

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

PETROCHEMICAL ENGINEERING

PCE 253

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GROUP 3

PRODUCTION AND APPLICATION OF LOWER ALKENES

CONTENT

- INTRODUCTION TO ALKENES
- REACTIONS OF ALKENES
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- APPLICATION OF ALKENES
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ALKENES(OLEFINS)

- Alkenes are unsaturated hydrocarbons. They form homologous series with the general molecular formula $C_n H_{2n}$.
- Alkenes contains a double bond, which is shown as two lines between two of the carbon atoms. The carbon-carbon double bond in alkene is made up of a σ –bond and a π – bond.
- The two carbon atoms containing the double bond show SP^2 hybridization. The double bond is called ethylenic or olefinic bond. The simplest member of the series is called ethene (or ethylene). The molecular formula is C_2H_4 .

- The most important olefins used for the production of petrochemicals are ethylene, propylene, the butylenes, and isoprene.
- Olefins are characterized by their higher reactivities compared to paraffinic hydrocarbons. They can easily react with reagents such as water, oxygen, hydrochloric acid, and chlorine to form valuable chemicals.
- Olefins can even add to themselves to produce important polymers such as polyethylene and polypropylene
- Ethylene is the most important olefin for producing petrochemicals, and therefore, many sources have been sought for its production.

INDUSTRIAL PREPARATIONS OF ALKENES

STEAM CRACKING

Cracking is the name given to the breaking up of large hydrocarbons molecules into smaller and more useful bits.

This is achieved by using high temperatures and pressures in the presence of a catalyst.

The hydrocarbon molecules are broken up in a fairly random way to produce mixtures of smaller hydrocarbons, some of which have carbon-carbon double bond.

Feedstocks for steam cracking range from light saturated hydrocarbons, such as ethane and propane, to naphtha and light and heavy gas oils

- In North America and the Middle East ethane (from natural gas) is the primary feedstock for the production of ethane whiles in Europe and Japan naphtha (from oil) is the major feedstock, which explains why steam cracking is frequently referred to as naphtha cracking.
- Steam cracking yields a large variety of products, ranging from hydrogen to fuel oil. The product distribution depends on the feedstock and on the processing conditions.
- Steam cracking yields a complex product mixture. In practice it is crucial to choose the reaction conditions in such a way that the product distribution is optimal. Usually this means that the amount of ethene produced should be as high as possible. Depending on market developments and the local situation, however, other products might be more desirable.

THE INDUSTRIAL PROCESS

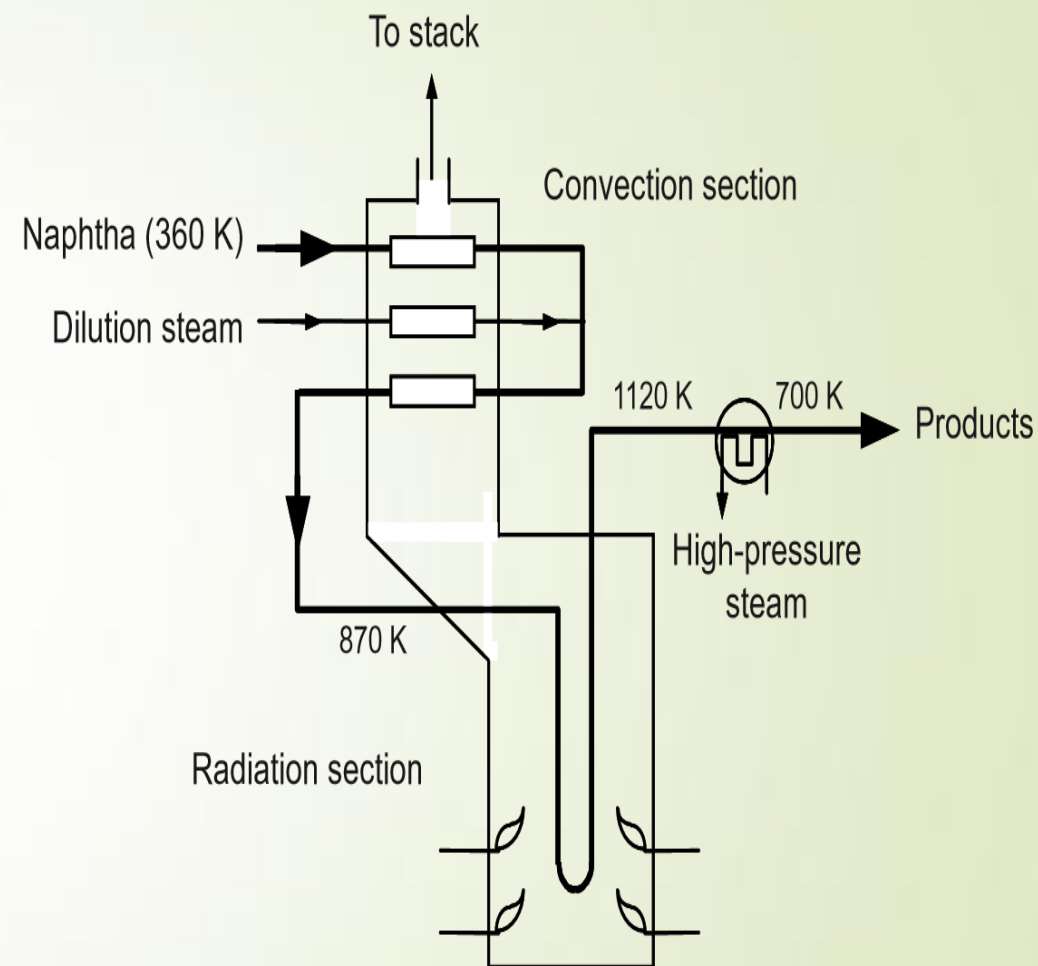
Requirements concerning steam cracking are as follows:

- Considerable heat input at high temperature level :a mixture of hydrocarbons and steam are preheated in the furnace and the radiation section where the reaction takes place.
- Imitation of hydrocarbon partial pressure
- Very short residence time $<1\text{s}$
- Rapid quench of the reaction products to preserve the composition: The hydrocarbons undergo cracking and, subsequently, the products are rapidly quenched to prevent further reaction and thus preserve the composition.

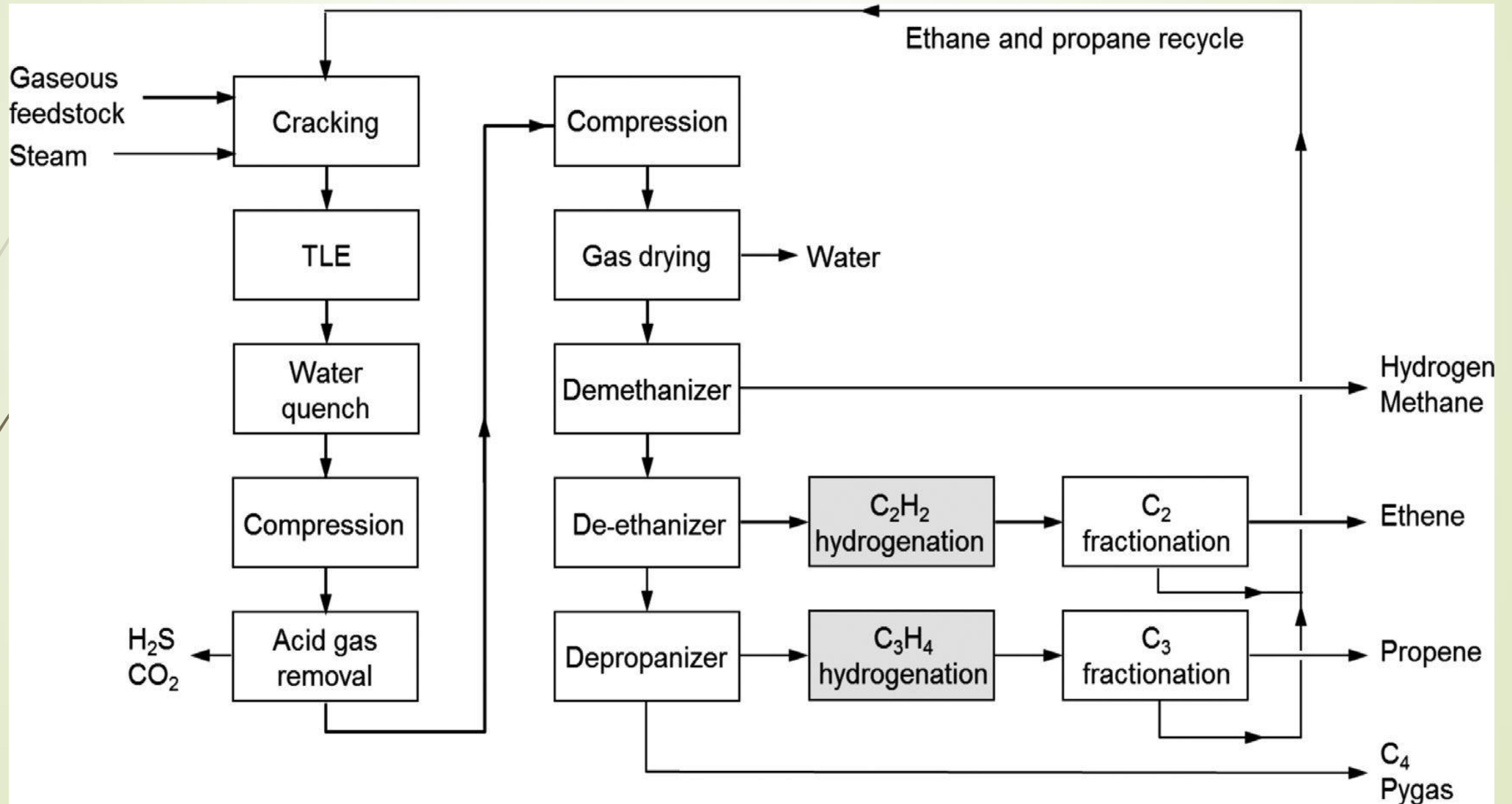
For naphtha no general product distribution can be given because naphtha is not a single compound and its composition varies with its source and refinery operating conditions and may include hydrocarbons ranging from C_3 to C_{15}

Alkanes can be converted relatively easily and when decomposed produce high yields of light products such as ethene and propene as a result of their high hydrogen content.

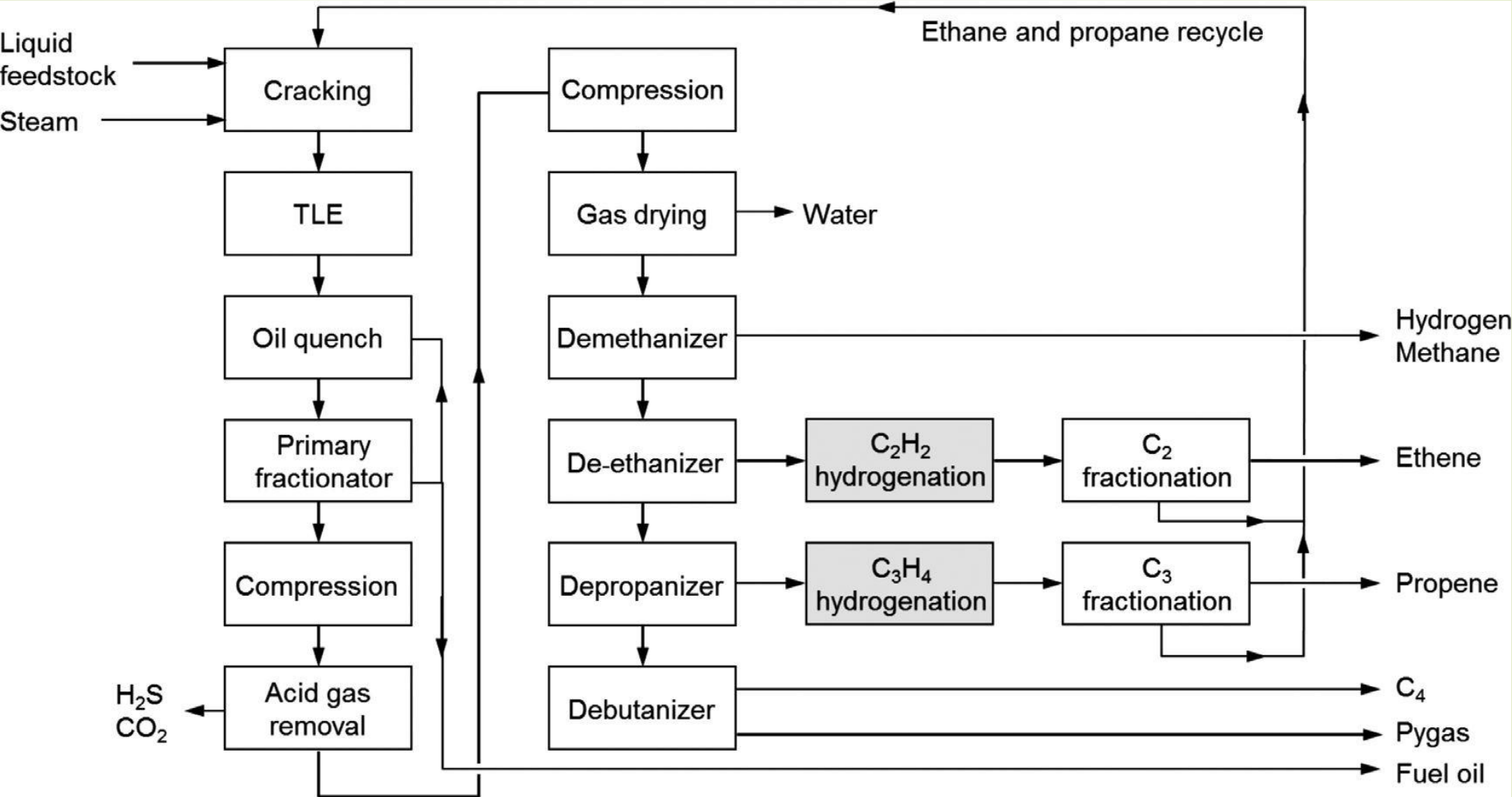
Aromatics, on the other hand, are very stable and they have a low hydrogen-to-carbon ratio, so their yield of light cracking products is negligible.



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Liquid feedstocks (Naptha and gas oil)



USES OF ALKENES

- Lower alkenes used as fuels and illuminant
- For the manufacture of a wide variety of polymers, examples are polyethene, polyvinylchloride (PVC) and Teflon
- As a raw materials for the manufacture of industrial chemicals such as; alcohols, aldehydes
- To produce 1,2-ethanediol(anti freeze compounds) for use in automobile radiators

ETHENE(ETHYLENE)

- Ethylene (ethene), the first member of the alkenes, is a colorless gas with a sweet odor. It is slightly soluble in water and alcohol. It is a highly active compound that reacts easily by addition to many chemical reagents
- It is the building block for a vast range of chemicals from plastics to antifreeze solutions and solvents.
- For example, ethylene with water forms ethyl alcohol. Addition of chlorine to ethylene produces ethylene dichloride (1,2-dichloroethane), which is cracked to vinyl chloride.

- Catalytic oxidation of ethylene produces ethylene oxide, which is hydrolyzed to ethylene glycol. Ethylene glycol is a monomer for the production of synthetic fibers.
- The main source for ethylene is the steam cracking of hydrocarbons

USES

- Polymers such as poly (Ethene), chloroethene (vinyl chloride) and poly (chloroethene) which is also PVC are produced by the use of ethylene.
- Ethylbenzene and hence phenylethene and poly (phenylethene), i.e. polystyrene

PROPENE

- It is also known as propylene or methyl ethylene which is an unsaturated organic compound having the chemical formula C_3H_6 .
- It has one double bond and is the second simplest of the member of the alkene class of hydrocarbons
- propylene (propene) is a reactive alkene that can be obtained from refinery gas streams, especially those from cracking processes, and it is coproduced with ethylene.

USES

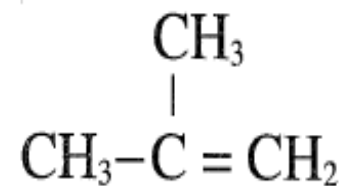
- Industrial preparation of phenol and acetone
- Rubbing alcohol, cosmetics, synthesis of acetone

BUTENE

- It is also known as butylene, is a series of alkenes with the general formula C_4H_8 .
- Butylenes (butenes) are by-products of refinery cracking processes and steam cracking units for ethylene production. Dehydrogenation of butanes is a second source of butenes.
- It also a linear alpha olefin produced either by separation from crude C4 refinery streams or from the reaction of ethylene.

ISOMERS OF BUTENE

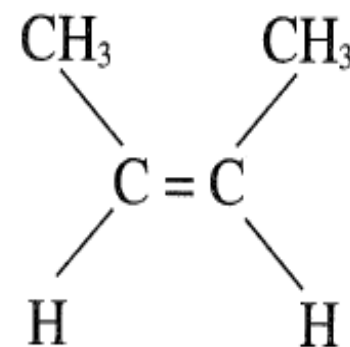
There are four butene isomers: three unbranched, “normal” butenes (n-butenes) and a branched isobutene (2-methylpropene). The three n-butenes are 1-butene and cis- and trans- 2-butene.



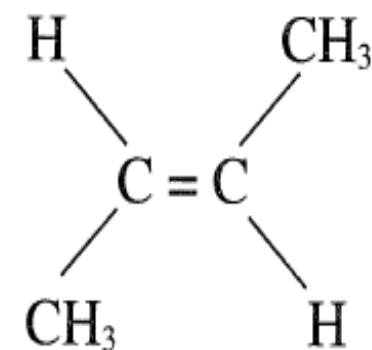
Isobutene



1- Butene



cis-2- Butene



trans-2-Butene

USES

- Butene-1 is also used as a building block in the production of plasticizers
- resistant polymers, lacquers and intermediates in the synthesis of nylon are prepared from butadiene.

THANK YOU

REFERENCE

Chemistry of chemical processes

Sami M, Lewis F.H

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