

CONSTANT VOLUME EXPLOSION EXPERIMENT:

Standard operating procedure

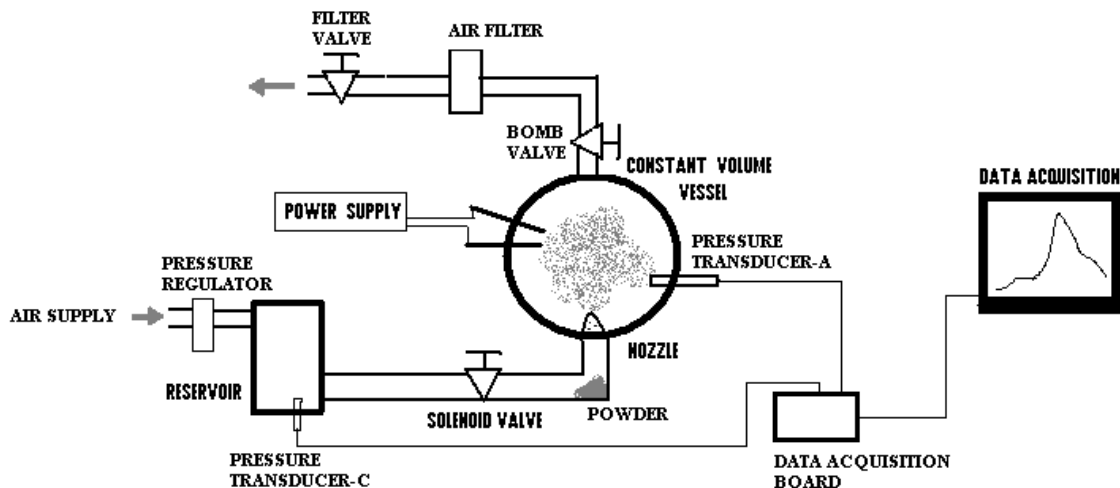
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OBJECTIVE:

- 1) Conduct constant volume explosion test of metallic and other solid fuel powders in the 9.2L vessel and collect sample for analysis.
- 2) Record the pressure traces and study the pattern of flame propagation.

EXPERIMENTAL SETUP:

A schematic presentation for the experimental setup is shown below.



Descriptions for each part of the experimental setup are given below:

Reservoir: Reservoir holds compressed air, supplied from a compressed air cylinder. The volume of the reservoir is seven liters. A pressure transducer connected to the reservoir records the pressure trace at Channel C of the data acquisition board. A D.C Power supply is connected to the transducer.

Constant Volume Vessel: The volume of the vessel is 9.2 liters. It is built of two halves held together by clamps. A pressure transducer fitted with the vessel records the pressure trace at Channel A of the data acquisition board. The two arms in the vessel hold the igniter wire. A DC Power supply is connected to the transducer.

Air Filter: After the experiment the gases released to the atmosphere pass through the air filter. It prevents exposing of burnt particles into the atmosphere.

Ball Valve: Ball valve is between the reservoir and the vessel. The ball valve opens to

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release the air from the reservoir for 0.2 sec before closing again. This action is performed, the moment START BUTTON is pressed.

Data Acquisition Board: It has four channels. A common configuration for the channels: Channel A records the pressure trace in the vessel, Channel B records the trigger pulse, Channel C records the pressure trace from the reservoir, and Channel D records the ignition pulse. Often, channel C is switched to record the pressure from the vessel using a different gain setting compared to channel A. Channel D can be switched to record the pressure signal from an auxiliary, piezoelectric pressure transducer. An example of the gain setting for the channels is shown below

CHANNEL	SIGNAL	SETTING (GAIN)	
		PUMPING	EXPERIMENT
A	DC	0.512	12.8
B	DC	0.512	12.8
C	DC	5.12	5.12
D	DC	2.56	2.56

Pressure Regulator: The pressure regulator attached to the reservoir gives the amount of air supplied to the reservoir. The regulator has the range of 5-100 psi.

Pressure Transducer:

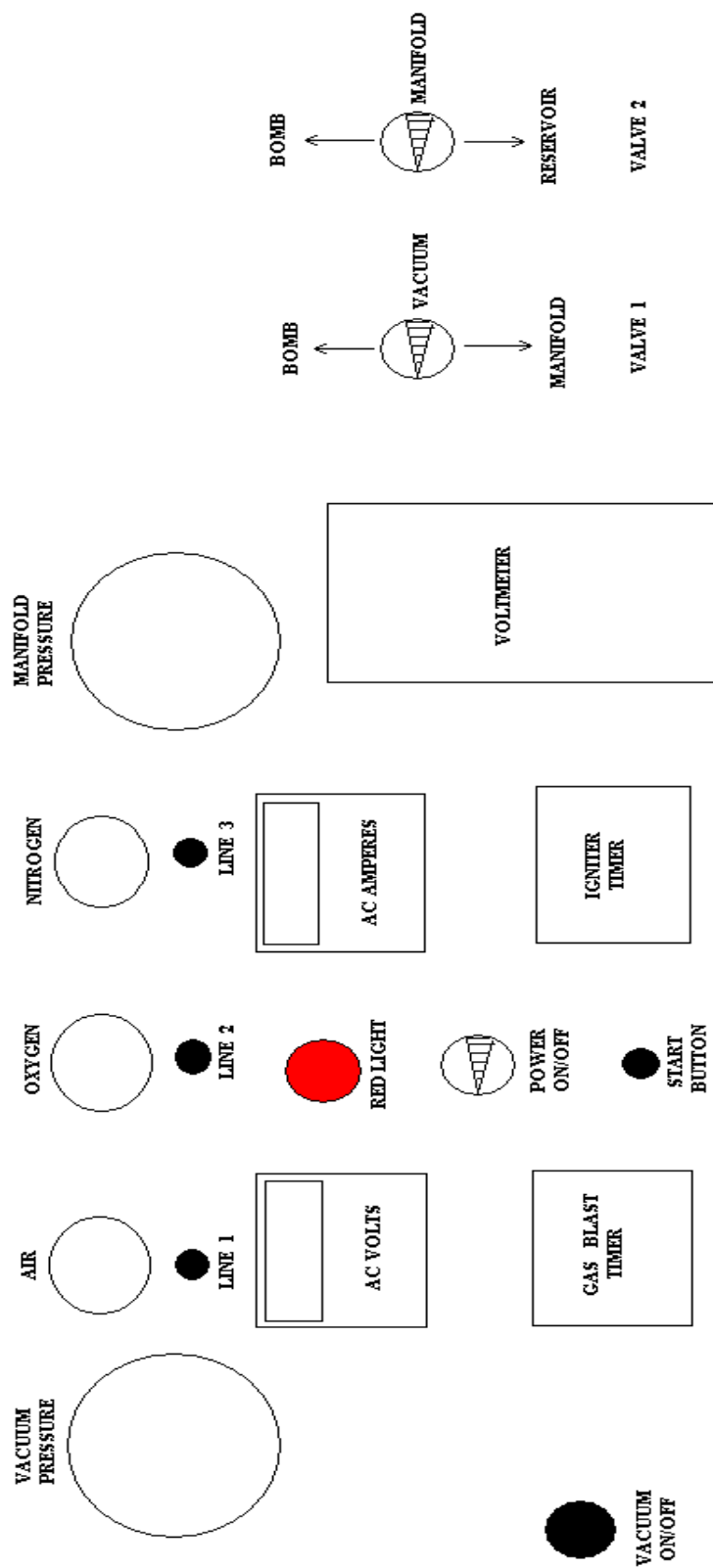
Two different pressure transducers are used: dynamic transducer and piezoelectric transducer. The former can record quasi-static pressure in the vessel, while the latter records rapid changes in pressure.

File Nomenclature: The pressure traces recorded are saved as generic ASCII format (*.ASCII) and also in binary format (*.DAT). The file names follow a simple nomenclature. For Ex: a file named 0220R065 has the first four characters as the month and the date of experiment and R065 is the run number.

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EXPERIMENTAL PROCEDURE / METHODOLOGY:

BEFORE THE EXPERIMENT:

STEP 1:

Clean the vessel. First, the vessel is cleaned with a brush for the remaining powders or reactants from the last experiment. Remove those after brushing and then use a vacuum cleaner to clean up the vessel. Next take the paper towel and wet it with ethanol or acetone and wipe out the interior of the vessel. The nozzle (inside and outside) and the O-ring (used between the vessel halves) should also be cleaned with ethanol. Close the door and lock it. Fill the reservoir with compressed air to about 80 psiG. That should be enough for puffing the vessel about 3-4 times. Puff the vessel without the nozzle and without the upper lid. The number of puffs depends on the amount of powder left in the powder reservoir (usually 4-5 is enough). Wipe the dust in the vessel and clean it with ethanol.

STEP 2:

Prepare the igniter wire. Cut off 5 cm of a tungsten wire and make a coil of it. Fix it between the electrical supply rods. Coat the igniter wire with Liquid Electrical Tape. The coating need not be a heavy coating but it should cover all parts of the igniter wire. Allow it to dry up (10-15 min). Clean the sample bottle and the spoon which is used to take powder. Weigh the required amount of powder, and load it inside the vessel powder reservoir. Attach the nozzle. Put the washer (O-ring) in before the vessel lid is placed over. Fasten the clamps. For fastening the vessel, place the upper half so that the marking on both the halves coincide. There are two markings for the convenience of aligning. Connect the electrical supply wire to the vessel. Change the system settings as explained below for pumping the vessel out.

STEP 3:

Data acquisition and system setup for pumping the vessel.

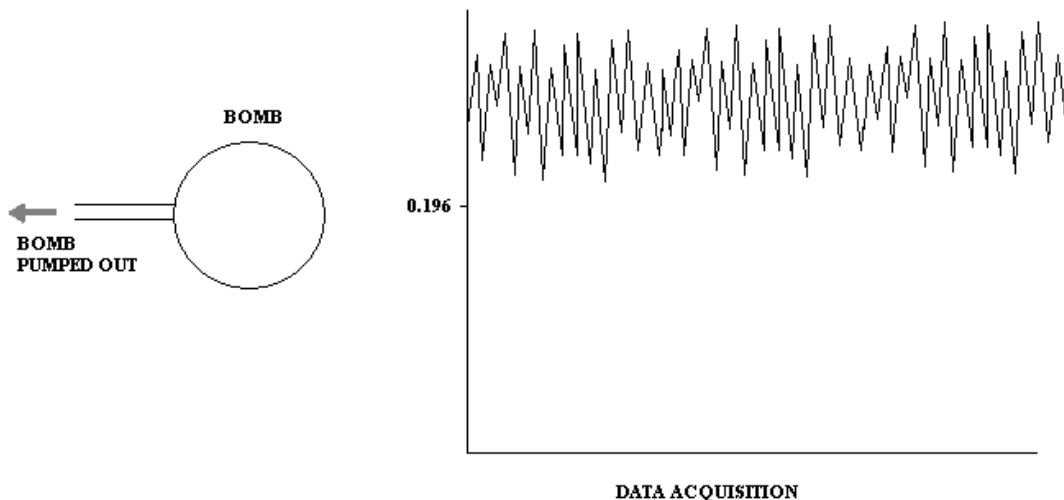
For pumping the vessel:

PC SETTINGS	A	B	C	D
GAIN	0.512	0.512	5.12	2.56
Trigger	automatic and continuous			
Sampling rate	500 kHz			
Amplitude range	0.071			
Amplitude position	0.196			
Display mode	overlayed			
Time position	0.000			
Compression ratio	1:50			

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Monitor the vessel pressure by running the data acquisition continuously.



Start the data acquisition by pressing the spacebar. Turn the vacuum valve (VALVE 1) slowly toward the VESSEL (see panel diagram). Observe the trace approaching from top of the screen. Turn the VALVE 1 back to normal position to stop the trace at 0.196V, which corresponds to 4.87 psiA {calibrated to $y=24.996x - 0.0242$ }. Press the spacebar to stop data acquisition and close the vessel valve.

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RUNNING THE EXPERIMENT:

STEP 4:

Change the settings for running the experiment.

For running the experiment:

PC SETTINGS	A	B	C	D
GAIN	12.8	12.8	5.12	2.56
Trigger	automatic and single shot			
Sampling rate	5 kHz			
Amplitude range	10.000			
Amplitude position	5.000			
Time position	0.000			
Compression ration	1:50			

Fill the reservoir with compressed air supplied through Line 1 (PANEL DIAGRAM). Fill the reservoir with 75-psiG compressed air by first turning the VALVE-2 towards the reservoir and then slowly opening LINE-1. Close LINE-1, when the MANIFOLD PRESSURE GAUGE OR PRESSURE REGULATOR shows 75-psi.

STEP 5:

Check the clamps on the vessel. Pull the safety door down and close it. Set the supply voltage from the transformer according to the length of the igniter wire as tabulated below.

Length of igniter wire(cm)	Time for burning(ms)	Voltage(VAC)
5	60	45.4
10	60	68.8
15	58	85.9

[The voltage required for a particular length of igniter wire was calculated by testing the igniter wire for different percentages of voltage supplied and finding the time it took to burn completely]

Keep turning the supply transformer till the required voltage is shown on the voltmeter. Turn the POWER ON/OFF switch to observe the red light glowing.

STEP 6:

Press the spacebar to start the data acquisition and immediately after that begin the experiment sequence by pressing the START BUTTON.

After observing the pressure traces on screen, save the file for all channels. Save the files

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in both binary and generic ASCII formats. Record the readings in the lab book. Record the final pressure in the vessel by pressing the spacebar again at least after one minute of doing the experiment. Save the trace for the final pressure, also in both binary and generic ASCII format.

AFTER THE EXPERIMENT:

STEP 7:

Open the vessel valve to vent it through the AIR FILTER. Vent the vessel 3 to 4 times. Wait for 2 to 3 minutes before opening the vessel. Before opening remove the electrical supply wire from the vessel. Collect the combustion product sample from the vessel and store it in an air-tight plastic bag. Label the bag with the experiment run number and the powder used.

STEP 8:

Clean the vessel completely without removing the nozzle. Wipe with ethanol. Remove the nozzle. Put the lid back over the vessel and clamp it. Pull down the door and lock it. Press the START BUTTON so that it's puffed once. Wait for some time for the residual powder to settle down (3 to 4 minutes). Vent the vessel to release the high pressured air inside by opening the VESSEL VALVE slowly. Remove the lid. Use a brush to wipe down the powder and then collect it using a paper. Clean the sample bottle before collecting the residual powder in it. Weigh the powder and enter the record in the lab notebook. Collect the residual powder in a air-tight plastic bag and label it with the run number and 'RESIDUAL' written on it.