Published on *American Council on Science and Health* (https://www.acsh.org)

Why Stuff Explodes

By Josh Bloom — July 11, 2016

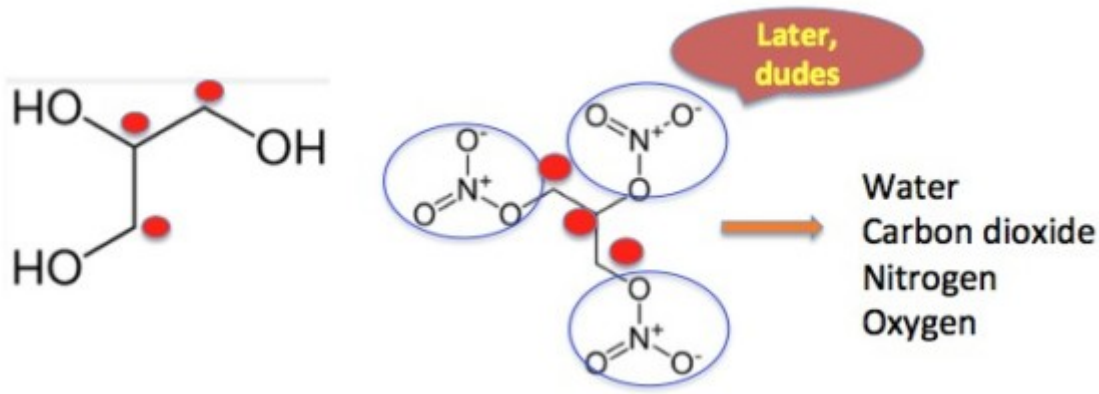
Nitrogen triiodide. Photo: Mentalfloss.com

The words "chemistry" and "easy" rarely go together. But, this rule is (more or less) broken when it comes to understanding the chemistry of explosives. Almost all of them have two things in common: lots of gas, and very little carbon.

By "gas," I mean molecules of any number of (usually common) gases that are built into (chemically part of) a molecule. The more nitrogen, oxygen, etc. atoms that are packed into a molecule, the more likely it will be to explode. The explosion energy comes from rapid release of the chemically-bound gas, which is built into the molecule. These gases are generally not content when they are "trapped" in other molecules, and when given the chance (heat, electricity, even touch) to escape, they do so gleefully.

So, it is a pretty safe bet that molecules that contain large quantities of gases are high energy. Sometimes very high.

A simple example is nitroglycerine, which is the explosive component of dynamite, as well as a drug for a heart condition called angina. A look at its chemical structure, especially when compared to its non-explosive precursor, glycerine, makes this rather clear.



Glycerine

- **Carbon-3**

Carbon-3
Oxygen-3
Nitrogen-0
% Carbon*- 39
No Boom

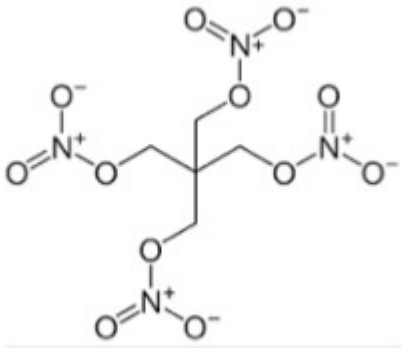
Nitroglycerine

- **Carbon-3**

Carbon-3
Oxygen-9
Nitrogen-3
% Carbon*- 16
Boom

*** Percentage of molecular weight**

Glycerine is a non-toxic sweetener that barely burns. Nitroglycerine is quite different. Its ratio of carbon, nitrogen, and oxygen is very high, and the molecule releases four different gases when ignited.



Pentaerythritol tetranitrate a/k/a PETN
"Plastic explosive"

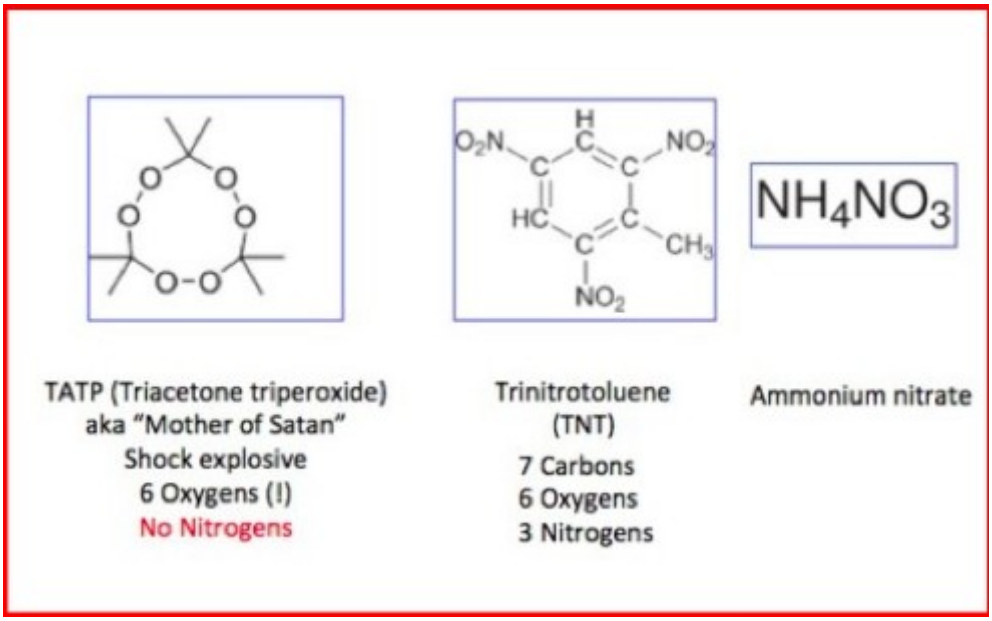
Let's take it a step further:

Carbon-5
Oxygen-12
Nitrogen-4
% Carbon*- 19
Boom

If you can stuff an extra nitro group (NO_2) onto the molecule, you get a rather famous chemical called PETN, aka plastic explosive. Although it doesn't blow up as easily as nitroglycerine, when it does, you don't want to be around. PETN is the reason that 12 trillion people in the US have had

to take off their shoes at airports since 2001.

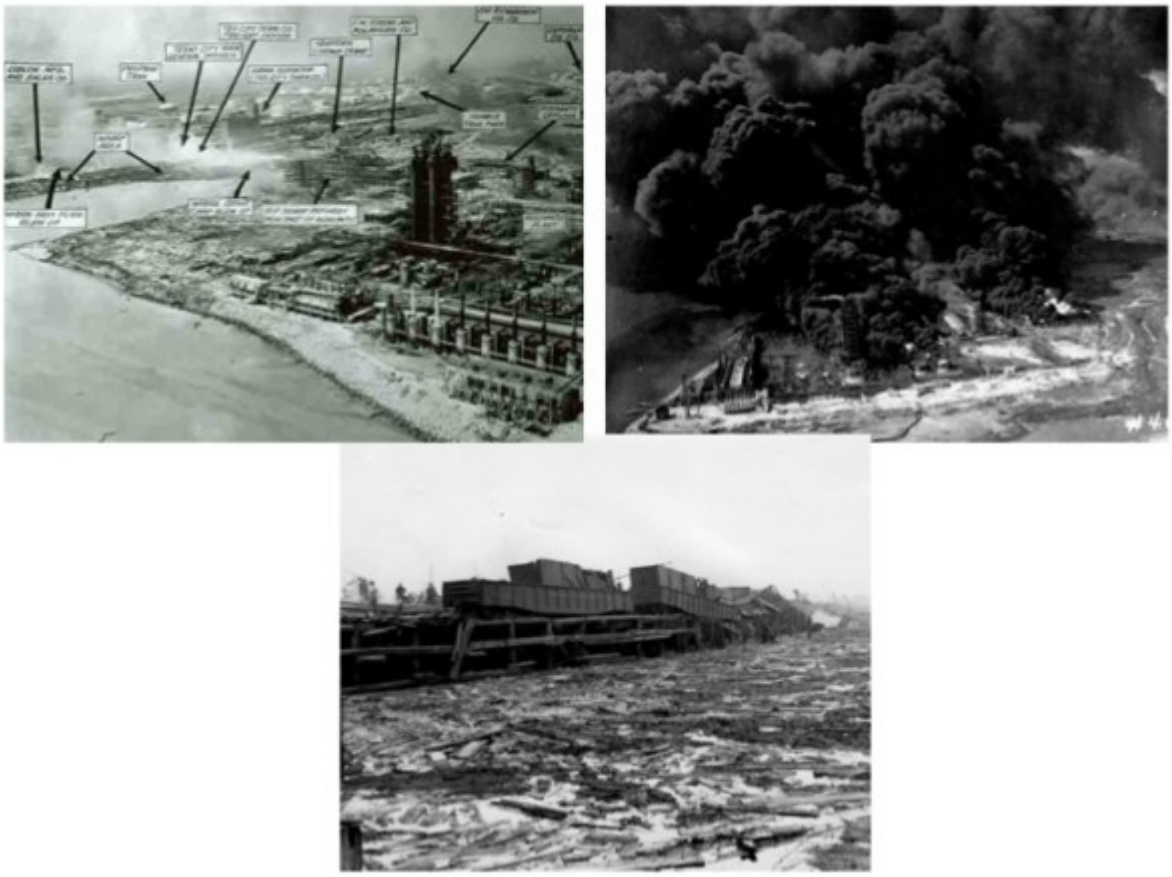
Since you've probably figured out by now that molecules that contain a low percentage of carbon and a high percentage of nitrogen and oxygen, take a look at these beauties:



Triacetone triperoxide (1) (TATP) is something that I would not only refuse to work with, but wouldn't even want to be in the same time zone with someone who was. Any chemist who looks at the structure will think "damn- that is just DYING to blow up!" And, they would be right. It is so anxious to get rid of all that oxygen that if you look at it funny, it goes off. Thus, its pseudonym, "Mother of Satan" is well earned. TATP has been used in a number of terrorist attacks, including the March 2106 bombings in Belgium.

As if it isn't bad enough, note that it contains no nitrogen. Dogs are trained to sniff out chemicals with nitrogen (many of them smell), but that doesn't fly here. TATP has no odor.

Ammonium nitrate blew up an entire city [1] in 1947. It is composed entirely of nitrogen, oxygen, and hydrogen. No carbon at all.



The Texas City Explosion of 1947 Photo: Texas City Library

But, if I had my druthers (This expression puzzles me. Have you even seen anyone either having them, or looking for the ones they lost?), I'd pick nitrogen triiodide (NI_3). You get the most bang for your buck. The following video requires no explanation: https://www.youtube.com/watch?v=2KlAf936E90 [2].

If you're in the mood for a couple of yuks at my expense, you can look at this rerun from February:

"Blowing Up Your Lab Mate is a Bad Idea, But It Sure Is Fun." [3]

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Note:

(1) Organic peroxides are notoriously unstable and dangerous. TATP is only one of many.

Source URL: https://www.acsh.org/news/2016/07/11/why-stuff-explodes

Links

[1] http://www.texascity-library.org/disaster/first.php

[2] https://www.youtube.com/watch?v=2KlAf936E90

[3] http://acsh.org/news/2016/02/02/blowing-up-your-lab-mate-a-bad-idea-but-it-sure-is-fun/