Bulletin No. 106

Explosives and Propellants

Parr Dynamic Pressure Recording System monitors the pressure associated with fast decomposition.

Often times the word “explosive” is used interchangeably for propellants and true explosives. However, the distinction between these two terms is critical when discussing the pressures formed during a reaction which takes place inside an oxygen bomb.

Chemical explosives can be classified as low or high explosives. Low (or deflagrating) explosives are used primarily for propelling; they are mixtures of readily combustible substances that when ignited undergo rapid combustion[1]. Propellants are often materials such as gun powders, smokeless powders or liquid fuels. Generally, propellants burn in a predicable manner at a controlled rate.

High (or detonating) explosives (e.g., TNT) are used mainly for shattering; they are unstable molecules that can undergo explosive decomposition without any external source of oxygen and in which the chemical reaction produces rapid shock waves. In an explosion, the reaction products fill a much greater volume than that occupied by the original material and exert an enormous amount of pressure[1].

The Parr 1108 Oxygen Bomb is acceptable for use when testing routine propellants. However, true explosives that create a shock wave when combusted, must be tested using the 1104 High Pressure Oxygen Bomb. Since the materials of explosive nature to be tested are largely uncharacterized, it is strongly recommended that the user start with small amounts of material.

It is not customary to test propellants and explosives in a pure oxygen atmosphere unless the data is to be used to derive the heat of formation of the sample. Some of the end products of the reaction will be combustible in the high pressure oxygen environment, such as free carbon and carbon monoxide. With high-pressure oxygen available, these products will burn to carbon dioxide and release additional heat that did not come from the initial reaction of interest. As

[1] Columbian Electronic Encyclopedia

this secondary combustion may give off nearly as much energy as the reaction of interest, purging the bomb with nitrogen prior to combustion and then completing the reaction under a 5 atm of nitrogen or argon environment is recommended.

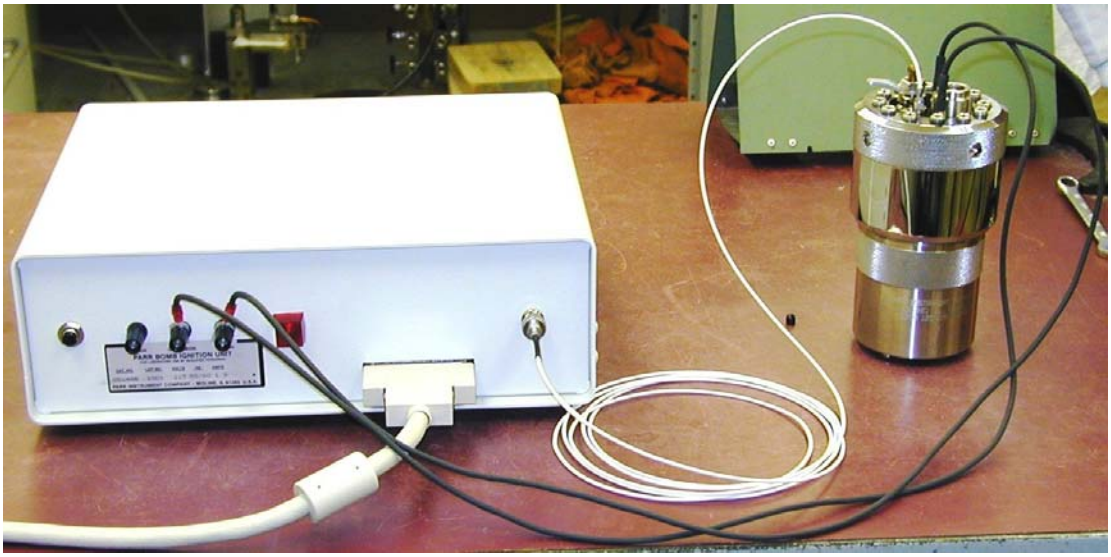
Heat of Detonation for Various Compounds

Material	Heat of Detonation (cal/g)
2,4,6-Trinitrotoluene (TNT)	1093
Pentaerythritol Tetranitrate (PETN)	1490
Cyclotetramethylene Tetranitramine (HMX)	1334
Cyclotrimethylene Trinitramine (RDX)	1452
Ethylenedianine Dinitrate (EDN)	1163
Hydrazine nitrate (HN)	1247
Hexanitrobenzene (HNB)	1653

The following table illustrates the effects of combustion/detonation of TNT under various conditions.

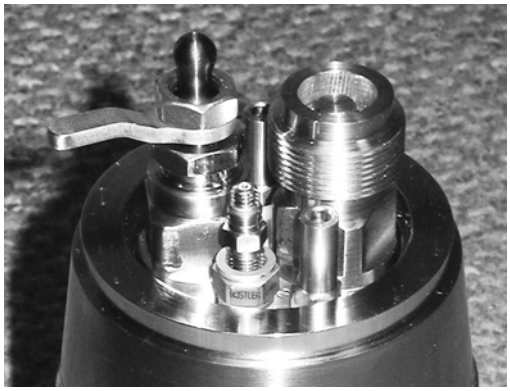
	Vacuum Detonation	CO2 Detonation	Oxygen Detonation	Unconfined Reaction
Heat, cal/g	1093	1116	3575	632
Products, mol/mol TNT – H20	1.60	1.55	2.65	0.17
CO2	1.25	1.19	6.82	0.063
CO	1.98	2.05	0.38	5.89
H2	0.46	0.45	0.050	2.31
C(s)	3.65	3.65	Not detected	1.01

The Parr Dynamic Pressure Recording System monitors the pressure associated with the fast decomposition associated with propellants and explosives. The System is comprised of sub-systems:



Parr Dynamic Pressure Recording System

1. The first subsystem includes a fast-time response, dynamic pressure transducer with the associated signal conditioning electronics. The transducer is capable of recording pressures up to 10000 psi. The useable upper frequency limit for the transducer is 100 kHz. The time constant of the measurement system is on the order of 10 minutes. As a result, short-static or "quasi-static" pressure measurements become feasible.



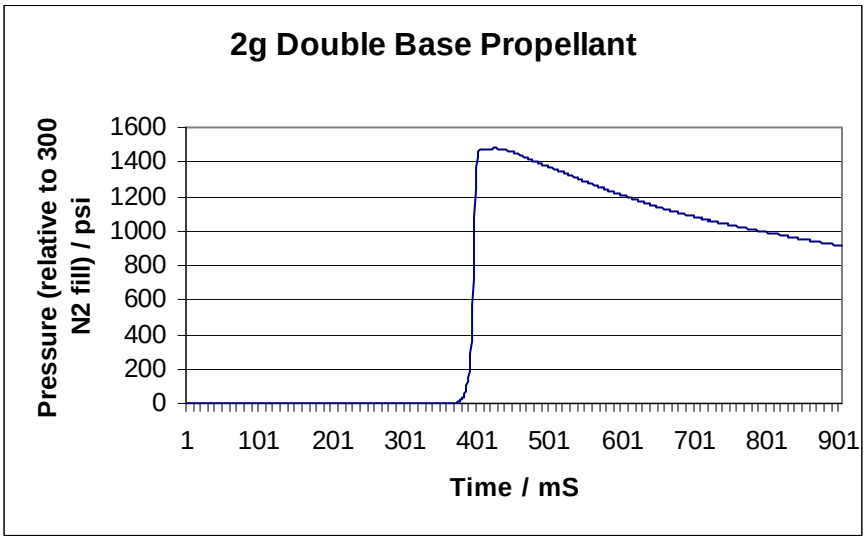
Bomb Head with Pressure Transducer

2. The system also includes a high speed (100 kS/s), PC based data acquisition board that is used to record the output of the transducer system. Data acquisition is triggered by the manual activation of the bomb ignition unit included in the interface box. Post triggered pressure data is saved to a PC disk file.

3. A Windows™ based user interface program is provided with the system. The program is equipped to stream data to disk after the combustion event is initiated. The data can then be easily exported to a spreadsheet for further analysis and plotting.

While the Dynamic Pressure Recording System is generally used with the Parr 1104 High-Strength Oxygen Bomb, it has also been used with the Parr 1108 Oxygen Bomb and the Parr 1109 Semi-micro bomb.

The following graph is derived from the Parr Dynamic Pressure Recording System.



For more information on customizing the Parr Dynamic Pressure Recording System for your application, contact us at parr@parrinst.com.

PARR INSTRUMENT COMPANY

211 Fifty-Third Street
Moline, Illinois 61265 USA
Phone 309/762-7716 Fax 309/762-9453
http://www.parrinst.com Email: parr@parrinst.com