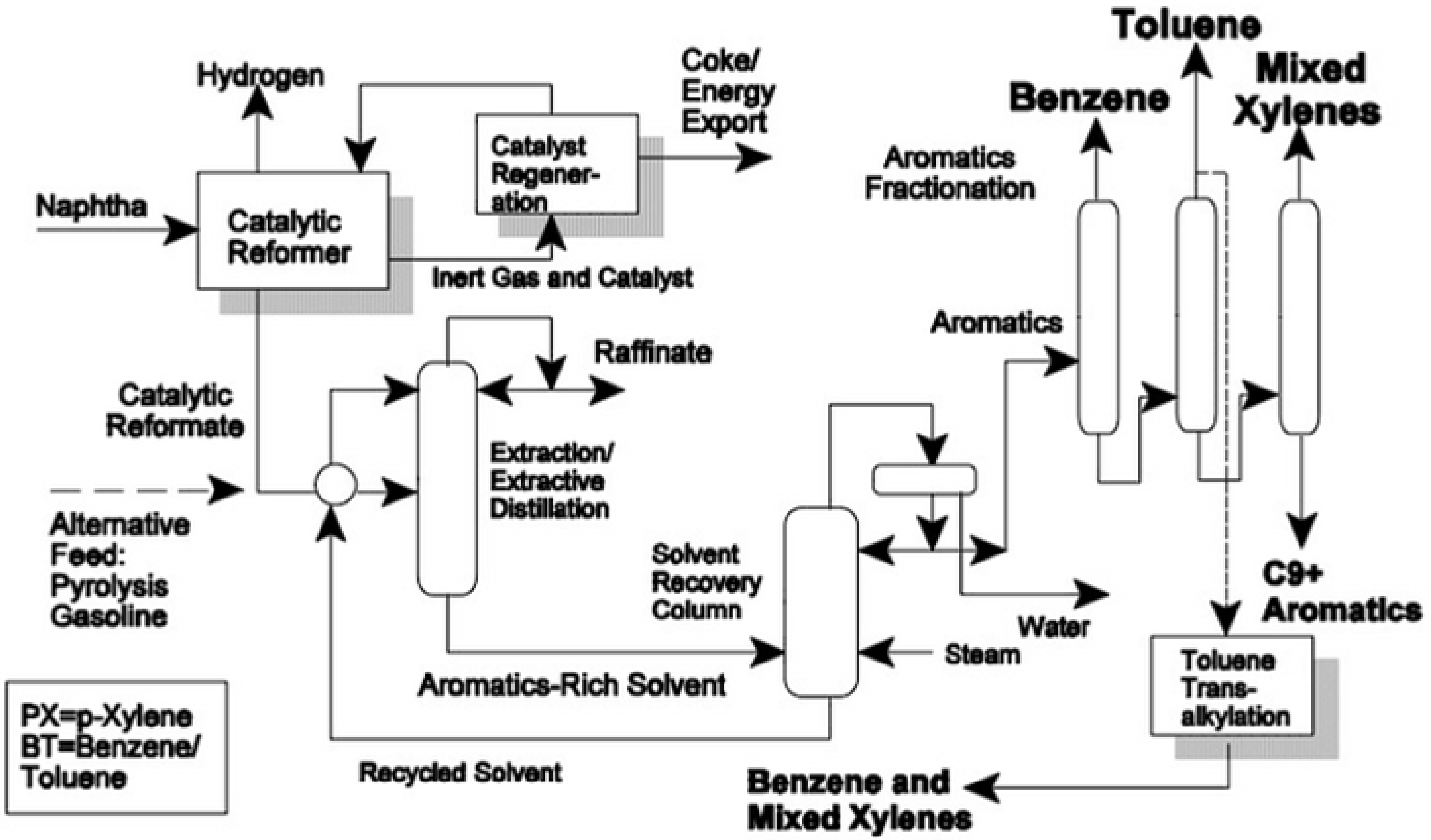
- Catalytic reforming enhances gasoline quality and produces valuable aromatic compounds crucial for manufacturing plastics, pharmaceuticals, and other chemicals.

FLOWCHART



- **Benzene Formation:**
- **Dehydrogenation of cyclohexane :**
- $C_6H_{12} \rightarrow C_6H_6 + 3H_2$
- **Toluene Formation:**
- **Dehydrogenation of Methylcyclohexane:**
- $C_7H_{14} \rightarrow C_7H_8 + 3H_2$
- **Isomerization of Xylene:**
- $C_8H_{10} \rightarrow C_7H_8 + CH_4$
- **Xylene Formation:**
- **Dehydrogenation of Ethylbenzene:**
- $C_8H_{10} \rightarrow C_8H_8 + H_2$
- **Isomerization of Ethylbenzene to form ortho-, meta-, and para-xylene:**
- $C_8H_{10} \rightarrow C_8H_{10}$
- **Methylation of Toluene:**
- $2C_7H_8 + C_2H_4 \rightarrow C_8H_{10} + C_2H_6$

Catalytic Reforming of Naphtha



Steam Cracking of Hydrocarbons

- Steam cracking is a pivotal process in the petrochemical industry, where hydrocarbon feedstocks like light liquid hydrocarbons or naphtha are **thermally decomposed** at high temperatures in the presence of **superheated steam**.

- This process occurs within a **cracking furnace**, where carbon-carbon bonds within the hydrocarbon molecules are broken, generating highly **reactive free radicals**. These radicals quickly react to form **intermediate species**, including aromatic hydrocarbons such as benzene, toluene, and xylene (BTX).

- After rapid cooling to stabilize the products, the mixture undergoes **separation** to isolate the desired BTX compounds, which are then collected for various industrial applications.

FLOWCHART

FEEDSTOCK PREPARATION

Feedstock Dilution with Steam

HEATING IN FURNACE

Cracking Reactions

QUENCHING AND PRODUCT SEPARATION

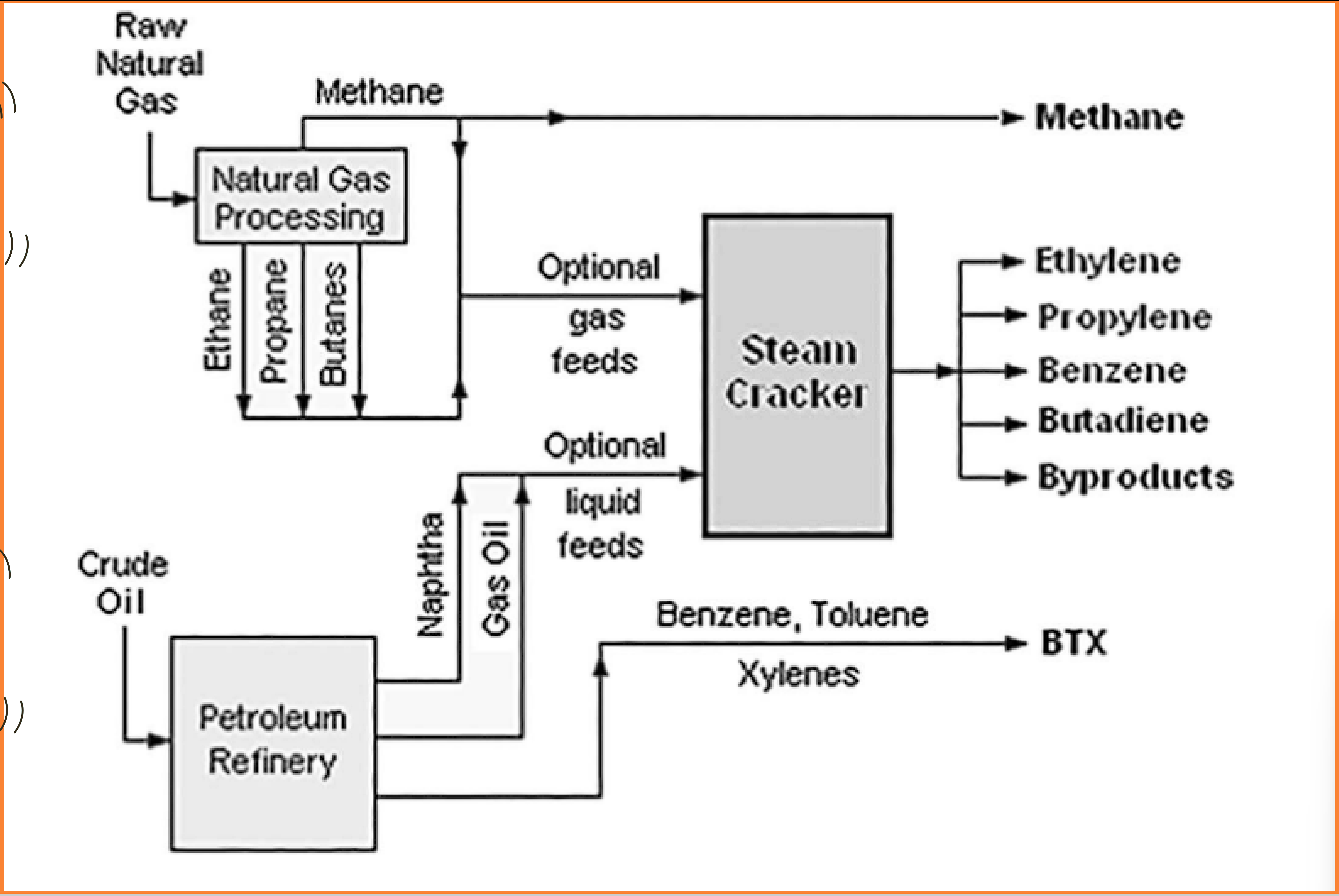
Product Recovery

- **Benzene Formation:**
- **Thermal Cracking of Cyclohexane :**
  $2C_6H_{12} \rightarrow C_6H_6 + C_6H_{14}$

- **Toluene Formation:**
- **Thermal Cracking of Heptane:**
  $C_7H_{16} \rightarrow C_6H_5CH_3 + CH_4$

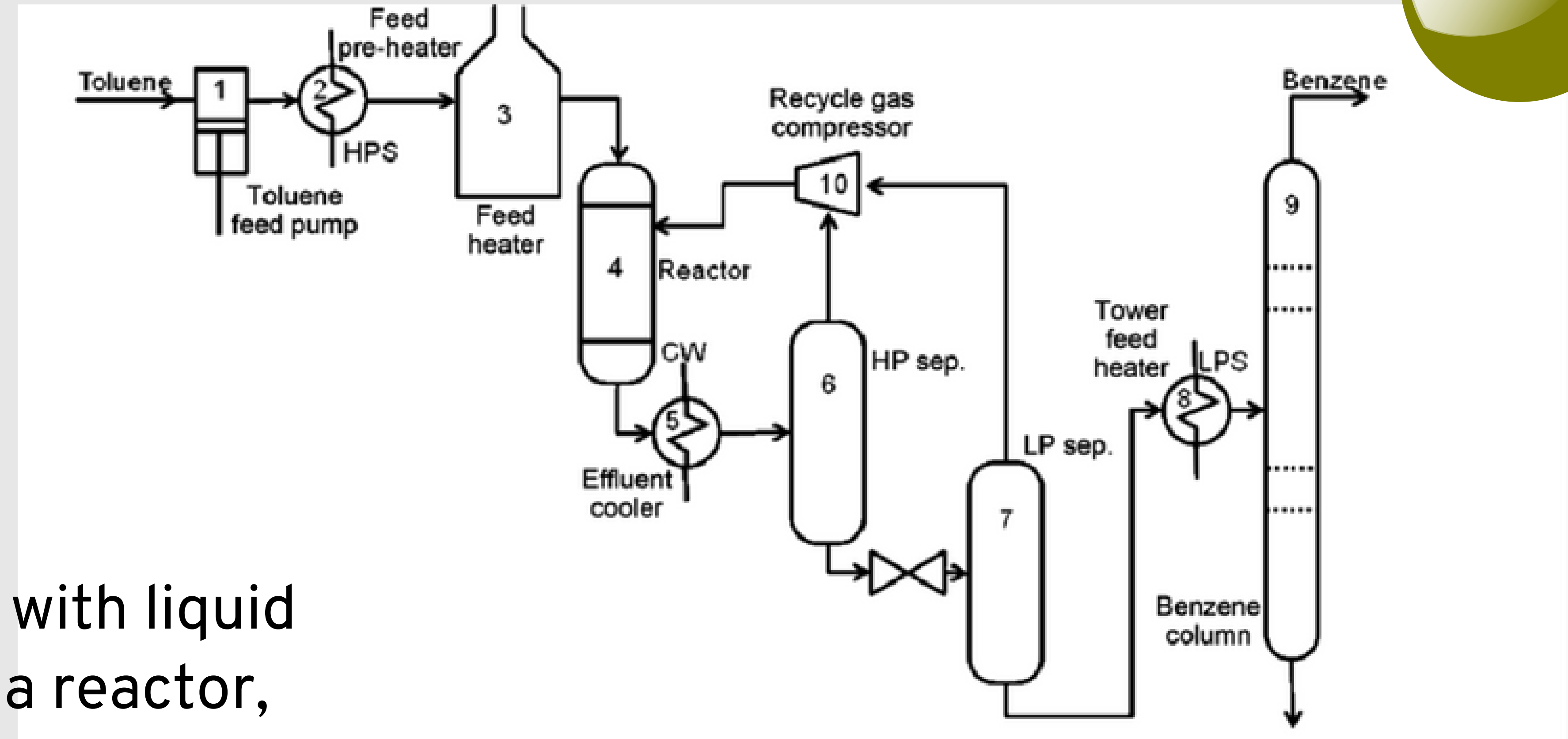
- **Xylene Formation:**
- **Thermal Cracking of Octane:**
  $C_8H_{18} \rightarrow C_6H_4(CH_3)_2 + C_2H_4$

Steam Cracking of Hydrocarbons



Hydrodealkylation

A method of converting toluene and dialkylbenzenes to benzene. This process involves the removal of alkyl groups (usually methyl groups) from the aromatic ring through catalytic hydrogenation.Hydrodealkylation is an important industrial process for the production of benzene.



Chemical Reactions:

$C6H5CH3 + H_2 \rightarrow C6H6 + CH4$

$C6H4(CH_3)2 + 2H2 \rightarrow C6H6 + 2CH4$

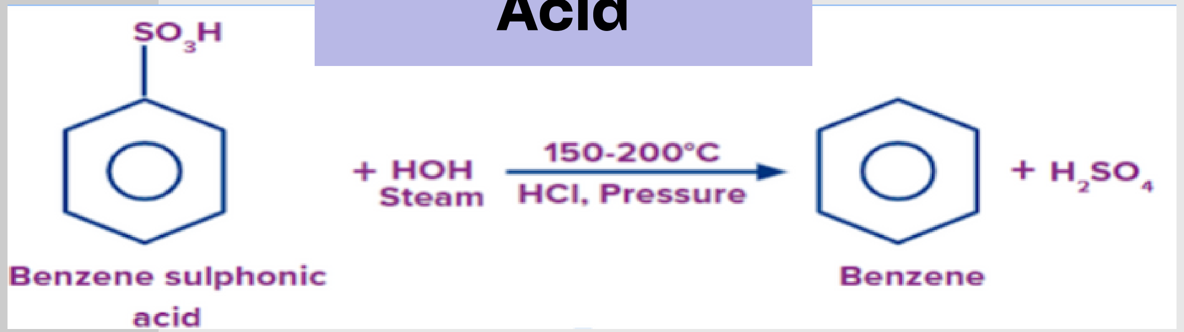
Process Description:

Compressed hydrogen-rich makeup and recycle gases combine with liquid alkyl aromatic feedstock after preheating. Processing occurs in a reactor, which may contain fixed bed catalyst or be tubular and non-catalytic. Effluent is cooled, separated into gas and liquid fractions, with much of the gas recycled. Liquid fraction is stripped of residual gas, fractionated to yield high-purity benzene, and recycle alkyl aromatics, achieving **95-98% toluene conversion to benzene.**

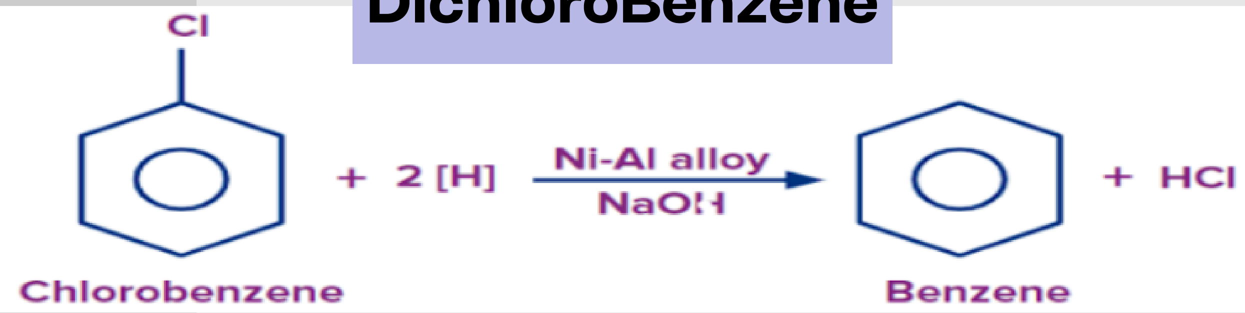
OTHER PROCESSES OF PRODUCTION OF BTX

Benzene

From Sulphonic Acid

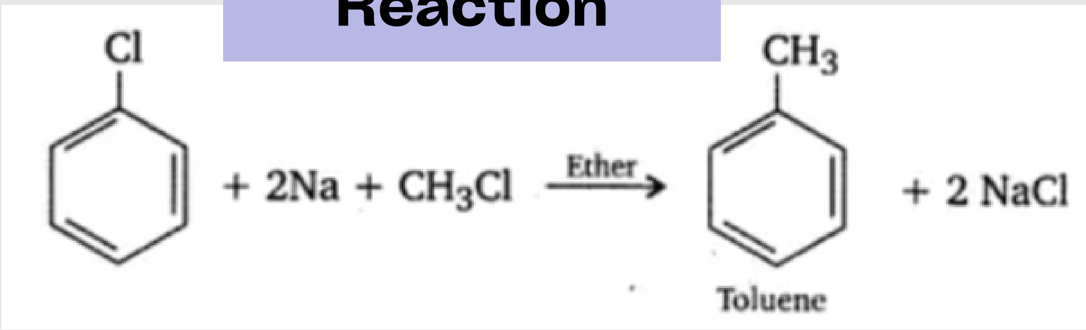


From DichloroBenzene

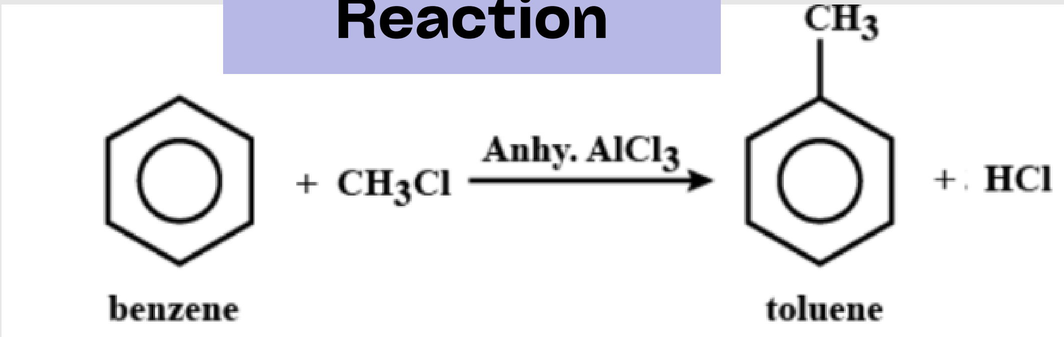


Toluene

Wurtz Fittig Reaction

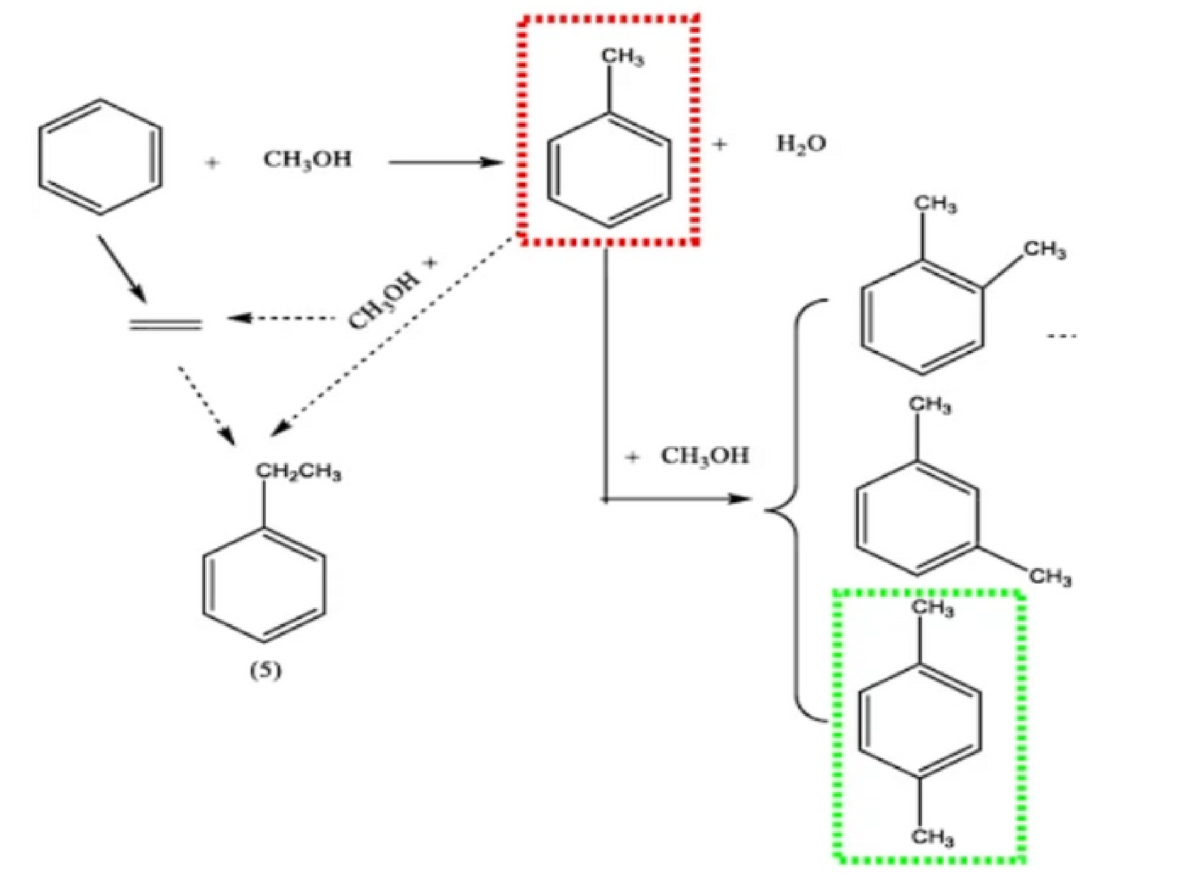


Friedel-Crafts Reaction

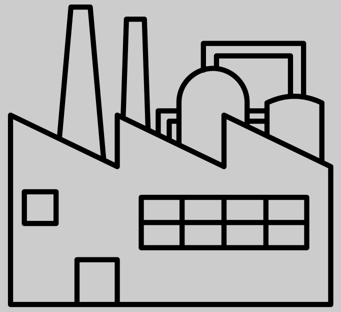


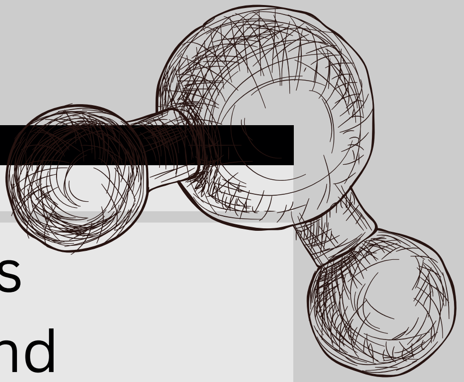
Xylene

Aromatic Alkylation



APPLICATIONS OF BTX IN INDUSTRIES



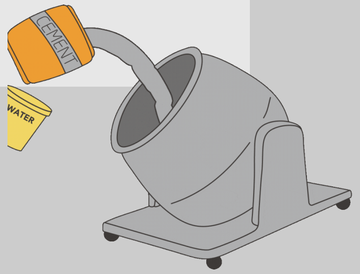


1. Solvent: Toluene and xylene are widely used as solvents in various industries, including paint and coatings, adhesives, rubber, printing inks, and pharmaceuticals.

2. Fuel Additive: Toluene is sometimes used as an octane booster in gasoline. It improves the octane rating of gasoline and enhances engine performance.

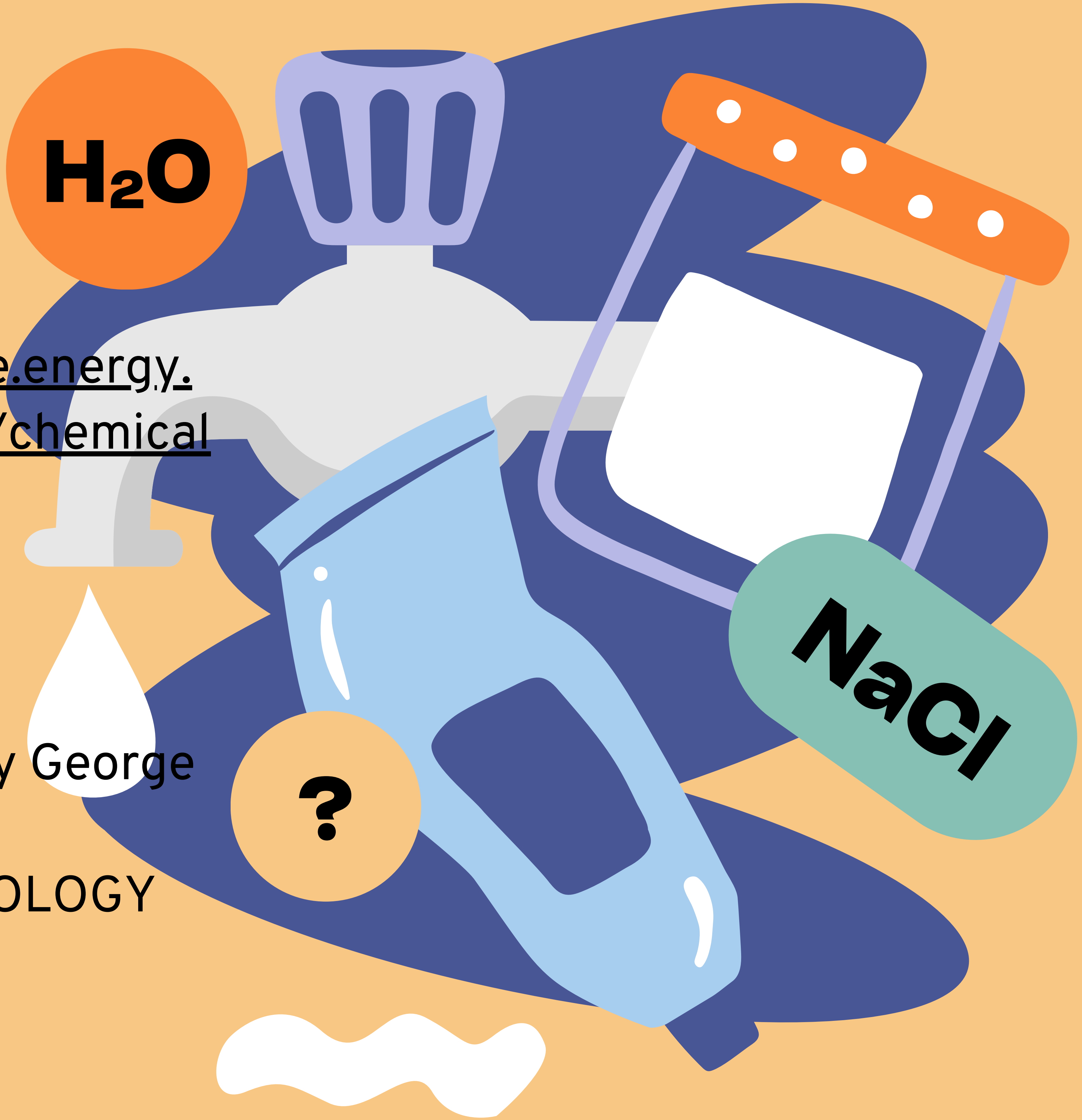
3. Feedstock for Chemical Synthesis: Benzene, toluene, and xylene are important raw materials for the production of various chemicals,plastics, synthetic fibers (such as polyester and nylon), resins, detergents, pesticides, pharmaceuticals, and explosives (such as TNT - trinitrotoluene).

4. Rubber and Tire Manufacturing: Toluene is used in the production of synthetic rubber, which is used in the manufacturing of tires, conveyor belts, hoses, and other rubber products.



REFERENCES

- https://wayback.archive-it.org/all/20131021081308/http://www1.eere.energy.gov/manufacturing/industries_technologies/chemicals/pdfs/profile_chap4.pdf
- https://hsseworld.com/wp-content/uploads/2020/12/Handbook-of-Petrochemical-Processes-2019.pdf
- Shreve's Chemical Process Industries,Book by George T. Austin and R. Norris Shreve
- DRYDEN'S OUTLINES OF CHEMICAL TECHNOLOGY FOR THE 21ST CENTURY,Book by Gopalarao



THANKYOU!!