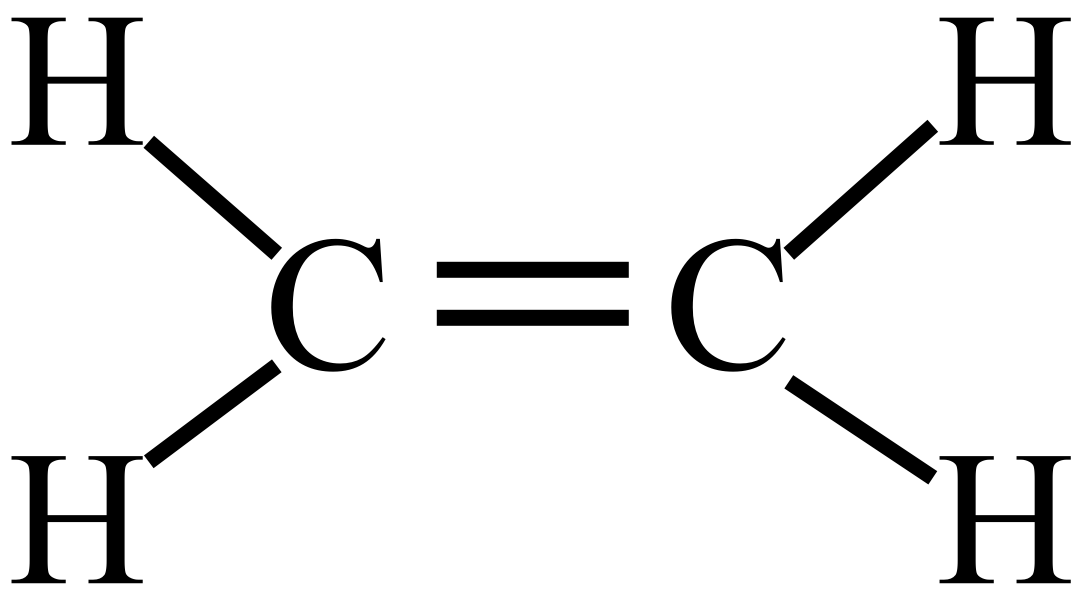
ETHENE

C_2H_4

$CH_2 == CH_2$



Uses for Ethene

- Microwave polyethene film
- Plastic milk bottles
- Large wheeled rubbish bins
- Poly Vinyl Chloride
- Polystyrene & Copolymers
- Ethanol

Composition of Natural Gas

- Mostly methane (CH_4)
- <10% Ethane
- May contain smaller percentage of alkanes like propane, butane and pentane
- May contain small amounts of N_2, CO_2 & H_2S

Composition of Crude Oil

- Mainly of alkanes
- A large range of alkanes present (CH_4 – $C_{70}H_{140}$ in numerous isomeric forms
- Small amounts of organic compounds containing S, N and O atoms

A Hydrocarbon

- A compound that contains CARBON and HYDROGEN atoms only

Alkanes

- Hydrocarbons with all single C – C bonds
- Thus are called Saturated Hydrocarbons
- General formula C_nH_{2n+2}

An Homologous Series

- A series of organic compounds
- similar chemical properties
- differ by a – CH_2 – group from the previous member
- Examples
  - The Alkanes
  - CH_4 C_2H_6 C_3H_8 C_4H_{10}

Alkenes

- Also hydrocarbons
- Have at least one double C – C bond
- So are Unsaturated hydrocarbons
- General Formula is C_nH_{2n}

Saturated versus Unsaturated

- Saturated contains all single C – C bonds
- Unsaturated contains at least one double or triple C – C bond

Alkanes

- CH_4 – Methane
- C_2H_6 – Ethane
- C_3H_8 – Propane
- C_4H_{10} – Butane
- C_5H_{12} – Pentane
- C_6H_{14} – Hexane
- C_7H_{16} – Heptane
- C_8H_{18} – Octane
- C_9H_{20} – Nonane
- $C_{10}H_{22}$ – Decane

Alkenes.

-
- C_2H_4 – Ethene
- C_3H_6 – Propene
- C_4H_8 – Butene
- C_5H_{10} – Pentene
- C_6H_{12} – Hexene
- C_7H_{14} – Heptene
- C_8H_{16} – Octene
- C_9H_{18} – Nonene
- $C_{10}H_{20}$ – Decene

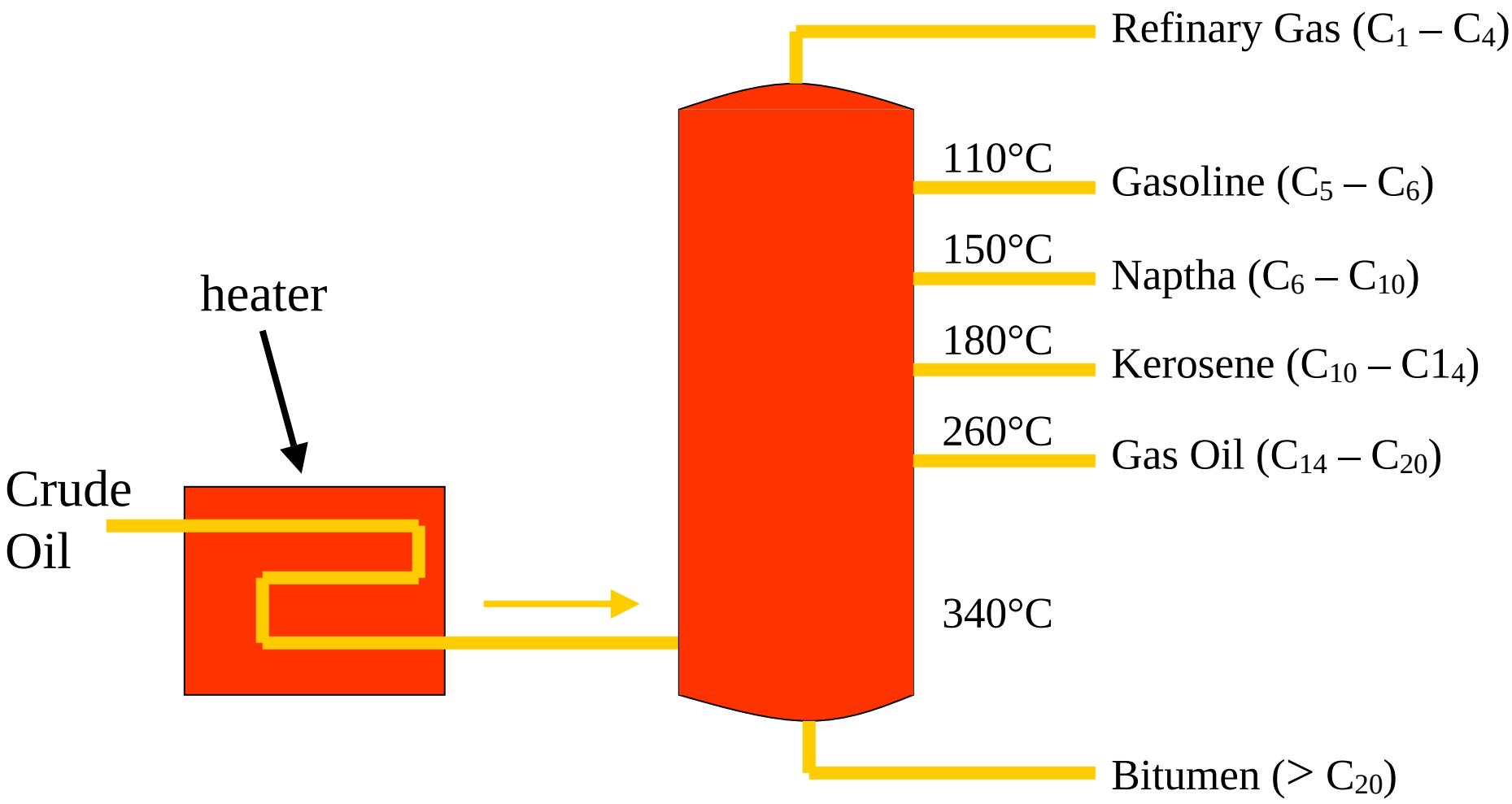
Production of ethene from crude oil

- Two main steps
  1. Fractional Distillation
  2. Cracking

Fractional Distillation

- Separation of components in crude oil
- Takes place in a fractionating tower
- Oil is separated into several fractions
- Each hydrocarbon in a fraction has a similar boiling temperature

Fractional Distillation



Fractional Distillation

- The bigger the hydrocarbon molecule, the higher it’s boiling temperature
- Due to the dispersion forces holding the molecules together being larger as the molecule gets larger

Cracking process

- Two types
  1. Thermal

     Produces unsaturated hydrocarbons such as ethene, used in petrochemical
  2. Catalytic

     To increase amount of lighter fractions recovered from crude oil

Thermal Cracking

- Typically involves an Alkane being converted to an Alkene

$C_2H_{6(g)} \rightleftharpoons C_2H_{4(g)} + H_{2(g)}$? H = +138kJ mol $^{-1}$

$C_3H_{8(g)} \rightleftharpoons C_2H_{4(g)} + CH_{4(g)}$? H = +81kJ mol $^{-1}$

Catalytic Cracking

- Typically involves a larger molecule being broken into smaller molecules
- This cannot involve high temperatures as these molecules would decompose
- Zeolite is used as the catalyst
- $C_{29}H_{60(g)} \rightarrow C_8H_{18\ (g)} + C_8H_{18\ (g)} + C_{13}H_{26\ (g)}$

Desulfurisation

- Is removal of sulfur compounds from crude oil
- Sulfur needs to be removed so as to
  - Minimise emissions of SO2
  - Prevent poisoning of catalysts
  - Manufacture sulfuric acid

Properties of Ethene

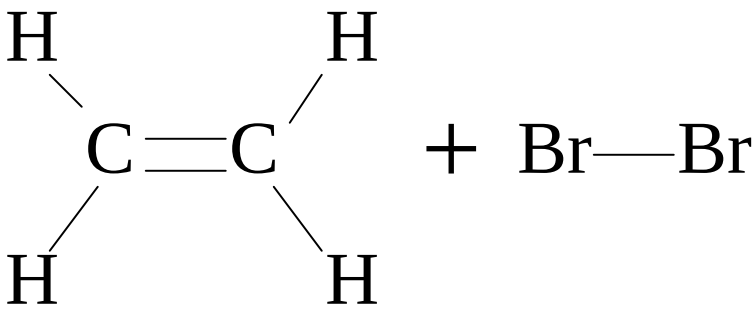
- Unsaturated
- Non – polar molecule
- Insoluble in water (and other polar solvents)
- A flammable gas
- Participates in Addition reactions
  - (test of unsaturation)

Properties of Ethene

- Polymerises to form Polyethene
- Very low BP (–104°C)
- Double bond makes it very reactive

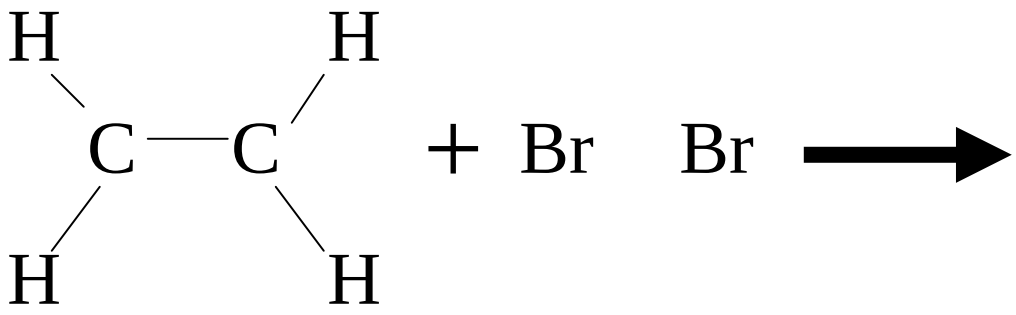
Test for Unsaturation.

- Dark brown bromine will turn clear



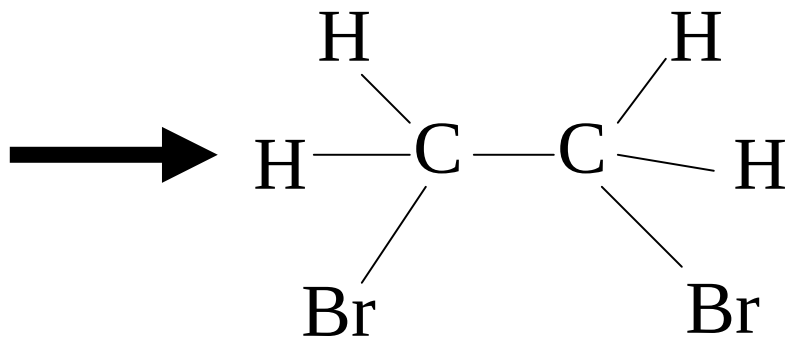
Test for Unsaturation.

- Dark brown bromine will turn clear



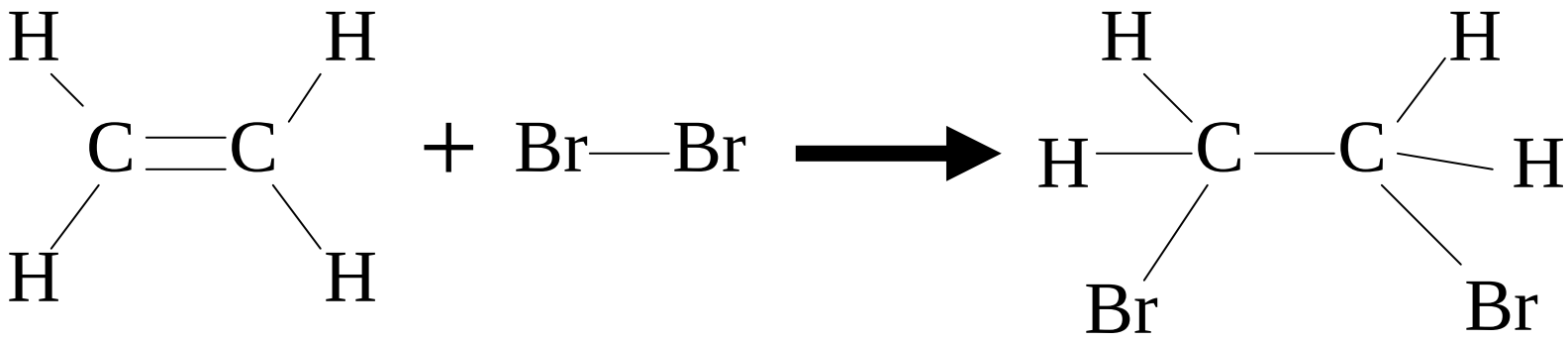
Test for Unsaturation.

- Dark brown bromine will turn clear



Test for Unsaturation.

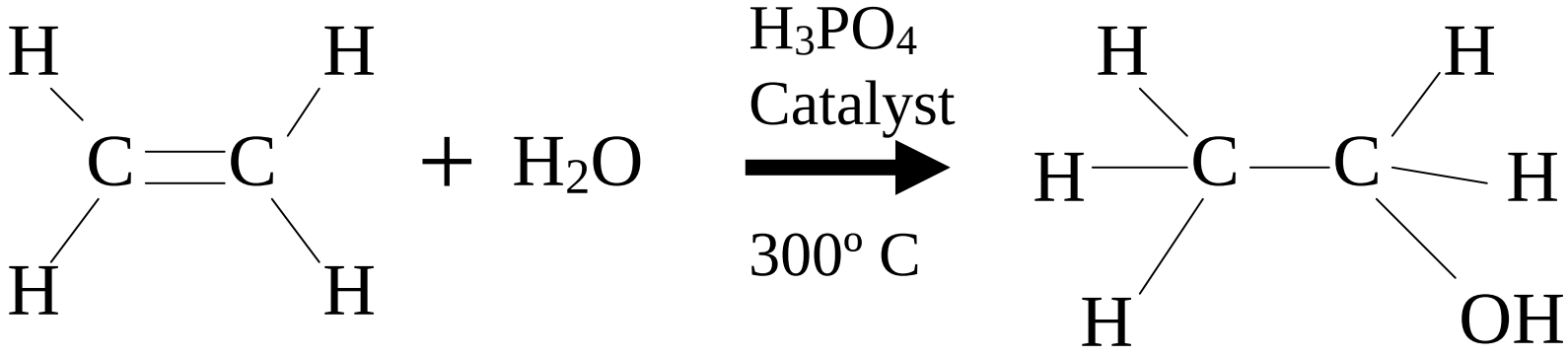
- Dark brown bromine will turn clear



Production of Ethanol from Ethene

- Addition of steam using a catalyst

$$C_2H_4 + H_2O \xrightarrow[300^o\ C]{H_3PO_4\ Catalyst} C_2H_5OH$$

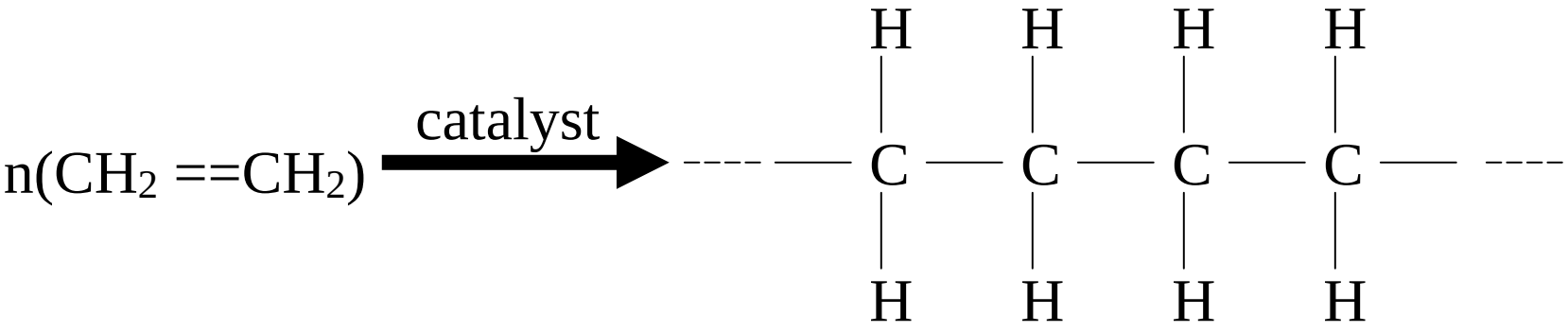


Production of Ethanol

- Fermentation of sugar is still used to make alcoholic beverages – which is ethanol
- Ethene method is used for ethanol for industrial purposes like solvents in cosmetics, pharmaceuticals and inks

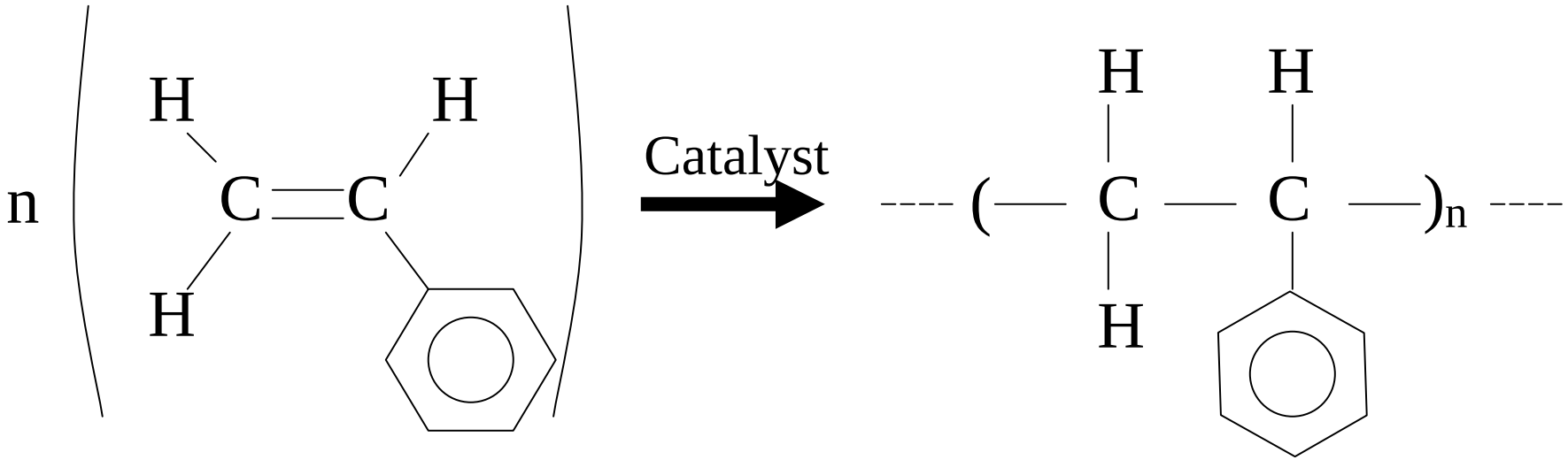
Production of Polyethene

- A type of addition reaction



– (CH$_2$ – CH$_2$) –
polyethene

Production of Polystyrene

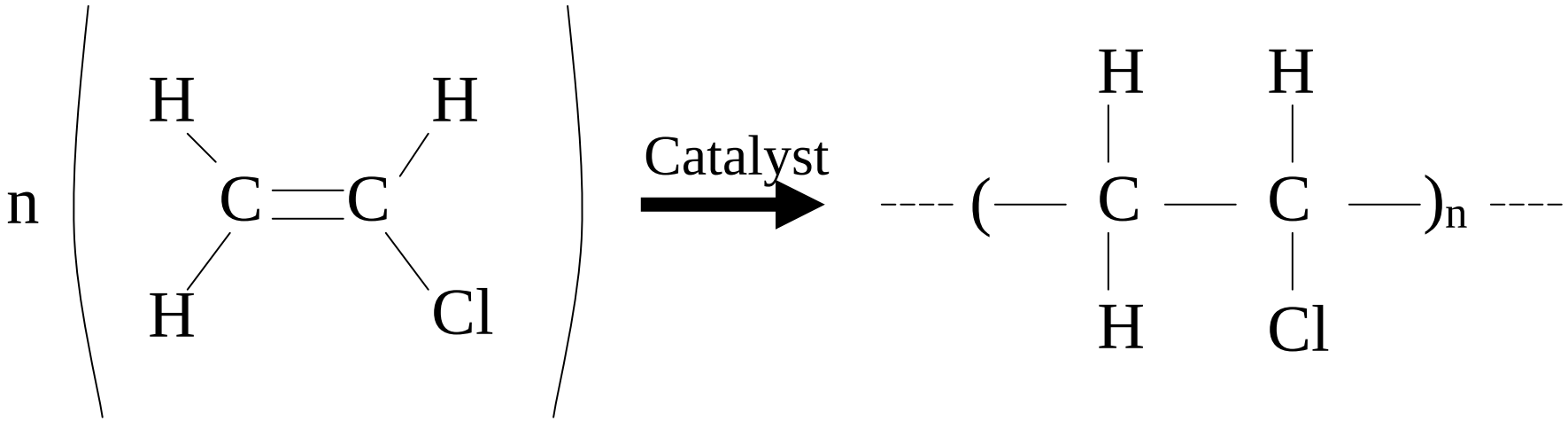


Styrene

Polystyrene

= benzene

Production of Polyvinyl Chloride (PVC)



Vinyl Chloride

PolyVinyl Chloride