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DIRECT CHLORINATION OF ETHYLENE FOR THE SYNTHESIS OF 1, 2-DICHLOROETHANE

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Abstract

This work arises in the process of analyzing the knowledge gained from lectures, practical, and laboratory classes on the subjects of ethylene, the technology of producing 1,2-dichloroethane by direct chlorination of ethylene, and 1,2-dichloroethane. The first four representatives of ethylene hydrocarbons are separated from the products of petroleum refining. They can also be obtained from gases formed during the coking of coal. Dichloroethane is used in many branches of industry. For example, it is used as a solvent in the purification of petroleum products and paraffins, in the extraction of oils, and also in the cleaning of metal products before chroming and nickel plating. Dichloroethane is an important factor in polymer production. The purpose of this is the production of polymers and synthetic materials, without which it is impossible to imagine modern life.

Keywords: Dichloroethane $CHCl_2–CH_2Cl$, Ethylene is an unsaturated hydrocarbon. Isomerism of olefins. As catalysts, water-removing agents such as sulfuric and phosphoric acids, potassium bisulfate, phosphorus(V) oxide, and others are used.

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Introduction

In recent years, the chemical industry has been developing rapidly. Today, most of the products being created belong specifically to the chemical industry, particularly to the organic chemical industry. In our republic as well, many laws and resolutions are being adopted to develop the chemical industry. In this regard, the words of our President I.A. Karimov — "Deepening structural changes in industry aimed at the rapid development of priority sectors such as energy, oil and gas–chemical, chemical, textile and light industry, non-ferrous metallurgy, mechanical engineering and automotive industry, pharmaceuticals, which ensure the increasing role and position of the Republic of Uzbekistan in the global division of labor; high-quality and deep processing of agricultural products, production of construction materials, and production of competitive products that are in constant demand on the world market; large-scale modernization of industrial enterprises, technical and technological renewal, and equipping them with the most modern high-tech equipment is our main goal" — are being implemented today as an important program of action[1].

Methods of Production

Ethylene hydrocarbons are found in crude oil. Compounds ranging from C_6H_{12} to $C_{13}H_{26}$ are separated from petroleum. The first four representatives of ethylene hydrocarbons are isolated from petroleum refining products. They can also be obtained from gases formed during the coking of coal. In industry, ethylene hydrocarbons are mainly produced from saturated hydrocarbons by removing hydrogen (dehydrogenation). In this process, chromium oxide is used as a catalyst:

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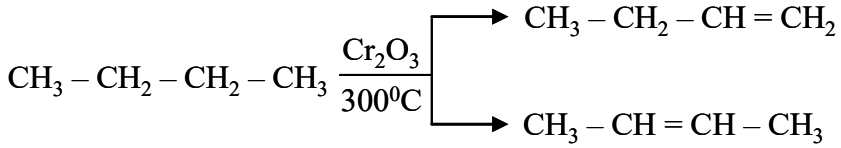
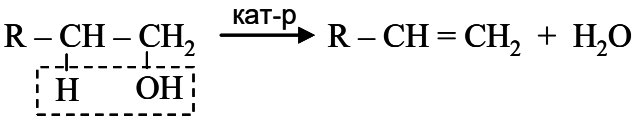
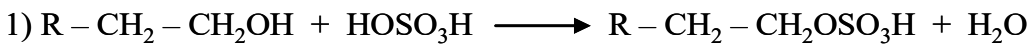
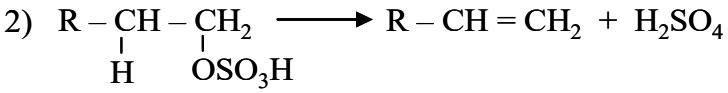


In laboratory conditions, ethylene hydrocarbons are obtained from saturated monohydric alcohols by removing water (dehydration) [2].



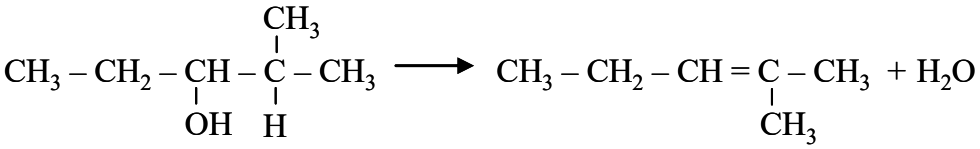
As catalysts, water-removing agents such as sulfuric and phosphoric acids, potassium bisulfate, phosphorus(V) oxide, and others are used. If the process is carried out in the vapor phase, aluminum oxide can be used as a catalyst. When the process is conducted in the presence of sulfuric acid as a catalyst, the formation of ethylene hydrocarbons from alcohols occurs according to the following mechanism:





In this process, water is eliminated most easily from tertiary alcohols, followed by secondary and then primary alcohols. From tertiary alcohols, water begins to be eliminated even when they are distilled together with sulfuric acid [3].

The elimination of water from alcohols proceeds according to Zaitsev's rule, in which hydrogen is removed from the carbon atom containing the least hydrogen, that is:



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During the dehydration of alcohols, the resulting ethylene hydrocarbon may undergo isomerization. Therefore, when this process is carried out, not a single hydrocarbon is formed, but rather a mixture of hydrocarbons.

Ethylene hydrocarbons can also be obtained by removing halogenated hydrogen from halogen-containing derivatives of hydrocarbons. In this case, agents that remove halogenated hydrogen, such as a dry alkali solution in alcohol, tertiary amines, quinoline, and others, are used. When iodine or bromine derivatives are used, good results are obtained. The process with chlorine derivatives proceeds with difficulty:

$$R - \underset{\underset{Br}{|}}{CH} - CH_2 - CH_3 \xrightarrow{KOH\ сп.эр.} R - CH = CH - CH_3 + KBr + H_2O$$

Ethylene hydrocarbons can also be obtained from dihalogen derivatives of hydrocarbons.

:

$$R - \underset{\underset{CH_2 - Br}{|}}{CH} - Br + Zn \longrightarrow R - \underset{\underset{CH_2}{||}}{CH} + ZnBr_2$$

However, in this case, the resulting ethylene hydrocarbons may isomerize in the presence of zinc halide. Therefore, instead of zinc powder, divalent chromium salts, sodium iodide, and others are used in these processes [4,5].

Ethylene hydrocarbons can also be obtained by hydrogenation of acetylene in the presence of a palladium catalyst:

$$R - C \equiv CH + H_2 \xrightarrow{Pd} R - CH = CH_2$$

Among the methods for obtaining olefins, the one most widely used in the laboratory is the pyrolysis of acetate esters. (400-500^{0}C):

$_nH_{2n+1} - OOC - CH_3 \rightarrow C_nH_{2n} + CH_3COOH$

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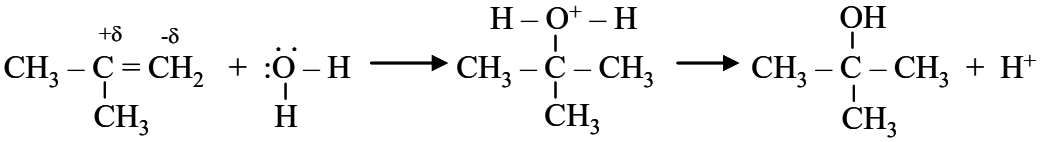
Hydration. Olefins react with water in the presence of a catalyst to form monohydric alcohols. Concentrated sulfuric acid is usually used as the catalyst. This process occurs via a carbocation mechanism, that is:

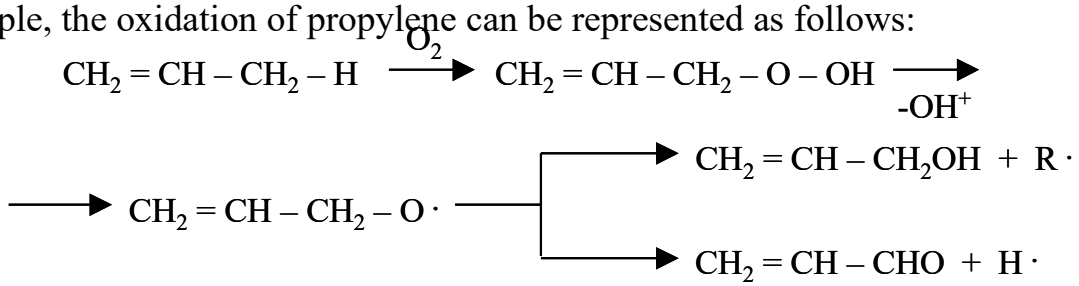


The more branched the olefin molecule, the easier the reaction proceeds, and the lower the concentration of sulfuric acid required. For example, when hydrating ethylene, 96–98% sulfuric acid is used; for propylene, 75–80% sulfuric acid; while isobutylene easily reacts in the presence of 34–50% sulfuric acid.

Today, a large amount of ethyl alcohol is produced industrially by this method. Since the use of sulfuric acid as a catalyst poses difficulties, in recent times the process is carried out using a heterogeneous (solid) catalyst.

Oxidation. The oxidation of olefins results in the formation of various oxygen-containing compounds as final products, depending on the reaction conditions and the nature of the oxidizing agent.

Olefins, when oxidized with atmospheric oxygen in the presence of catalysts such as bismuth, molybdenum, or vanadium oxides at high temperatures (380–450 °C), yield unsaturated alcohols, carbonyl compounds, and acids. For example, the oxidation of propylene can be represented as follows:



When oxidation is carried out with atmospheric oxygen in the presence of a silver catalyst, epoxide compounds are formed:

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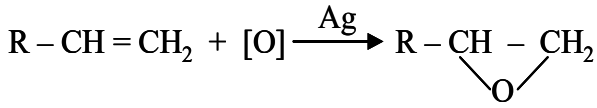
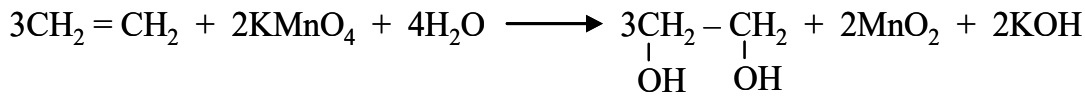
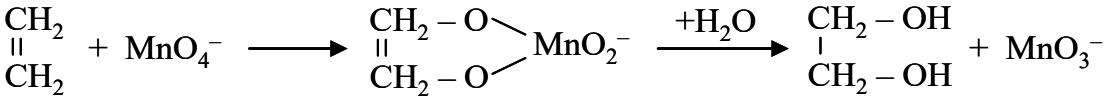


Here, the silver catalyst serves to convert molecular oxygen into its atomic form. An aqueous solution of potassium permanganate oxidizes olefins to form dihydric (two-hydroxyl) alcohols:



The reaction mechanism can be represented as follows:

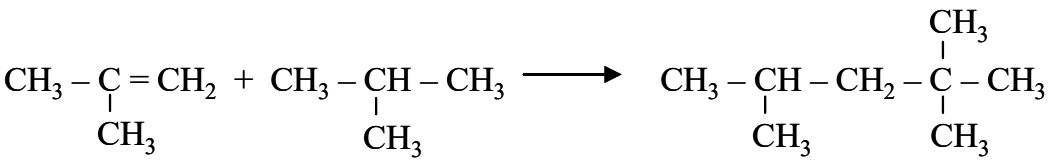


Strong oxidizing agents (such as chromic acid, nitric acid, and others) break the ethylene hydrocarbon molecule at the site of the double bond. As a result, acids or a mixture of ketones and acids are formed.

Alkylation

The introduction of hydrocarbon residues (alkyl groups) into the molecules of various organic compounds is called an alkylation reaction.

Olefins have the ability to add to paraffins in the presence of phosphoric or sulfuric acid. In industry, this reaction is used to produce iso-octane:



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Conclusion

In this work, we studied the technology of 1,2-dichloroethane production. The heat required to carry out the reaction, the heats of each substance, the amount of heat lost, and the amount released are presented in the heat balance. According to this, 9109.27 kW of heat is needed to conduct the reaction.

The type of reactor required for the production of dichloroethane, its dimensions, and the material it is made from are given in the mechanical calculation of the main equipment. It was determined that the reactor has a height of 10 m and a diameter of 1.4 m. Its body is made of 18X10HT steel, and the nozzles are made of CT3 material.

The types of substances formed in the process and methods to reduce them are presented in the sections on environmental protection and industrial safety.

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