

7.2: INDUSTRIAL PREPARATION AND USE OF ALKENES

OBJECTIVES

After completing this section, you should be able to

1. discuss the industrial importance of ethylene (ethene) and propylene (propene).
2. describe, briefly, the industrial process known as thermal cracking.

STUDY NOTES

Among the most important and most abundant organic chemicals produced worldwide are the two simple alkenes, ethylene and propylene. They are used as the starting materials to synthesize numerous valuable compounds.

Produced from ethylene (ethene)

Chemical	Uses
ethanol	solvent; constituent of cleaning preparations; in synthesis of esters
acetaldehyde	slug killer, in the form of methaldehyde (CH_3CHO) ₄
acetic acid	manufacture of vinyl acetate polymers, ethyl acetate solvent and cellulose acetate polymers
ethylene oxide	"cellosolves" (industrial solvents)
ethylene glycol	anti-freeze; production of DacronOR
ethylene dichloride	solvent; production of vinyl chloride
vinyl chloride	manufacture of poly (vinyl chloride)—PVC
vinyl acetate	manufacture of poly (vinyl acetate) used in paint emulsions, plywood adhesives and textiles
polyethylene	"plastic" bags; toys; packaging

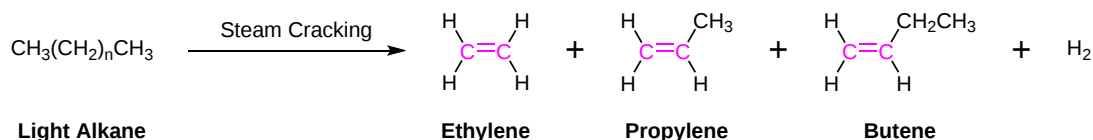
Produced from propylene (propene)

Chemical	Uses
isopropyl alcohol	rubbing alcohol; cosmetics; synthesis of acetone
propylene oxide	manufacture of polyurethanes; polyesters
cumene	industrial preparation of phenol and acetone
polypropylene	molded articles (e.g., kitchenware); fibres for indoor-outdoor carpeting

INDUSTRIAL PREPARATION OF ETHYLENE AND PROPYLENE

Ethene (CH_2CH_2) and propene (CH_3CHCH_2), are most often called by their common names—ethylene and propylene. Ethylene is a major commercial chemical. The US chemical industry produces about 25 billion kilograms of ethylene annually, more than any other synthetic organic chemical. More than half of this ethylene goes into the manufacture of polyethylene, one of the most familiar plastics. Propylene is also an important industrial chemical. It is converted to plastics, isopropyl alcohol, and a variety of other products. Both ethylene and propylene are the feedstock for the industrial synthesis of a wide variety of small organic molecules.

Ethylene, propylene, and butylene ($\text{CH}_3\text{CH}_2\text{CHCH}_2$) are typically industrially synthesized through the steam cracking of light alkanes ($\text{C} < 8$) obtained from fractional distillation of crude oil. Cracking is the name given to a number of petroleum refining processes which break up large hydrocarbon molecules into smaller fragment. Steam cracking is achieved without a catalyst by using high temperatures ($\sim 900^\circ\text{C}$) and produces a mixtures of products containing high proportions of hydrocarbons with double bonds. There is not any single unique reaction happening during steam cracking. The hydrocarbon molecules are broken up in a fairly random way but the process can be generically represented by the reaction below.



The mechanism of the steam cracking is complex and believed to involve the formation of free radicals. The high temperatures of steam cracking is enough to cause the homolytic cleavage of C-C and C-H bonds in the starting material. The cleavage of C-C bonds inherently creates smaller hydrocarbons as represented below.

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