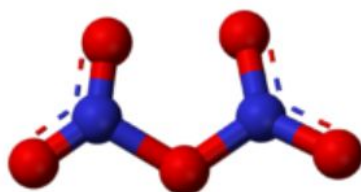
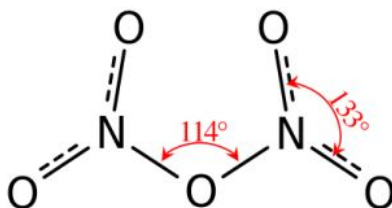


Dinitrogen pentoxide

Dinitrogen pentoxide is the chemical compound with the formula N_2O_5 . Also known as nitrogen pentoxide, N_2O_5 is one of the binary nitrogen oxides, a family of compounds that only contain nitrogen and oxygen. It is an unstable and potentially dangerous oxidizer that once was used as

a reagent when dissolved in chloroform for nitrations but has largely been superseded by NO_2BF_4 (nitronium tetrafluoroborate).

Dinitrogen pentoxide



Names

IUPAC name

Dinitrogen pentaoxide

Other names

Nitric anhydride

Nitronium nitrate

Nitryl nitrate

DNPO

Anhydrous nitric acid

SMILES

Properties

Chemical formula

N_2O_5

Molar mass

108.01 g/mol

Appearance

white solid

Density

1.642 g/cm³ (18 °C)

Melting point

41 °C (106 °F; 314 K)
[1]

Boiling point

47 °C (117 °F; 320 K)
sublimes

Solubility in water

reacts to give [HNO₃](#)

Solubility

soluble in [chloroform](#)
negligible in [CCl₄](#)

<u>Magnetic susceptibility</u> . (χ)	$-35.6 \cdot 10^{-6} \text{ cm}^3/\text{mol}$ (aq)
<u>Dipole moment</u>	1.39 D
Structure	
<u>Crystal structure</u>	hexagonal
<u>Molecular shape</u>	planar, C_{2v} (approx. D_{2h}) $\text{N-O-N} \approx 180^\circ$
Thermochemistry	
<u>Std molar entropy</u> . (S^\ominus_{298})	178.2 $\text{J K}^{-1} \text{ mol}^{-1}$ (s) 355.6 $\text{J K}^{-1} \text{ mol}^{-1}$ (g)
<u>Std enthalpy of formation</u> ($\Delta_f H^\ominus_{298}$)	-43.1 kJ/mol (s) +11.3 kJ/mol (g)
<u>Gibbs free energy</u> .	114.1 kJ/mol

Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa).

x verify. (what is ^{✓x} ?)

Infobox references

N₂O₅ is a rare example of a compound that adopts two structures depending on the conditions: most commonly it is a salt, but under some conditions it is a polar molecule:



Syntheses and properties

N_2O_5 was first reported by Deville in 1840, who prepared it by treating AgNO_3 with Cl_2 .^{[2][3]} A recommended laboratory synthesis entails dehydrating nitric acid (HNO_3) with phosphorus(V) oxide:^[4]

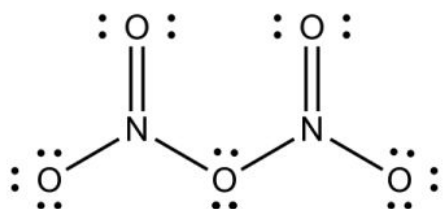


In the reverse process, N_2O_5 reacts with water (hydrolyses) to produce nitric acid. Thus, dinitrogen pentoxide is the anhydride of nitric acid:



N_2O_5 exists as colourless crystals that sublime slightly above room temperature. The salt eventually decomposes at room temperature into NO_2 and O_2 .^[5]

Structure



Lewis structure of gas-phase N_2O_5

Solid N_2O_5 is a salt, consisting of separated anions and cations. The cation

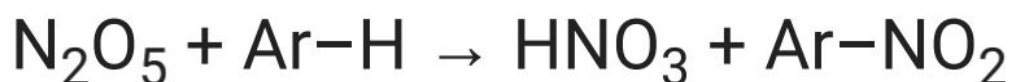
is the linear nitronium ion NO_2^+ and the anion is the planar nitrate ion NO_3^- . Thus, the solid could be called *nitronium nitrate*. Both nitrogen centers have oxidation state +5.

The intact molecule $\text{O}_2\text{N}-\text{O}-\text{NO}_2$ exists in the gas phase (obtained by subliming N_2O_5) and when the solid is extracted into nonpolar solvents such as CCl_4 . In the gas phase, the $\text{O}-\text{N}-\text{O}$ angle is 133° and the $\text{N}-\text{O}-\text{N}$ angle is 114° . When gaseous N_2O_5 is cooled rapidly ("quenched"), one can obtain the metastable molecular form,

which exothermically converts to the ionic form above $-70\text{ }^{\circ}\text{C}$.^[4]

Reactions and applications

Dinitrogen pentoxide, for example as a solution in chloroform, has been used as a reagent to introduce the NO_2 functionality. This nitration reaction is represented as follows:



where Ar represents an arene moiety.

For this use, dinitrogen pentoxide has been largely replaced by nitronium tetrafluoroborate $[\text{NO}_2]^+[\text{BF}_4]^-$. This salt retains the high reactivity of NO_2^+ , but it is thermally stable, decomposing at about 180 °C (into NO_2F and BF_3). The reactivity of the NO_2^+ can be further enhanced with strong acids that generate the "super-electrophile" HNO_2^{2+} .

Dinitrogen pentoxide is relevant to the preparation of explosives.^{[3][6]}

In the atmosphere, dinitrogen pentoxide is an important reservoir of the NO_x species

that are responsible for ozone depletion: its formation provides a null cycle with which NO and NO₂ are temporarily held in an unreactive state.^[7] Mixing ratios of several ppbv have been observed in polluted regions of the night-time troposphere.^[8] Dinitrogen pentoxide has also been observed in the stratosphere^[9] at similar levels, the reservoir formation having been postulated in considering the puzzling observations of a sudden drop in stratospheric NO₂ levels above 50 °N, the so-called 'Noxon cliff'.

Variations in N_2O_5 reactivity in aerosols can result in significant losses in tropospheric ozone, hydroxyl radicals, and NO_x concentrations.^[10] Two important reactions of N_2O_5 in atmospheric aerosols are: 1) Hydrolysis to form nitric acid^[11] and 2) Reaction with halide ions, particularly Cl^- , to form ClNO_2 molecules which may serve as precursors to reactive chlorine atoms in the atmosphere.^{[12][13]}

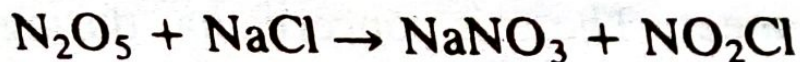
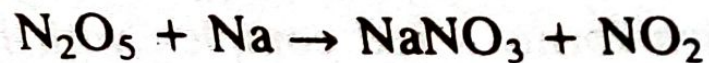
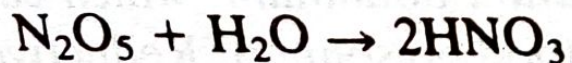
Hazards

N_2O_5 is a strong oxidizer that forms explosive mixtures with organic

OXOACIDS OF NITROGEN

Dinitrogen pentoxide N_2O_5

N_2O_5 is prepared by carefully dehydrating HNO_3 with P_2O_5 at low temperatures. It is a colourless deliquescent solid, which is highly reactive, is a strong oxidizing agent, and is light sensitive. It is the anhydride of HNO_3 .



In the gas phase N_2O_5 decomposes into NO_2 , NO and O_2 . Nitrogen trioxide NO_3 may be formed by treating N_2O_5 with O_3 .

X-ray diffraction shows that solid N_2O_5 is ionic $NO_2^+ NO_3^-$: it should in reality be called nitronium nitrate. It is covalent in solution and in the gas phase, and probably has the structure:

