

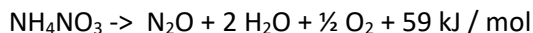


## Nitrous Oxide

July 2022

### Nitrous Oxide

Nitrous oxide is manufactured by thermally decomposing ammonium nitrate. The decomposition starts after the ammonium nitrate has fully dehydrated.



This decomposition reaction must be controlled once it starts otherwise it will quickly over pressurize the reactor. Air Products second worst accident in the Maryland facility was due to this. As a result, there is only one N<sub>2</sub>O manufacturing system supplier worldwide. Their system has numerous controls in place to mitigate this hazard. All gas suppliers purchase their systems.

Nitrous oxide, laughing gas is considered by many to be a fairly benign gas that is widely used in surgical procedures. It however is a thermodynamically unstable gas and like acetylene can decompose exothermically into N<sub>2</sub> and O<sub>2</sub>. The reaction heat will cause other N<sub>2</sub>O molecules to decompose making the reaction self-sustaining until all of it is decomposed. This decomposition reaction cannot be self-sustaining if there is any liquid N<sub>2</sub>O present as the liquid will absorb enough of the decomposition energy to quench the reaction.

In a cylinder that is filled only with gas it becomes dangerous when the diameter is greater than 6". This will allow the reaction wave front to compress and heat the remaining N<sub>2</sub>O until bulk detonation (pressure piling) occurs. The following incidents were examples of this

1. Linde AGA N<sub>2</sub>O Explosion and Fire, July 2, 2001, Holland



Fig. 1: Linde N<sub>2</sub>O Tanker Explosion

2. Rutan N<sub>2</sub>O explosion, July 27, 2007 (3 fatalities and 3 injuries)



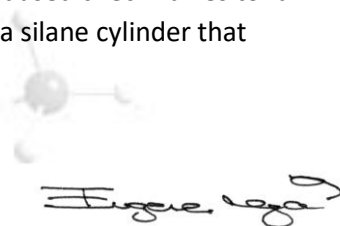
3. N<sub>2</sub>O Explosion, Airgas, FL Aug 28, 2016 (1 fatality)

### N<sub>2</sub>O Explosion, Airgas, FL Aug 28, 2016



4. N<sub>2</sub>O Explosion, Taiwan Specialty Chemicals, Changbin Semiconductor Company July 21, 2020

Nitrous oxide reaction of soft valve seats due to adiabatic compression heat. Caused check valves to fail at Solkatronic and Osaka University. In the latter case it allowed N<sub>2</sub>O to backfill a silane cylinder that ultimately exploded killing 2 graduate students.



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