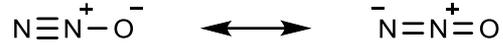


## Background



N<sub>2</sub>O is a colorless gas with a variety of diverse uses:

- Mild anesthetic in surgery and dentistry
- Oxidant in rocket and vehicle engines (NOS)
- Recreational drug
- Aerosol propellant used to dispense whipped cream as a foam



## Safety

- N<sub>2</sub>O is generally non-toxic, but it is still a compressed, liquefied gas
- Major hazards include asphyxia, mental and physical impairment, and vitamin B<sub>12</sub> deficiency in cases of chronic abuse

## Historical Use

- First inhaled drug used for surgical anesthesia in 1844
- Analgesic use first reported by the British chemist Humphry Davy in 1798 while studying “medical airs”
- Popular among British aristocracy as early as 1799



## Pharmacology and Mechanism of Action

- N<sub>2</sub>O has a broad range of pharmacological effects, many of which are not well understood
- Clinically relevant effects include:

### Opioid Receptor Agonist (Analgesic)

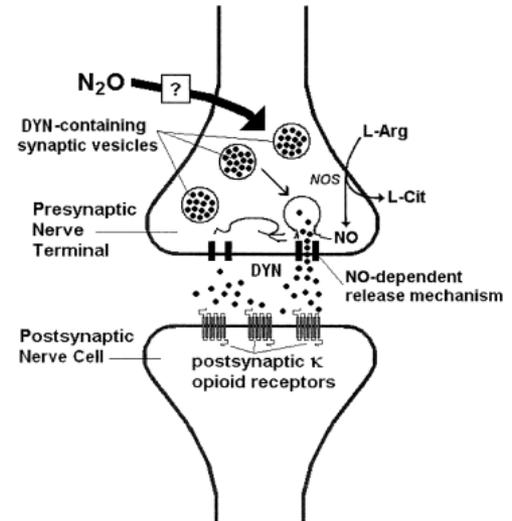
- N<sub>2</sub>O-induced analgesia is antagonized by naloxone
- Cross tolerance observed between N<sub>2</sub>O and morphine
- N<sub>2</sub>O mediates release of endogenous opioid peptides

### GABA/Benzodiazepine Receptor Agonist (Anxiolytic)

- Cross tolerance observed between N<sub>2</sub>O and benzodiazepines
- Molecular mechanism unknown, potentially analogous to opioid agonism

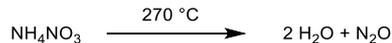
### NMDA Antagonist / Ligand-Gated Ion Channel Binding (Anesthetic)

- Molecular mechanism of general anesthesia is hotly debated
- N<sub>2</sub>O up-regulates NMDA ligand in the cerebral cortex



## Industrial Production and Use

N<sub>2</sub>O is commercially synthesized through controlled pyrolysis of ammonium nitrate



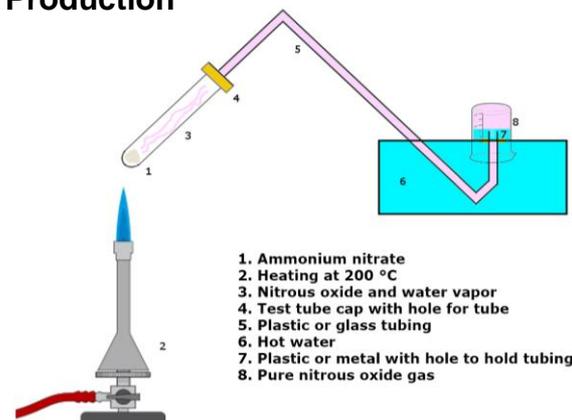
N<sub>2</sub>O is used in the industrial synthesis of azide salts as well



Alternate synthesis at lower temperature:



## Laboratory Production

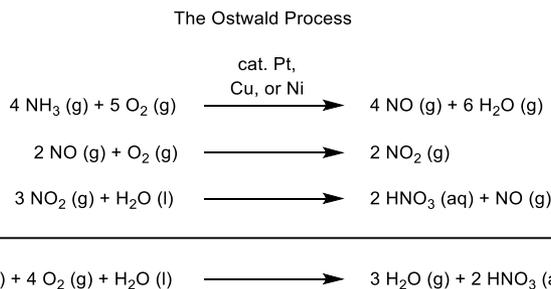


1. Ammonium nitrate
2. Heating at 200 °C
3. Nitrous oxide and water vapor
4. Test tube cap with hole for tube
5. Plastic or glass tubing
6. Hot water
7. Plastic or metal with hole to hold tubing
8. Pure nitrous oxide gas

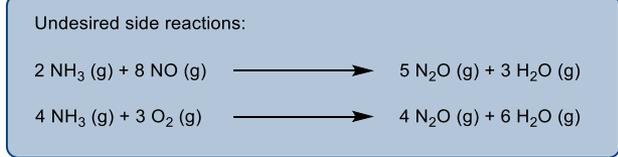
Volkova, A. V. *Russ. J. Gen. Chem.* **2019**, 89, 1338. <https://doi.org/10.1134/S107036321906032X>

## Nitrous Oxide as a Pollutant

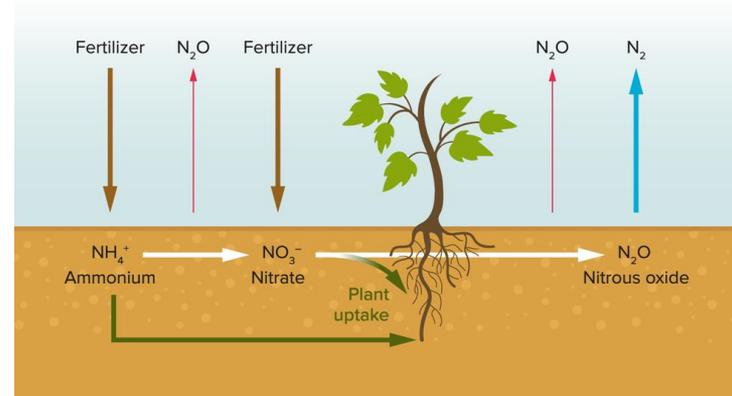
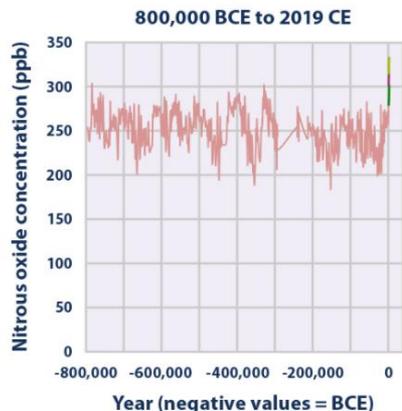
N<sub>2</sub>O in the stratosphere depletes ozone



N<sub>2</sub>O is a waste byproduct of industrial nitric acid production



- N<sub>2</sub>O is roughly 300x more potent as a greenhouse gas than CO<sub>2</sub>
- Since it's less abundant, it's only the third largest contributor to atmospheric warming
- The majority of anthropogenic nitrous oxide emissions are from the use of fertilizers in agriculture



U.S. Environmental Protection Agency (2010), "[Methane and Nitrous Oxide Emissions from Natural Sources](#)". Report EPA 430-R-10-001.