CHME 302

CHEMICAL ENGINEERING LABORATORY I

EXPERIMENT 7

BOMB CALORIMETER

Objective

Objective of this experiment is to get familiar with one of the most common methods used in measurement of heat of combustion. Concepts of Heat of combustion and first law of thermodynamics for closed systems will be used to analyze this experiment.

Preliminary Work

1. Study applications of first law of thermodynamics to closed systems and working principles of bomb calorimeter. Students should also be familiar with concept of heat of combustion.
2. Visit the lab. in advance to familiarize yourself with the experimental set-up with the consent of the teaching assistant

Experimental Set-up

Bomb calorimeter mainly composed of two parts the bomb and the calorimeter. Bomb is the stainless steel shell in which the sample is placed. Combustion reaction also takes place in this shell under 30 atm Pressure (oxygen). Calorimeter is mainly composed of an insulating outer cover with a stirrer on top and a bucket for placement of bomb and water. Other components of the calorimeter are ignition system and thermocouple used to measure temperature of water heated as a result of combustion. Overview of the system can be found figure 1 whereas bomb calorimeter is described in figure 2.

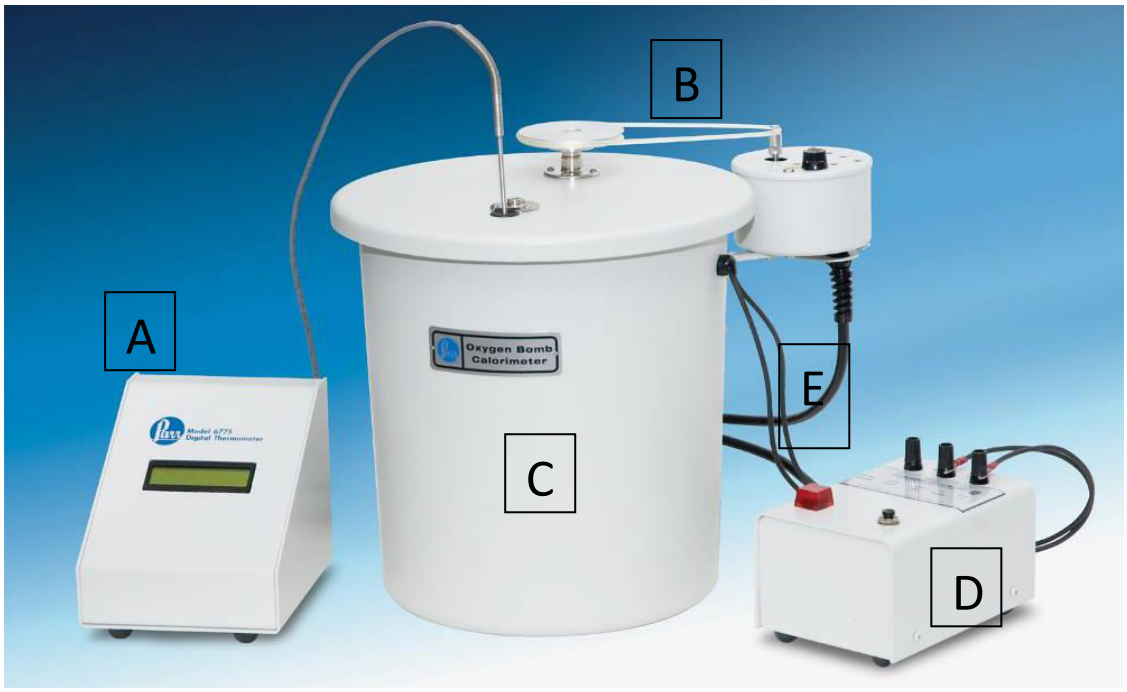

Figure 1. Overview of the Oxygen Bomb Calorimeter. A: Temperature display connected to thermocouple, B: stirrer shaft, C: Calorimeter Cover, D: Ignition Unit, E: cables entering the bomb for ignition.

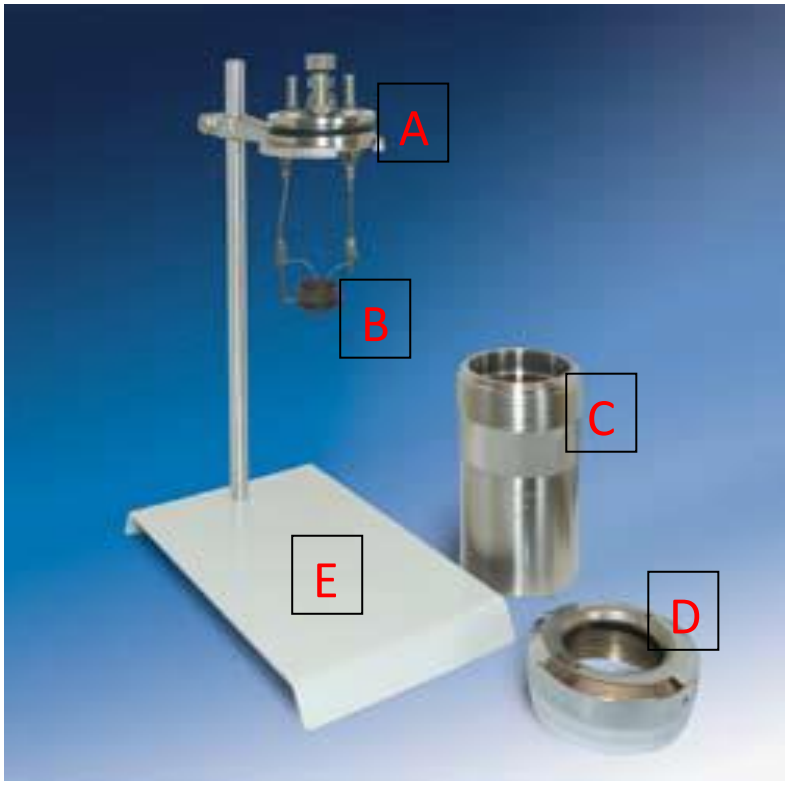

Figure 2. Parts of bomb shell. A: bomb head where ignition wire and sample capsule (B) placed. C: bomb cylinder, D: Cap used to close the bomb, E: bomb head stand used to place bomb head during preparation of sample and placement of ignition wire

Closer view of sample capsule is also given in figure 3. This figure allows a better view of ignition wire and how it should be positioned.

Figure 3. Closer view of sample capsule and ignition wire.

Ends of ignition wire is placed in the holes under the caps shown in Figure 3 then caps pulled down to sustain position of the wire. Wire should be placed in a way that it remains slightly above the sample.

Oxygen is fed in to the bomb by the use of a special regulator. Regulator should be placed on the gas cylinder as shown in figure 4.

Figure 4. Oxygen Gas Regulator

Procedure

Experiment will be conducted in two steps; in the first step heat capacity of the calorimeter will be determined and in the second step using the heat capacity of the calorimeter heat of combustion of the sample given will be tested.

Step 1

i. Place bomb head on the stand
ii. Place ignition wire as shown in figure 3
iii. Place 1 g benzoic acid pellet (whose heat of combustion is known) in to the sample capsule
iv. Place bomb cap in to the bomb cylinder
v. Close the bomb by screwing the cap (D in figure 3). Hand screwing is sufficient but you shouldn't see any threads on the cylinder.
vi. Close the outlet valve and place the tip at the end of the regulator tubing on to the gas inlet valve on the bomb head, open valve of the oxygen cylinder very slowly and keep it open until you see 30 atm on the bigger pressure indicator then close gas inlet. Inlet valve will keep oxygen inside the bomb.
vii. Fill the bucket inside the calorimeter with 1 L of de-ionized water
viii. Place the bomb inside the bucket

ix. Plug the cables for electrodes both on the bomb and the ignition unit. One end of the cables should be placed to normal and 10 cm ports on the ignition unit and other ends should be placed on bomb head.

x. Close the cap of the calorimeter. Be careful with the stirrer.

xi. Place the thermocouple as shown in the figure 1

xii. Stir the stirrer with your hand first in order to observe if there is anything that can affect its functioning then put stirrer band on as shown in figure 1

xiii. Turn on the stirrer

xiv. Wait two minutes to obtain a homogeneous temperature distribution inside the bucket

xv. Press ignition button for 5 sec.

xvi. Record temperature rise for 5 min.

Repeat Step 1 for the sample given for second step of the experiment.

Note : Be careful. Sample placed in the sample cap should remain at its first location. Do not shake the bomb during its placement.

Analysis

i. Using temperature rise and heat of combustion of benzoic acid pellets calculate specific heat capacity of the bucket. You can neglect shaft work, heat losses from the bucket and other sider reactions occurring in the bomb like nitric and sulfuric acid formation and combustion energy of the wire

ii. By using the heat capacity you determined, calculate the heat of combustion for the sample you have been given.

Appendices

Schematic Representation of the Bomb

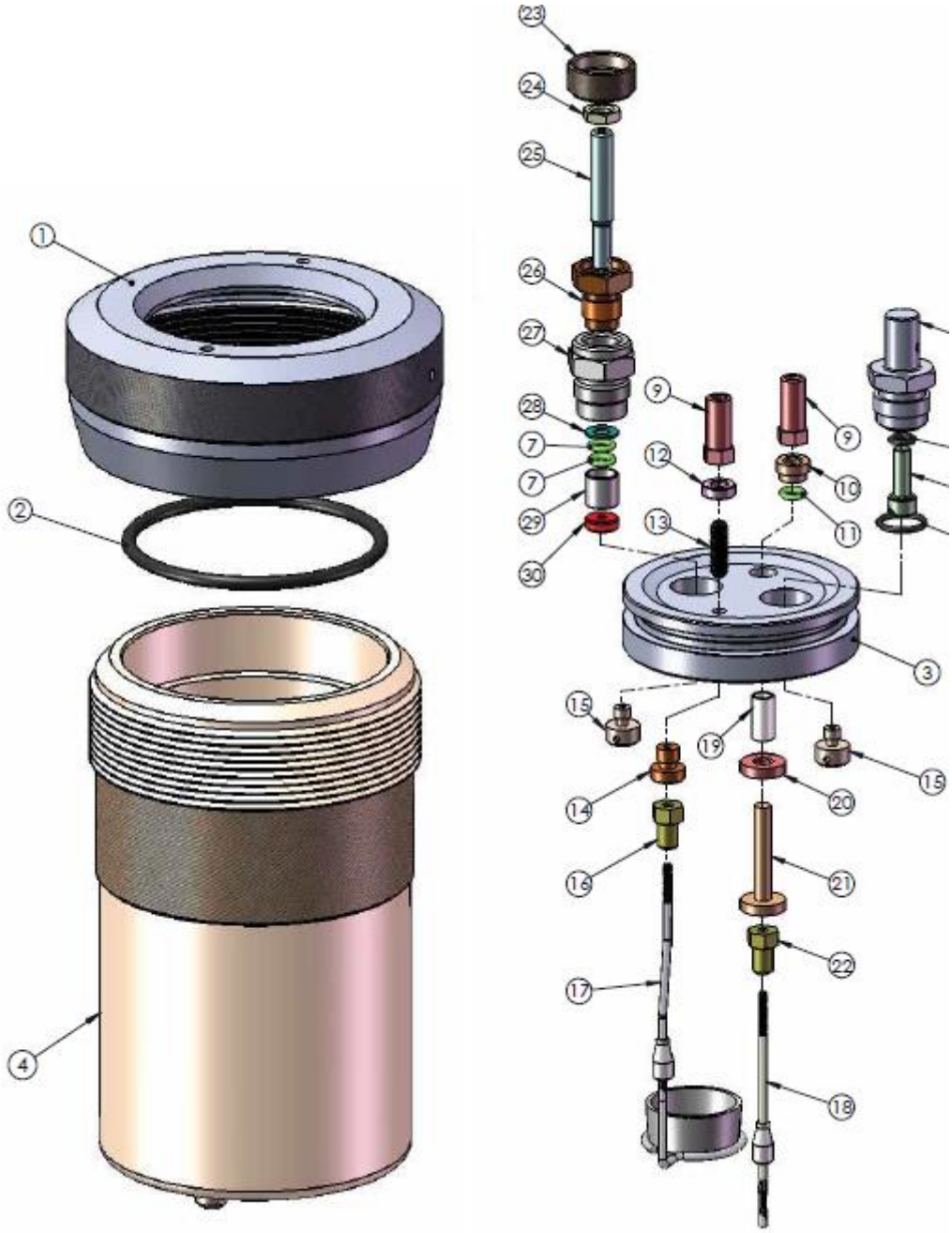

Figure A1. Schematic representation of the bomb and bomb head

1108 Parts Diagram Key

Key	Item	Description
1	103A	Screw Cap
2	230A	O-ring 2-3/8 ID Buna-N
3	394A12 394A12CL	Bomb Head, Bare Bomb Head for Chlorine Service
4	A101A A101ACL	Bomb Cylinder sold only with 103A Screw Cap as Part No. AA101A Bomb Cylinder for Chlorine Service sold only with 103A Screw Cap as Part No. AA101ACL
5	395A2	Inlet Valve Body
6	415A	O-ring 7/16 ID Buna-N
7	238A	O-ring 3/16 ID Buna-N
8	403A	Check Valve
9	411A	Terminal Nut
10	143AC	Insulator Delrin
11	238A	O-ring 3/16 ID Buna-N
12	388A	Spacer
13	SC1932SC10	Socket Head Set Screw
14	278A3	Adapter Bushing
15	404A2	Deflector Nut
16	406A	Lock Nut
17	5A10	Loop Electrode with Sleeve
18	4A10	Straight Electrode with Sleeve
19	401A	Sleeve Insulator
20	96AC	Electrode Insulator
21	402A	Electrode Core
22	406A	Lock Nut
23	407A	Valve Knob
24	398A	Lock Nut
25	400A A420A	Valve Needle Valve Needle with Knob (Nos. 23, 24, 25)
26	397A	Compression Nut
27	396A	Outlet Valve Body
28	7VBCM	Washer Monel
29	378A	Packing Cup
30	20VB	Valve Seat Kel-F
	Item	Complete Assemblies
	AA101A	Bomb Cylinder with 103A Screw Cap
	AA101ACL	Bomb Cylinder for Chlorine Service with 103A Screw Cap
	A416A3	Bomb Head Assembly
	A416A3CL	Bomb Head Assembly for Chlorine Service