CHEMICAL EXPLOSIVES

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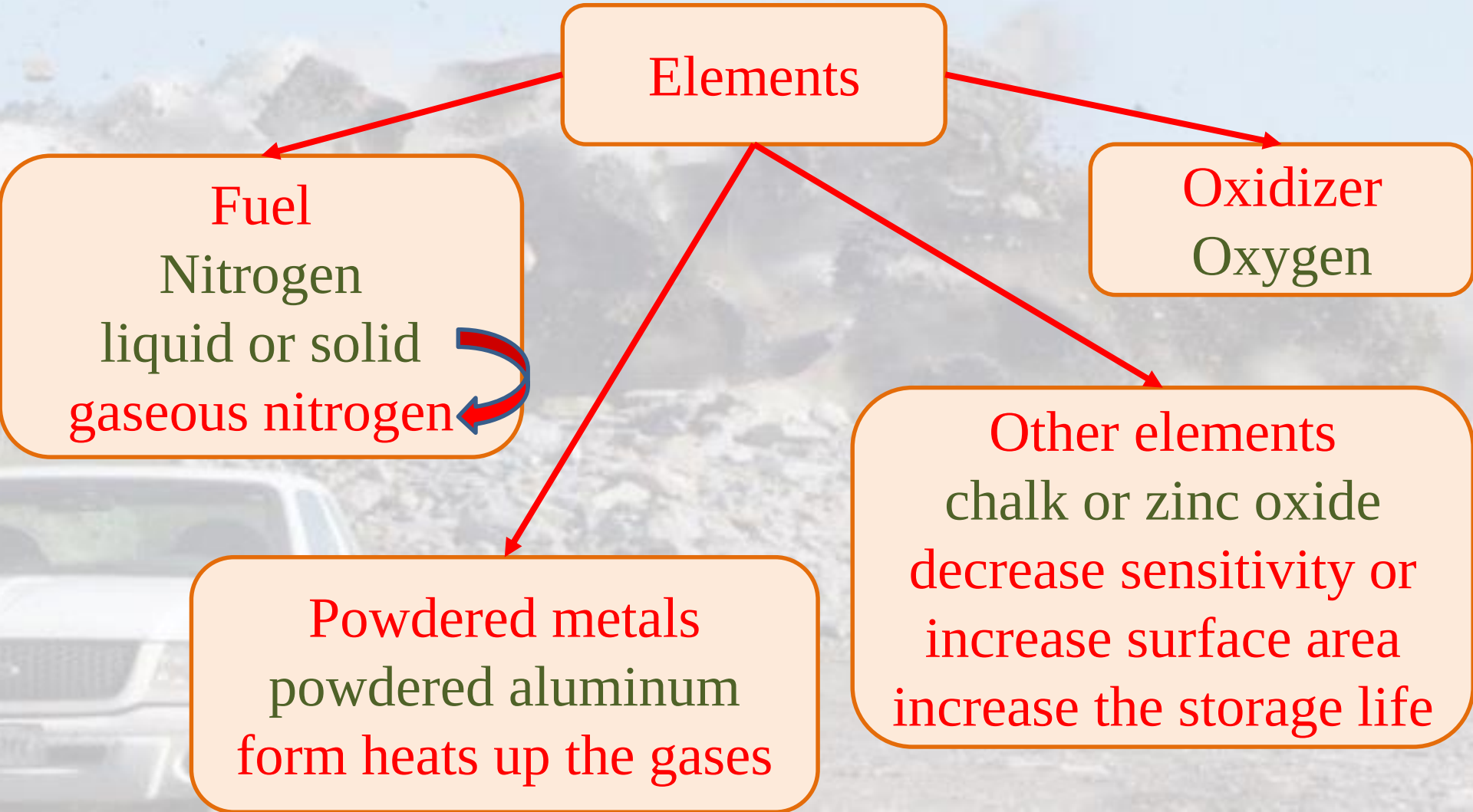
Chemical explosives: are materials that under rapid chemical reactions to release gaseous products and energy. These gases under high pressure exert forces against borehole walls which causes the rock to fracture.



EXPLOSIVE INGREDIENTS

INGREDIENT	CHEMICAFLO RMULA	FUNCTION
Nitroglycerin	$C_3H_5O_9N_3$	Explosive Base
Nitrocellulose	$C_6H_7O_{11}N_3$	Explosive Base
Trinitrotoluene (TNT)	$C_7H_5O_6N_3$	Explosive Base
Ammonium Nitrate	$H_4O_3N_2$	Oxygen Carrier
Sodium Nitrate	$NaNO_3$	Oxygen Carrier
Fuel Oil	CH_2	Fuel
Wood Pulp	$C_6H_{10}O_5$	Fuel
Carbon	C	Fuel
Powdered Aluminum	Al	Sensitizer-Fuel
Chalk	$CaCO_3$	Antacid
Zinc Oxide	ZnO	Antacid
Sodium Chloride	NaCl	Flame Depressant

Common table salt actually makes an explosive less efficient because it functions as a flame depressant and cools the reaction. On the other hand, the addition of table salt allows the explosive to be used in explosive methane atmospheres because the cooler flame and shorter flame duration make it less likely that a gas explosion would occur. This is the reason that permissible explosives are used in coal mines or in tunneling operations in a sedimentary rock where methane is encountered.

The basic elements or ingredients which directly produce work in blasting are those elements that form gases when they react, such as carbon, hydrogen, oxygen, and nitrogen.

When carbon reacts with oxygen, it can either form carbon monoxide or carbon dioxide.

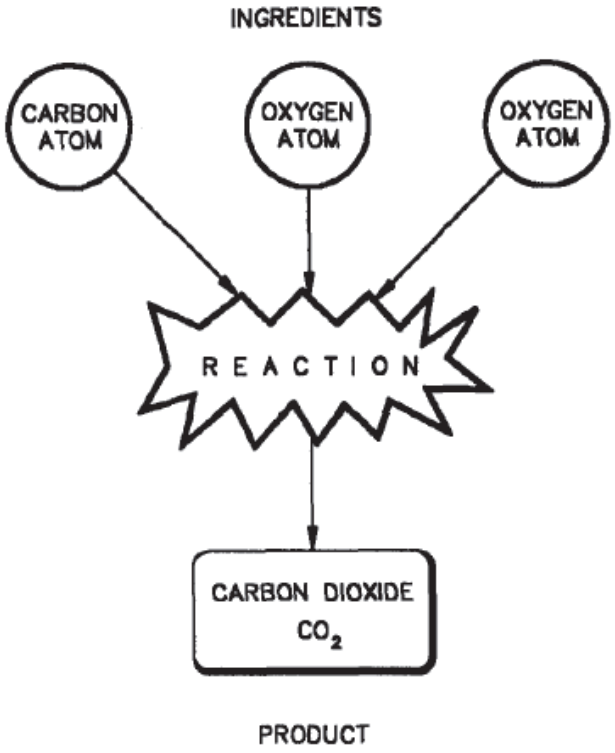
In order to extract the maximum heat from the reaction, we want all elements to be completely oxidized or in other words for carbon dioxide to form rather than carbon monoxide.

COMPOUND	FORMULA	MOL. WEIGHT	Qp or Qr (KcaVMole)
Corundum	$A1_20_3$	102.0	-399.1
Fuel Oil	CH_2	14.0	- 7.0
Nitro methane	CH_3O_2N	61.0	- 21.3
Nitroglycerin	$C_3H_5O_9N_3$	227.1	- 82.7
PETN	$C_5H_8O_{12}N_4$	316.1	-123.0
TNT	$C_7H_5O_6N_3$	227.1	- 13.0
Carbon monoxide	CO_2	28.0	- 26.4
Carbon dioxide	CO	44.0	- 94.1
Water	H_2O	18.0	- 57.8
Ammonium nitrate	$N_2H_4O_3$	80.1	- 87.3
Aluminum	A1	27.0	0.0
Carbon	C	12.0	0.0
Nitrogen	N	14.0	0.0
Nitrogen oxide	NO	30.0	+21.6
Nitrogen dioxide	NO_2	46.0	+21.6

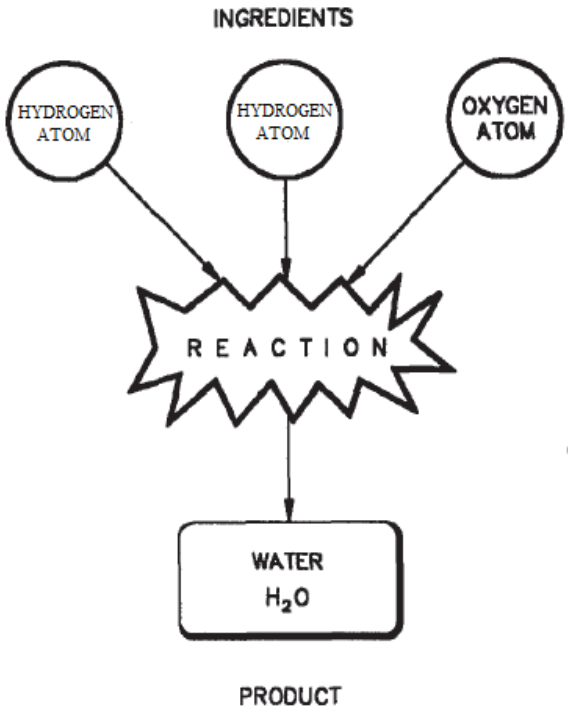
The difference in heat released when one carbon atom forms carbon monoxide versus the case where one carbon atom forms carbon dioxide

$$\Delta H = H_{\text{products}} - H_{\text{reactants}} \qquad \begin{cases} < 0 & \text{exothermic} \\ > 0 & \text{endothermic} \end{cases}$$

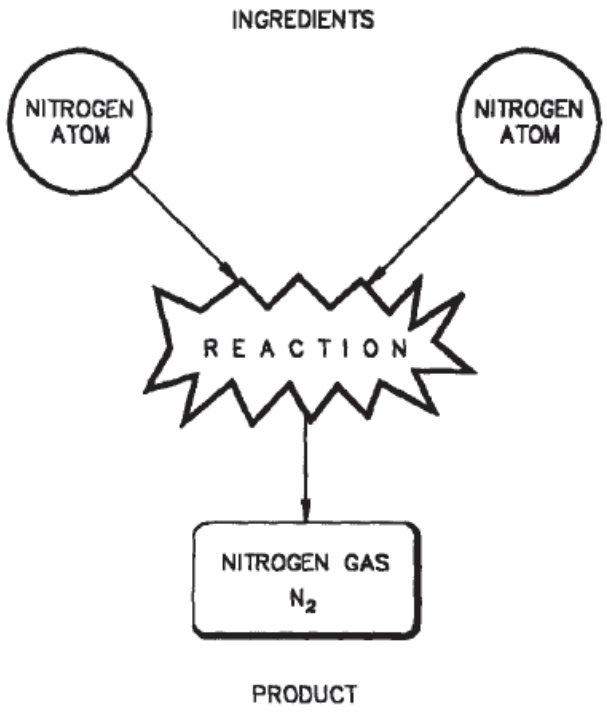
Ideal Reactions



Carbon-Oxygen Ideal Reactions



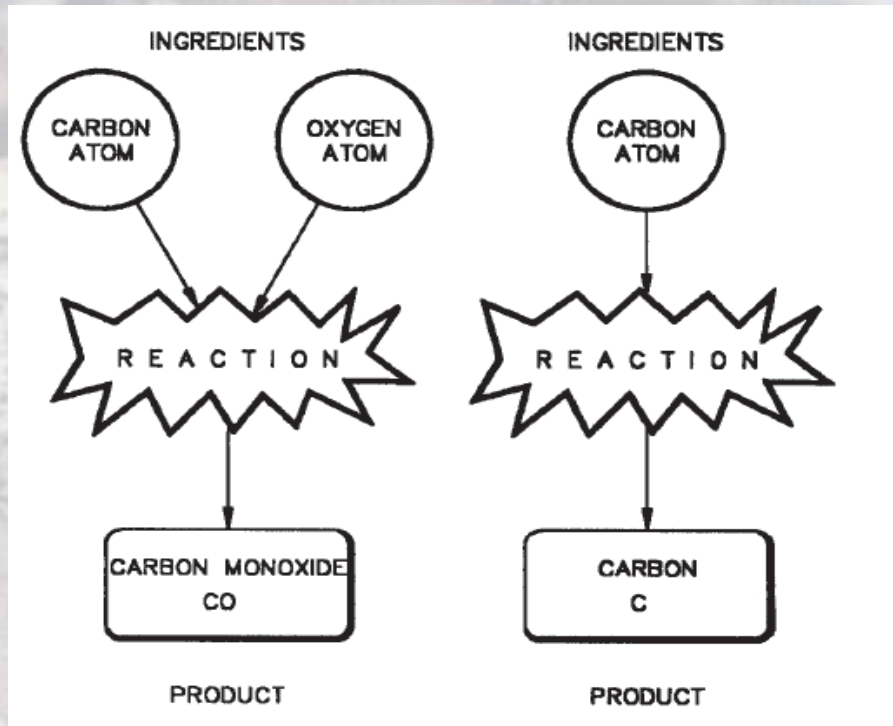
Hydrogen-Oxygen Ideal Reactions



Nitrogen-Nitrogen Ideal Reactions

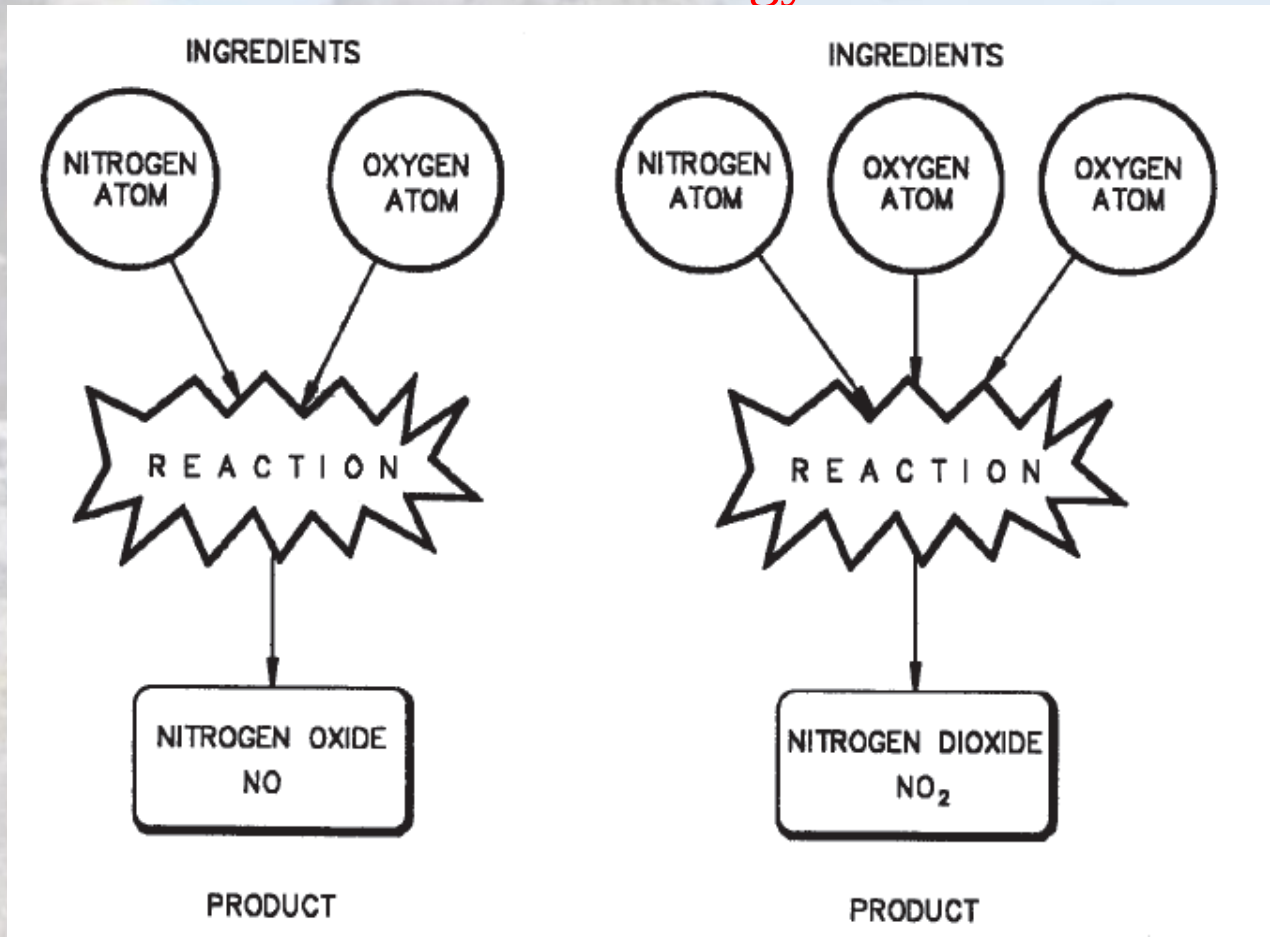
If only the ideal reactions occur from the carbon, hydrogen, oxygen, and nitrogen, there is no oxygen leftover or any additional oxygen needed. The explosive is oxygen balanced and produces the maximum amount of energy.

If two ingredients are mixed together, such as ammonium nitrate and fuel oil, and an excess amount of fuel oil is put into the mixture, the explosive reaction is said to be oxygen negative. This means that there is not enough oxygen to fully combine with the carbon and hydrogen to form the desired end products. Instead, what occurs is that free carbon (soot) and carbon monoxide will be liberated

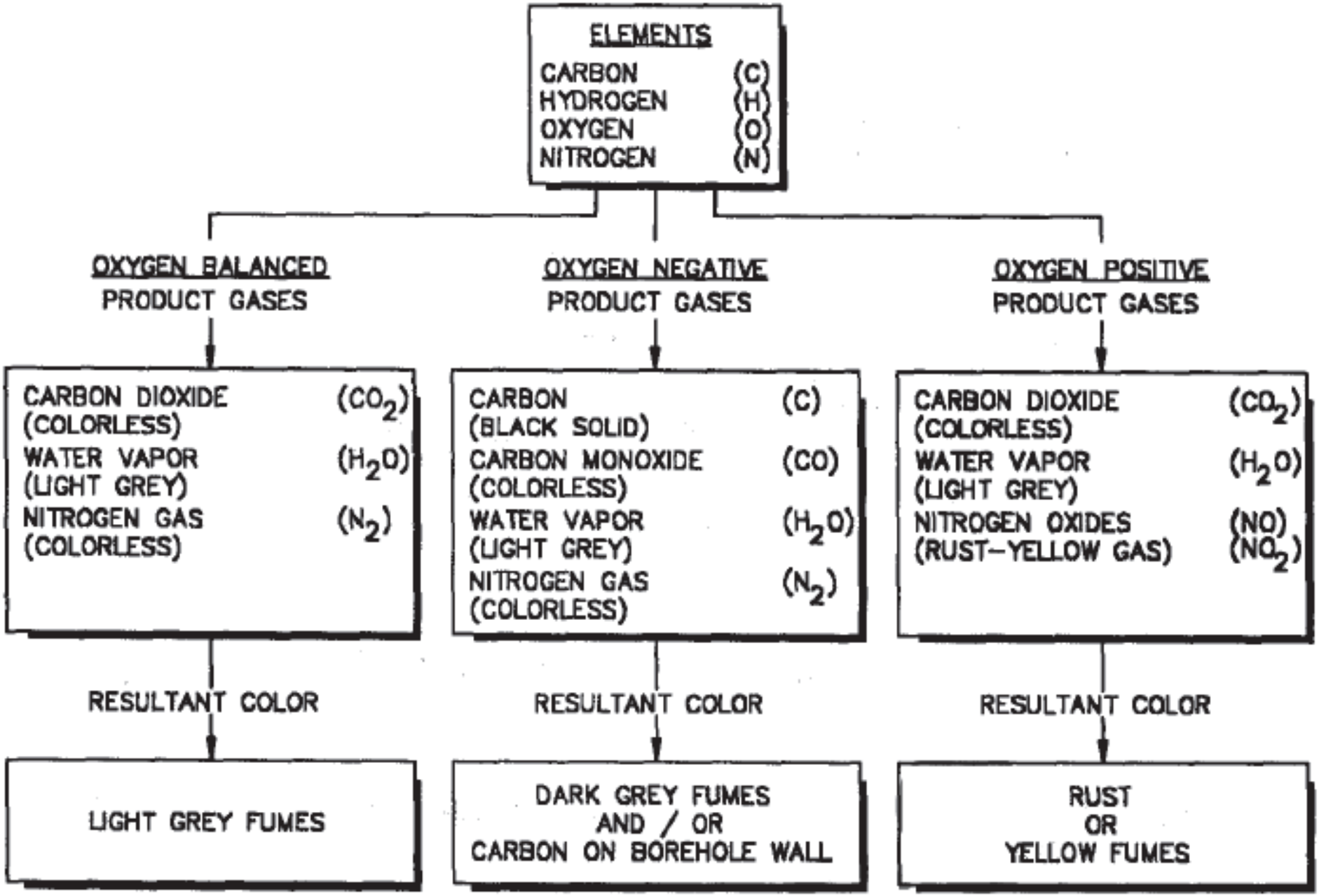


If too little fuel is added to a mixture of ammonium nitrate and fuel oil, then the mixture has excess oxygen which cannot react with carbon or hydrogen. This is called an oxygen positive reaction. What occurs is that the nitrogen which is normally an inert gas will be changed from nitrogen gas to an oxide of nitrogen. If oxides of nitrogen are formed, they will form rust-colored fumes and reduce the energy of the reaction.

The energy is reduced because other ideal gases release heat when they form; nitrogen oxides absorb heat in order for them to form. Water and carbon dioxide have a negative sign which means they give off heat when they form. The nitrogen oxides have a plus sign meaning that they take in heat when they form.



Identification of Problem Mixtures of ANFO and Fuel Oil

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