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0 ratings0% found this document useful (0 votes)49 views107 pagesSaveSave Ethylene Production Process For Later0%0% found this document useful, undefined Hydrocarbon compound ($H_2C=CH_2$) "Ethene" redirects here; not to be confused with ethane or ethyne. Ethylene Names Preferred IUPAC name Ethene[1] Systematic IUPAC name Ethene Other names Refrigerant R-1150 Identifiers CAS Number 74-85-1 Y 3D model (JSmol) Interactive image Beilstein Reference 1730731 ChEBI CHEBI:18153 Y ChEMBL ChEMBL117822 Y ChemSpider 6085 Y ECHA InfoCard 100.000.742 EC Number 200-815-3 Gmelin Reference 214 KEGG C06547 Y PubChem CID 6325 RTECS number KU5340000 UNII 91GW059KN7 Y UN number 1962 1038 CompTox Dashboard (EPA) DTXSID1026378 InChI InChI=1S/C2H4/c1-2/h1-2H2 YKey: VGGSQFUCUMXWEO-UHFFFAOYSA-N YInChI=1/C2H4/c1-2/h1-2H2Key: VGGSQFUCUMXWEO-UHFFFAOYAE SMILES C=C Properties Chemical formula C2H4 Molar mass 28.054 g·mol−1 Appearance colourless gas Density 1.178 kg/m3 at 15 °C, gas[2] Melting point −169.2 °C (−272.6 °F; 104.0 K) Boiling point −103.7 °C (−154.7 °F; 169.5 K) Solubility in water 131 mg/L (25 °C);[3] 2.9 mg/L[4] Solubility in ethanol 4.22 mg/L[4] Solubility in diethyl ether good[4] Acidity (pKa) 44 Conjugate acid Ethenium Magnetic susceptibility (χ) −15.30·10−6 cm3/mol Viscosity 10.28 μPa·s[5] Structure Molecular shape D2h Dipole moment zero Thermochemistry Std molarentropy (S298) 219.32 J·K−1·mol−1 Std enthalpy offormation (ΔfH298) +52.47 kJ/mol Hazards GHS labelling: Pictograms Signal word Danger Hazard statements H220, H336 Precautionary statements P210, P261, P271, P304+P340, P312, P377, P381, P403, P403+P233, P405, P501 NFPA 704 (fire diamond) 2 4 2 Flash point −136 °C (−213 °F; 137 K) Autoignitiontemperature 542.8 °C (1,009.0 °F; 815.9 K) Safety data sheet (SDS) ICSC 0475 Related compounds Related compounds EthaneAcetylene Propene Supplementary data page Ethylene (data page) Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa). Y verify (what is YN ?) Infobox references Chemical compound Ethylene (IUPAC name: ethene) is a hydrocarbon which has the formula C2H4 or H2C=CH2. It is a colourless, flammable gas with a faint "sweet and musky" odour when pure.[7] It is the simplest alkene (a hydrocarbon with carbon–carbon double bonds). Ethylene is widely used in the chemical industry, and its worldwide production (over 150 million tonnes in 2016[8]) exceeds that of any other organic compound.[9][10] Much of this production goes toward creating polyethylene, which is a widely used plastic containing polymer chains of ethylene units in various chain lengths. Production emits greenhouse gases, including methane from feedstock production and carbon dioxide from any non-sustainable energy used. Ethylene is also an important natural plant hormone and is used in agriculture to induce ripening of fruits.[11] The hydrate of ethylene is ethanol. Orbital description of bonding between ethylene and a transition metal This hydrocarbon has four hydrogen atoms bound to a pair of carbon atoms that are connected by a double bond. All six atoms that comprise ethylene are coplanar. The H-C-H angle is 117.4°, close to the 120° for ideal sp^2 hybridized carbon. The molecule is also relatively weak: rotation about the C-C bond is a very low energy process that requires breaking the π-bond by supplying heat at 50 °C.[citation needed] The π-bond in the ethylene molecule is responsible for its useful reactivity. The double bond is a region of high electron density, thus it is susceptible to attack by electrophiles. Many reactions of ethylene are catalyzed by transition metals, which bind transiently to the ethylene using both the π and π* orbitals.[citation needed] Being a simple molecule, ethylene is spectroscopically simple. Its UV-vis spectrum is still used as a test of theoretical methods.[12] Diagram of uses of ethene Major industrial reactions of ethylene include in order of scale: 1) polymerization, 2) oxidation, 3) halogenation and hydrohalogenation, 4) alkylation, 5) hydration, 6) oligomerization, and 7) hydroformylation. In the United States and Europe, approximately 90% of ethylene is used to produce ethylene oxide, ethylene dichloride, ethylbenzene and polyethylene.[13] Most of the reactions with ethylene are electrophilic addition.[citation needed] Main industrial uses of ethylene. Clockwise from the upper right: its conversions to ethylene oxide, precursor to ethylene glycol; to ethylbenzene, precursor to styrene; to various kinds of polyethylene; to ethylene dichloride, precursor to vinyl chloride. See also: Ziegler–Natta catalyst and Polyethylene Polyethylene production uses more than half of the world's ethylene supply. Polyethylene, also called polyethene and polythene, is the world's most widely used plastic. It is primarily used to make films in packaging, carrier bags and trash liners. Linear alpha-olefins, produced by oligomerization (formation of short-chain molecules) are used as precursors, detergents, plasticisers, synthetic lubricants, additives, and also as co-monomers in the production of polyethylenes.[13] Ethylene is oxidized to produce ethylene oxide, a key raw material in the production of surfactants and detergents by ethoxylation. Ethylene oxide is also hydrolyzed to produce ethylene glycol, widely used as an automotive antifreeze as well as higher molecular weight glycols, glycol ethers, and polyethylene terephthalate.[14][15] Main article: Wacker process Ethylene oxidation in the presence of a palladium catalyst can form acetaldehyde. This conversion remains a major industrial process (10M kg/y).[16] The process proceeds via the initial complexation of ethylene to a Pd(II) center.[citation needed] Major intermediates from the halogenation and hydrohalogenation of ethylene include ethylene dichloride, ethyl chloride, and ethylene dibromide. The addition of chlorine entails "oxychlorination", i.e. chlorine itself is not used. Some products derived from this group are polyvinyl chloride, trichloroethylene, perchloroethylene, methyl chloroform, polyvinylidene chloride and copolymers, and ethyl bromide.[17] Major chemical intermediates from the alkylation with ethylene is ethylbenzene, precursor to styrene. Styrene is used principally in polystyrene for packaging and insulation, as well as in styrene-butadiene rubber for tires and footwear. On a smaller scale, ethyltoluene, ethylanilines, 1,4-hexadiene, and aluminium alkyls. Products of these intermediates include polystyrene, unsaturated polyesters and ethylene-propylene terpolymers.[17] The hydroformylation (oxo reaction) of ethylene results in propionaldehyde, a precursor to propionic acid and n-propyl alcohol.[17] Ethylene has long represented the major nonfermentative precursor to ethanol. The original method entailed its conversion to diethyl sulfate, followed by hydrolysis. The main method practiced since the mid-1990s is the direct hydration of ethylene catalyzed by solid acid catalysts:[18] C2H4 + H2O → CH3CH2OH Ethylene is dimerized by hydrovinylation to give n-butenes using processes licensed by Lummus or IFP. The Lummus process produces mixed n-butenes (primarily 2-butenes) while the IFP process produces 1-butene. 1-Butene is used as a comonomer in the production of certain kinds of polyethylene.[19] Main article: Ethylene (plant hormone) Ethylene is a hormone that affects the ripening and flowering of many plants. It is widely used to control freshness in horticulture and fruits.[20] The scrubbing of naturally occurring ethylene delays ripening.[21] Adsorption of ethylene by nets coated in titanium dioxide gel has also been shown to be effective.[22] An example of a niche use is as an anesthetic agent (in an 85% ethylene/15% oxygen ratio).[23] It is also used as a refrigerant gas for low temperature applications under the name R-1150.[24] Global ethylene production was 107 million tonnes in 2005,[9] 109 million tonnes in 2006,[25] 138 million tonnes in 2010, and 141 million tonnes in 2011.[26] By 2013, ethylene was produced by at least 117 companies in 32 countries. To meet the ever-increasing demand for ethylene, sharp increases in production facilities are added globally, particularly in the Mideast and in China.[27] Production emits greenhouse gas, namely significant amounts of carbon dioxide.[28] Ethylene is produced by several methods in the petrochemical industry. A primary method is steam cracking (SC) where hydrocarbons and steam are heated to 750–950 °C. This process converts large hydrocarbons into smaller ones and introduces unsaturation. When ethane is the feedstock, ethylene is the product. Ethylene is separated from the resulting mixture by repeated compression and distillation.[17] In Europe and Asia, ethylene is obtained mainly from cracking naphtha, gasoil and condensates with the coproduction of propylene, C4 olefins and aromatics (pyrolysis gasoline).[29] Other procedures employed for the production of ethylene include Fischer-Tropsch synthesis and methanol-to-olefins (MTO).[30] Although of great value industrially, ethylene is rarely synthesized in the laboratory and is ordinarily purchased.[31] It can be produced via dehydration of ethanol with sulfuric acid or in the gas phase with aluminium oxide or activated alumina.[32] Ethylene is produced from methionine in nature. The immediate precursor is 1-aminocyclopropane-1-carboxylic acid.[33] Chlorobis(ethylene)rhodium dimer is a well-studied complex of ethylene.[34] Ethylene is a fundamental ligand in transition metal alkene complexes. One of the first organometallic compounds, Zeise's salt is a complex of ethylene. Useful reagents containing ethylene include Pt(PPh3)2(C2H4) and Rh2Cl2(C2H4)4. The Rh-catalysed hydroformylation of ethylene is conducted on an industrial scale to provide propionaldehyde.[35] Some geologists and scholars believe that the famous Greek Oracle at Delphi (the Pythia) went into her trance-like state as an effect of ethylene rising from ground faults.[36] Ethylene appears to have been discovered by Johann Joachim Becher, who obtained it by heating ethanol with sulfuric acid;[37] he mentioned the gas in his Physica Subterranea (1669).[38] Joseph Priestley also mentions the gas in his Experiments and observations relating to the various branches of natural philosophy: with a continuation of the observations on air (1779), where he reports that Jan Ingenhousz saw ethylene synthesized in the same way by a Mr. Enée in Amsterdam in 1777 and that Ingenhousz subsequently produced the gas himself.[39] The properties of ethylene were studied in 1795 by four Dutch chemists, Johann Rudolph Deimann, Adrien Paets van Troostwyck, Anthoni Lauwerenburgh and Nicolas Bondt, who found that it differed from hydrogen gas and that it contained both carbon and hydrogen.[40] This group also discovered that ethylene could be combined with chlorine to produce the Dutch oil, 1,2-dichloroethane; this discovery gave ethylene the name used for it at that time, olefiant gas (oil-making gas.)[41] The term olefiant gas is in turn the etymological origin of the modern word "olefin", the class of hydrocarbons in which ethylene is the first member.[citation needed] In the mid-19th century, the suffix -ene (an Ancient Greek root added to the end of female names meaning "daughter of") was widely used to refer to a molecule or part thereof that contained one fewer hydrogen atoms than the molecule being modified. Thus, ethylene (C2H4) was the "daughter of ethyl" (C2H5). The name ethylene was used in this sense as early as 1852.[42] In 1866, the German chemist August Wilhelm von Hofmann proposed a system of hydrocarbon nomenclature in which the suffixes -ane, -ene, -ine, -one, and -une were used to denote the hydrocarbons with 0, 2, 4, 6, and 8 fewer hydrogens than their parent alkane.[43] In this system, ethylene became ethene. Hofmann's system eventually became the basis for the Geneva nomenclature approved by the International Congress of Chemists in 1892, which remains at the core of the IUPAC nomenclature. However, by that time, the name ethylene was deeply entrenched, and it remains in wide use today, especially in the chemical industry. Following experimentation by Luckhardt, Crocker, and Carter at the University of Chicago,[44] ethylene was used as an anesthetic.[45][7] It remained in use through the 1940s, even while chloroform was being phased out. Its pungent odor and its explosive nature limit its use today.[46] The 1979 IUPAC nomenclature rules made an exception for retaining the non-systematic name ethylene;[47] however, this decision was reversed in the 1993 rules,[48] and it remains unchanged in the newest 2013 recommendations,[49] so the IUPAC name is now ethene. In the IUPAC system, the name ethylene is reserved for the divalent group -CH2CH2-. Hence, names like ethylene oxide and ethylene dibromide are permitted, but the use of the name ethylene for the two-carbon alkene is not. Nevertheless, use of the name ethylene for H2C=CH2 (and propylene for H2C=CHCH3) is still prevalent among chemists in North America.[50] "A key factor affecting petrochemicals life-cycle emissions is the methane intensity of feedstocks, especially in the production segment."[51] Emissions from cracking of naptha and natural gas (common in the US as gas is cheap there) depend a lot on the source of energy (for example gas burnt to provide high temperatures[52]) but that from naptha is certainly more per kg of feedstock.[53] Both steam cracking and production from natural gas via ethane are estimated to emit 1.8 to 2kg of CO2 per kg ethylene produced,[54] totalling over 260 million tonnes a year.[55] This is more than all other manufactured chemicals except cement and ammonia.[56] According to a 2022 report using renewable or nuclear energy could cut emissions by almost half.[53] Like all hydrocarbons, ethylene is a combustible asphyxiant. It is listed as an IARC group 3 agent, since there is no current evidence that it causes cancer in humans.[57] RediRipe, an ethylene detector for fruits.

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International Chemical Safety Card 0475 MSDS Retrieved from " 2 2-Butene cis trans cis trans Names Preferred IUPAC name But-2-ene Other names β-Butylene Identifiers CAS Number 107-01-7 Y(cis): 590-18-1 Y(trans): 624-64-6 Y 3D model (JSmol) Interactive image(cis): Interactive image(trans): Interactive image Beilstein Reference 1718755 1361341 ChEBI CHEBI:48363 Y(cis): CHEBI:48366(trans): CHEBI:48365 ChemSpider 11719 Y(cis): 4449912 N(trans): 56442 N ECHA InfoCard 100.003.140 EC Number 203-452-9 Gmelin Reference 25196 1140 1141 PubChem CID (cis): 5287573(trans): 62695 RTECS number EM2932000 1718756 UNII S1SK37516R Y(cis): L35ORC9C05 Y(trans): 017NGL487F Y CompTox Dashboard (EPA) DTXSID1026748 InChI InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3 YKey: IAQRGUVFOMOMEM-UHFFFAOYSA-N YInChI=1/C4H8/c1-3-4-2/h3-4H,1-2H3Key: IAQRGUVFOMOMEM-UHFFFAOYAW(cis): InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3/b4-3-Key: IAQRGUVFOMOMEM-ARJAWSKDSA-N(trans): InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3/b4-3+Key: IAQRGUVFOMOMEM-ONEGZZNKSA-N SMILES C(=CC)C(cis): C/C=C\C(trans): C/C=C/C Properties Chemical formula C4H8 Molar mass 56.106 g/mol Density 0.641 g/ml (cis, 3.7 °C)[1]0.626 g/ml (trans, 0.9 °C)[2] Melting point −138.9 °C (−218.0 °F; 134.2 K) (cis)[1]−105.5 °C (trans)[2] Boiling point 0.8 to 3.7 °C (33.4 to 38.7 °F; 273.9 to 276.8 K) (Z = 3.7 °C)[1] (E = 0.8 °C)[2] Magnetic susceptibility (χ) −42.6·10−6 cm3/mol (cis) −43.3·10−6 cm3/mol (trans) Hazards[3] GHS labelling: Pictograms Signal word Danger Hazard statements H220 Precautionary statements P210, P377, P381, P403 NFPA 704 (fire diamond) 1 4 0 Flash point −72 °C (−98 °F; 201 K)[1][2] Autoignitiontemperature 325 °C (617 °F; 598 K)[1][2] Related compounds Related butenes 1-Butenecis-2-Butenetrans-2-ButeneIsobutene Related compounds ButaneButyne Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa). N verify (what is YN ?) Infobox references Chemical compound 2-Butene is an acyclic alkene with four carbon atoms. It is the simplest alkene exhibiting cis/trans-isomerism (also known as (E/Z)-isomerism); that is, it exists as two geometric isomers cis-2-butene ((Z)-but-2-ene) and trans-2-butene ((E)-but-2-ene). It is a petrochemical, produced by the catalytic cracking of crude oil or the dimerization of ethylene. Its main uses are in the production of high-octane gasoline (petrol) on alkylation units and butadiene,[4] although some 2-butene is also used to produce the solvent butanone via hydration reaction to 2-butanol followed by oxidation. The two isomers are extremely difficult to separate by distillation because of the proximity of their boiling points (~4 °C for cis and ~1 °C for trans[5]). However, separation is unnecessary in most industrial settings, as both isomers behave similarly in most of the desired reactions. A typical industrial 2-butene mixture is 70% (Z)-but-2-ene (cis-isomer) and 30% (E)-but-2-ene (trans-isomer). Butane and 1-butene are common impurities, present at 1% or more in industrial mixtures, which also contain smaller amounts of isobutene, butadiene and butyne.[4] ^ a b c d e Record in the GESTIS Substance Database of the Institute for Occupational Safety and Health ^ a b c d e Record in the GESTIS Substance Database of the Institute for Occupational Safety and Health ^ cis-2-Butene, International Chemical Safety Card 0397, Geneva: International Programme on Chemical Safety, March 1996. trans-2-Butene, International Chemical Safety Card 0398, Geneva: International Programme on Chemical Safety, March 1996. ^ a b 2-Butene (PDF), SIDS Initial Assessment Report, Geneva: United Nations Environment Programme, February 1995. ^ Chemical Safety Information from Intergovernmental Organizations Archived December 9, 2009, at the Wayback Machine SIDS Initial Assessment Report for 2-Butene from the Organisation for Economic Co-operation and Development (OECD) Retrieved from " 3 2-Butene cis trans cis trans Names Preferred IUPAC name But-2-ene Other names β-Butylene Identifiers CAS Number 107-01-7 Y(cis): 590-18-1 Y(trans): 624-64-6 Y 3D model (JSmol) Interactive image(cis): Interactive image(trans): Interactive image Beilstein Reference 1718755 1361341 ChEBI CHEBI:48363 Y(cis): CHEBI:48366(trans): CHEBI:48365 ChemSpider 11719 Y(cis): 4449912 N(trans): 56442 N ECHA InfoCard 100.003.140 EC Number 203-452-9 Gmelin Reference 25196 1140 1141 PubChem CID (cis): 5287573(trans): 62695 RTECS number EM2932000 1718756 UNII S1SK37516R Y(cis): L35ORC9C05 Y(trans): 017NGL487F Y CompTox Dashboard (EPA) DTXSID1026748 InChI InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3 YKey: IAQRGUVFOMOMEM-UHFFFAOYSA-N YInChI=1/C4H8/c1-3-4-2/h3-4H,1-2H3Key: IAQRGUVFOMOMEM-UHFFFAOYAW(cis): InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3/b4-3-Key: IAQRGUVFOMOMEM-ARJAWSKDSA-N(trans): InChI=1S/C4H8/c1-3-4-2/h3-4H,1-2H3/b4-3+Key: IAQRGUVFOMOMEM-ONEGZZNKSA-N SMILES C(=CC)C(cis): C/C=C\C(trans): C/C=C/C Properties Chemical formula C4H8 Molar mass 56.106 g/mol Density 0.641 g/ml (cis, 3.7 °C)[1]0.626 g/ml (trans, 0.9 °C)[2] Melting point −138.9 °C (−218.0 °F; 134.2 K) (cis)[1]−105.5 °C (trans)[2] Boiling point 0.8 to 3.7 °C (33.4 to 38.7 °F; 273.9 to 276.8 K) (Z = 3.7 °C)[1] (E = 0.8 °C)[2] Magnetic susceptibility (χ) −42.6·10−6 cm3/mol (cis) −43.3·10−6 cm3/mol (trans) Hazards[3] GHS labelling: Pictograms Signal word Danger Hazard statements H220 Precautionary statements P210, P377, P381, P403 NFPA 704 (fire diamond) 1 4 0 Flash point −72 °C (−98 °F; 201 K)[1][2] Autoignitiontemperature 325 °C (617 °F; 598 K)[1][2] Related compounds Related butenes 1-Butenecis-2-Butenetrans-2-ButeneIsobutene Related compounds ButaneButyne Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa). N verify (what is YN ?) Infobox references Chemical compound 2-Butene is an acyclic alkene with four carbon atoms. It is the simplest alkene exhibiting cis/trans-isomerism (also known as (E/Z)-isomerism); that is, it exists as two geometric isomers cis-2-butene ((Z)-but-2-ene) and trans-2-butene ((E)-but-2-ene). It is a petrochemical, produced by the catalytic cracking of crude oil or the dimerization of ethylene. Its main uses are in the production of high-octane gasoline (petrol) on alkylation units and butadiene,[4] although some 2-butene is also used to produce the solvent butanone via hydration reaction to 2-butanol followed by oxidation. The two isomers are extremely difficult to separate by distillation because of the proximity of their boiling points (~4 °C for cis and ~1 °C for trans[5]). However, separation is unnecessary in most industrial settings, as both isomers behave similarly in most of the desired reactions. 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