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Is no2 paramagnetic or diamagnetic

All nitrogen oxides are thermodynamically unstable with respect to decomposition to N2 and O2, but they are kinetically stable, ie. the rate of decomposition is very slow. All the oxides contain Nprr-Oprtr bonding. Nitrous Oxide/Dinitrogen oxide (N2O): The oxidation state of N is +1, and this compound is a colourless gas and chemically inert. isoelectronic with CO2 and N3–. The N-N bond order is ~2.5 Nitric Oxide/Nitrogen Monoxide (NO): The oxidation state of N is +2, and this is a colourless, paramagnetic gas (ie. it is a radical, or contains an unpaired electron). It plays an important role in the formation of ozone in the atmosphere. π-acid: acts as a 1-electron (σ-) or 3-electron (σ- + π-) donor in forming transition metal complexes, eg. Cr(NO)4 is a tetrahedral 18-electron complex. Dinitrogen Trioxide (N2O3): The oxidation state of N is +3. This is a blue solid or liquid, which dissociates to NO and NO2 in the gas phase, and reacts with water to give nitrous acid (HNO2). Nitrogen Dioxide (NO2): The oxidation state of N is +4. This exists in equilibrium between NO2 and N2O4. NO2 is a brown, paramagnetic gas (ie. it contains an unpaired electron), and N2O4 is a colourless, diamagnetic solid (ie. it contains only paired electrons). Dinitrogen Pentoxide (N2O5): The oxidation state of N is +5. This is the acid anhydride of nitric acid, and has a symmetric, planar structure. Chemical compound Not to be confused with nitric oxide (formula NO), nitrous oxide (N2O), or generic nitrogen oxide pollutants NOx. "NO2" redirects here. For other uses, see NO2 (disambiguation). Nitrogen dioxide NO2 converts to the colorless dinitrogen tetroxide (N2O4) at low temperatures and reverts to NO2 at higher temperatures. Names IUPAC name Nitrogen dioxide Other names Nitrogen(IV) oxide,[1] deutoxide of nitrogen Identifiers CAS Number 10102-44-0 Y 3D model (JSmol) Interactive imageInteractive image ChEBI ChEBI:33101 Y ChemSpider 2297499 Y ECHA InfoCard 100.030.234 EC Number 233-272-6 Gmelin Reference 976 PubChem CID 3032552 RTECS number QW9800000 UNII S7G510RUBH N UN number 1067 CompTox Dashboard (EPA) DTXSID7020974 InChI InChI=1S/NO2/c2-1-3 YKey: JCXJVPUVTGWGSNB-UHFFFAOYSA-N YInChI=1/NO2/c2-1-3Key: JCXJVPUVTGWGSNB-UHFFFAOYAA SMILES N(=O)[O][N+](=O)[O-] Properties Chemical formula NO+2 Molar mass 46.006 g/mol[2] Appearance Brown gas[2] Odor Chlorine-like Density 1.880 g/L[2] Melting point −9.3 °C (15.3 °F; 263.8 K)[2] Boiling point 21.15 °C (70.07 °F; 294.30 K)[2] Solubility in water Hydrolyses Solubility Soluble in CCl4, nitric acid,[3] chloroform Vapor pressure 98.80 kPa (at 20 °C) Magnetic susceptibility (χ) +150.0·10−6 cm3/mol[4] Refractive index (nD) 1.449 (at 20 °C) Structure Point group C2v Molecular shape Bent Thermochemistry[5] Heat capacity (C) 37.2 J/(mol·K) Std molarentropy (So298) 240.1 J/(mol·K) Std enthalpy of formation (ΔfH⊖298) +33.2 kJ/mol Hazards Main hazards Poison, oxidizer Safety data sheet ICSC 0930 GHS pictograms GHS Signal word Danger GHS hazard statements H270, H314, H330 GHS precautionary statements P220, P260, P280, P284, P305+351+338, P310 NFPA 704 (fire diamond) 3 0 OX Lethal dose or concentration (LD, LC): LC50 (median concentration) 30 ppm (guinea pig, 1 h)315 ppm (rabbit, 15 min)68 ppm (rat, 4 h)138 ppm (rat, 30 min)1000 ppm (mouse, 10 min)[7] LCLo (lowest published) 64 ppm (dog, 8 h)64 ppm (monkey, 8 h)[7] NIOSH (US health exposure limits): PEL (Permissible) C 5 ppm (9 mg/m3)[6] REL (Recommended) ST 1 ppm (1.8 mg/m3)[6] IDLH (Immediate danger) 13 ppm[6] Related compounds Related nitrogen oxides Dinitrogen pentoxide Dinitrogen tetroxide Dinitrogen trioxide Nitric oxide Nitrous oxide Related compounds Chlorine dioxide Carbon dioxide 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 Nitrogen dioxide is a chemical compound with the formula NO2. It is one of several nitrogen oxides. NO2 is an intermediate in the industrial synthesis of nitric acid, millions of tons of which are produced each year for use primarily in the production of fertilizers. At higher temperatures it is a reddish-brown gas. It can be fatal if inhaled in large quantity.[8] Nitrogen dioxide is a paramagnetic, bent molecule with C2v point group symmetry. Properties Nitrogen dioxide is a reddish-brown gas above 21.2 °C (70.2 °F; 294.3 K) with a pungent, acrid odor, becomes a yellowish-brown liquid below 21.2 °C (70.2 °F; 294.3 K), and converts to the colorless dinitrogen tetroxide (N2O4) below −11.2 °C (11.8 °F; 261.9 K).[6] The bond length between the nitrogen atom and the oxygen atom is 119.7 pm. This bond length is consistent with a bond order between one and two. Unlike ozone, O3, the ground electronic state of nitrogen dioxide is a doublet state, since nitrogen has one unpaired electron,[9] which decreases the alpha effect compared with nitrite and creates a weak bonding interaction with the oxygen lone pairs. The lone electron in NO2 also means that this compound is a free radical, so the formula for nitrogen dioxide is often written as •NO2. The reddish-brown color is a consequence of preferential absorption of light in the blue region of the spectrum (400 – 500 nm), although the absorption extends throughout the visible (at shorter wavelengths) and into the infrared (at longer wavelengths). Absorption of light at wavelengths shorter than about 400 nm results in photolysis (to form NO + O, atomic oxygen); in the atmosphere the addition of O atom so formed to O2 results in ozone formation. Preparation and reactions Nitrogen dioxide typically arises via the oxidation of nitric oxide by oxygen in air:[10] 2 NO + O2 → 2 NO2 Nitrogen dioxide is formed in most combustion processes using air as the oxidant. At elevated temperatures nitrogen combines with oxygen to form nitric oxide: O2 + N2 → 2 NO In the laboratory, NO2 can be prepared in a two-step procedure where dehydration of nitric acid produces dinitrogen pentoxide, which subsequently undergoes thermal decomposition: 2 HNO3 → N2O5 + H2O 2 N2O5 → 4 NO2 + O2 The thermal decomposition of some metal nitrates also affords NO2: 2 Pb(NO3)2 → 2 PbO + 4 NO2 + O2 Alternatively, reduction of concentrated nitric acid by metal (such as copper). 4 HNO3 + Cu → Cu(NO3)2 + 2 NO2 + 2 H2O Or finally by adding concentrated nitric acid over tin, hydrated stannic oxide is produced as byproduct. 4 HNO3 + Sn → H2O + H2SnO3 + 4 NO2 Main reactions Basic thermal properties NO2 exists in equilibrium with the colourless gas dinitrogen tetroxide (N2O4): 2 NO2 ⇌ N2O4 The equilibrium is characterized by ΔH = −57.23 kJ/mol, which is exothermic. NO2 is favored at higher temperatures, while at lower temperatures, dinitrogen tetroxide (N2O4) predominates. Dinitrogen tetroxide (N2O4) can be obtained as a white solid with melting point −11.2 °C.[10] NO2 is paramagnetic due to its unpaired electron, while N2O4 is diamagnetic. The chemistry of nitrogen dioxide has been investigated extensively. At 150 °C, NO2 decomposes with release of oxygen via an endothermic process (ΔH = 14 kJ/mol): 2 NO2 → 2 NO + O2 As an oxidizer As suggested by the weakness of the N–O bond, NO2 is a good oxidizer. Consequently, it will combust, sometimes explosively, with many compounds, such as hydrocarbons. Hydrolysis It hydrolyses to give nitric acid and nitrous acid: 2 NO2 (N2O4) + H2O → HNO2 + HNO3 This reaction is one step in the Ostwald process for the industrial production of nitric acid from ammonia.[11] This reaction is negligibly slow at low concentrations of NO2 characteristic of the ambient atmosphere, although it does proceed upon NO2 uptake to surfaces. Such surface reaction is thought to produce gaseous HNO2 (often written as HONO) in outdoor and indoor environments.[12] Formation from decomposition of nitric acid Nitric acid decomposes slowly to nitrogen dioxide by the overall reaction: 4 HNO3 → 4 NO2 + 2 H2O + O2 The nitrogen dioxide so formed confers the characteristic yellow color often exhibited by this acid. Conversion to nitrates NO2 is used to generate anhydrous metal nitrates from the oxides:[10] MO + 3 NO2 → M(NO3)2 + NO Conversion to nitrites Alkyl and metal iodides give the corresponding nitrites: 2 CH3I + 2 NO2 → 2 CH3NO2 + I2 TiI4 + 4 NO2 → Ti(NO2)4 + 2 I2 Ecology NO2 is introduced into the environment by natural causes, including entry from the stratosphere, bacterial respiration, volcanos, and lightning. These sources make NO2 a trace gas in the atmosphere of Earth, where it plays a role in absorbing sunlight and regulating the chemistry of the troposphere, especially in determining ozone concentrations.[13] Uses NO2 is used as an intermediate in the manufacturing of nitric acid, as a nitrating agent in manufacturing of chemical explosives, as a polymerization inhibitor for acrylates, as a flour bleaching agent...[14] 223 and as a room temperature sterilization agent.[15] It is also used as an oxidizer in rocket fuel, for example in red fuming nitric acid; it was used in the Titan rockets, to launch Project Gemini, in the maneuvering thrusters of the Space Shuttle, and in unmanned space probes sent to various planets.[16] Human-caused sources and exposure For the general public, the most prominent sources of NO2 are internal combustion engines burning fossil fuels.[8] Outdoors, NO2 can be a result of traffic from motor vehicles.[17] Indoors, exposure arises from cigarette smoke,[18] and butane and kerosene heaters and stoves.[19] Workers in industries where NO2 is used are also exposed and are at risk for occupational lung diseases, and NIOSH has set exposure limits and safety standards.[6] Agricultural workers can be exposed to NO2 arising from grain decomposing in silos; chronic exposure can lead to lung damage in a condition called "Silo-filler's disease".[20][21] Historically, nitrogen dioxide was also produced by atmospheric nuclear tests, and was responsible for the reddish colour of mushroom clouds.[22] Toxicity Main article: Nitrogen dioxide poisoning Gaseous NO2 diffuses into the epithelial lining fluid (ELF) of the respiratory epithelium and dissolves. There, it chemically reacts with antioxidant and lipid molecules in the ELF. The health effects of NO2 are caused by the reaction products or their metabolites, which are reactive nitrogen species and reactive oxygen species that can drive bronchoconstriction, inflammation, reduced immune response, and may have effects on the heart.[23] Pathways indicated by a dotted line are those for which evidence is limited to findings from experimental animal studies, while evidence from controlled human exposure studies is available for pathways indicated by a solid line. Dashed lines indicate proposed links to the outcomes of asthma exacerbation and respiratory tract infections. Key events are subclinical effects, endpoints are effects that are generally measured in the clinic, and outcomes are health effects at the organism level. NO2 = nitrogen dioxide; ELF = epithelial lining fluid.[23]:4–62 Nitrogen dioxide diffusion tube for air quality monitoring. Positioned in the City of London Aceut harm due to NO2 exposure is only likely to arise in occupational settings. Direct exposure to the skin can cause irritations and burns. Only very high concentrations of the gaseous form cause immediate distress: 100–200 ppm can cause mild irritation of the nose and throat, 250–500 ppm can cause edema, leading to bronchitis or pneumonia, and levels above 1000 ppm can cause death due to asphyxiation from fluid in the lungs. There are often no symptoms at the time of exposure other than transient cough, fatigue or nausea, but over hours inflammation in the lungs causes edema.[24][25] For skin or eye exposure, the affected area is flushed with saline. For inhalation, oxygen is administered, bronchodilators may be administered, and if there are signs of methemoglobinemia, a condition that arises when nitrogen-based compounds affect the hemoglobin in red blood cells, methylene blue may be administered.[26][27] It is classified as an extremely hazardous substance in the United States as defined in Section 302 of the U.S. Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11002), and it is subject to strict reporting requirements by facilities which produce, store, or use it in significant quantities.[28] Health effects of NO2 exposure Main article: Nitrogen dioxide poisoning Even small day-to-day variations in NO2 can cause changes in lung function.[29] Chronic exposure to NO2 can cause respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma. NO2 creates ozone which causes eye irritation and exacerbates respiratory conditions, leading to increased visits to emergency departments and hospital admissions for respiratory issues, especially asthma.[30] The effects of toxicity on health have been examined using questionnaires and in-person interviews in an effort to understand the relationship between NO2 and asthma. The influence of indoor air pollutants on health is important because the majority of people in the world spend more than 80% of their time indoors.[31] The amount of time spent indoors depends upon on several factors including geographical region, job activities, and gender among other variables. Additionally, because home insulation is improving, this can result in greater retention of indoor air pollutants, such as NO2.[31] With respect to geographic region, the prevalence of asthma has ranged from 2 to 20% with no clear indication as to what's driving the difference.[31] This may be a result of the "hygiene hypothesis" or "western lifestyle" that captures the notions of homes that are well insulated and with fewer inhabitants.[31] Another study examined the relationship between nitrogen exposure in the home and respiratory symptoms and found a statistically significant odds ratio of 2.23 (95% CI: 1.06, 4.72) among those with a medical diagnosis of asthma and gas stove exposure.[32] A major source of indoor exposure to NO2 is the use of gas stoves for cooking or heating in homes. According to the 2000 census, over half of US households use gas stoves[33] and indoor exposure levels of NO2 are, on average, at least three times higher in homes with gas stoves compared to electric stoves with the highest levels being in multifamily homes. Exposure to NO2 is especially harmful for children with asthma. Research has shown that children with asthma who live in homes with gas stoves have greater risk of respiratory symptoms such as wheezing, cough and chest tightness.[32][34] Additionally, gas stove use was associated with reduced lung function in girls with asthma, although this association was not found in boys.[35] Using ventilation when operating gas stoves may reduce the risk of respiratory symptoms in children with asthma. In a cohort study with inner-city minority African American Baltimore children to determine if there was a relationship between NO2 and asthma for children aged 2 to 6 years old, with an existing medical diagnosis of asthma, and one asthma related visit, families of lower socioeconomic status were more likely to have gas stoves in their homes. The study concluded that higher levels of NO2 within a home were linked to a greater level of respiratory symptoms among the study population. This further exemplifies that NO2 toxicity is dangerous for children.[36] Environmental effects Interaction of NO2 and other NOx with water, oxygen and other chemicals in the atmosphere can form acid rain which harms sensitive ecosystems such as lakes and forests.[37] Elevated levels of NO2 can also harm vegetation, decreasing growth, and reduce crop yields.[38] Avoiding NO2 toxicity While using a gas stove, it is advised to also use ventilation. Studies show that in homes with gas stoves, if ventilation is used while using gas stoves, then children have lower odds of asthma, wheezing and bronchitis as compared to children in homes that never used ventilation.[39] If venting isn't possible, then replacing gas stoves with electric stove could be another option. Replacing gas stoves with electric ranges could greatly reduce the exposure to indoor NO2 and improve the respiratory function of children with asthma. It is important to keep gas stoves and heaters in good repair so they are not polluting extra NO2. 2015 International Residential Code that requires that vent hoods are used for all stoves and set standards for residential buildings. This requires that all range hoods have a vent that discharges outside. You can also prevent NO2 exposure by avoiding cigarette smoking and not idling your car whenever possible.[40] Environmental limits The U.S. EPA has set safety levels for environmental exposure to NO2 at 100 ppb, averaged over one hour, and 53 ppb, averaged annually.[8] As of February 2016, no area of the US was out of compliance with these limits and concentrations ranged between 10 and 20 ppb, and annual average ambient NO2 concentrations, as measured at area-wide monitors, have decreased by more than 40% since 1980.[34] However, NO2 concentrations in vehicles and near roadways are appreciably higher than those measured at monitors in the current network. In fact, in-vehicle concentrations can be 2–3 times higher than measured at nearby area-wide monitors. Near-roadway (within about 50 metres (160 ft)) concentrations of NO2 have been measured to be approximately 30 to 100% higher than concentrations away from roadways. Individuals who spend time on or near major roadways can experience short-term NO2 exposures considerably higher than measured by the current network. Approximately 16% of U.S. housing units are located within 300 feet (91 m) of a major highway, railroad, or airport (approximately 48 million people). Studies show a connection between breathing elevated short-term NO2 concentrations, and increased visits to emergency departments and hospital admissions for respiratory issues, especially asthma. NO2 exposure concentrations near roadways are of particular concern for susceptible individuals, including asthmatics, children, and the elderly.[30] For limits in other countries see the table in the Ambient air quality criteria article. See also Dinitrogen tetroxide Nitric oxide (NO) – pollutant that is short lived because it converts to NO2 in the presence of ozone Nitrite Nitrous oxide (N2O) – "laughing gas", a linear molecule, isoelectronic with CO2 but with a nonsymmetric arrangement of atoms (NNO) Nitrlyl References ^ "nitrogen dioxide (CHEBI:33101)". Chemical Entities of Biological Interest (ChEBI). UK: European Bioinformatics Institute. 13 January 2008. Main. Archived from the original on 4 March 2016. Retrieved 4 October 2011. ^ a b c d e Haynes, 4.79. ^ Mendiara, S. N.; Sagedahl, A.; Perissinotti, L. J. (2001). "An electron paramagnetic resonance study of nitrogen dioxide dissolved in water, carbon tetrachloride and some organic compounds". Applied Magnetic Resonance. 20 (1–2): 275–287. doi:10.1007/BF03162326. S2CID 97875925. ^ Haynes, 4.134. ^ Haynes, 5.16. ^ a b c d e NIOSH Pocket Guide to Chemical Hazards. "Nitrogen dioxide". 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