Heaven's Light is Our Guide
Rajshahi University of Engineering and Technology

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Lab Report 3: Determination Of Higher Calorific Value Of A Fuel Using Bomb Calorimeter

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Experiment No.: 03

Experiment Name: Determination of Higher Calorific Value of a fuel Using Bomb Calorimeter.

Objectives:

i) To know the calorific value of a given fuel (Diesel).
ii) To know the function of a bomb calorimeter.
iii) To know the application of a bomb calorimeter.

Theory:

The calorific value of a fuel is the amount of heat released by the complete combustion of 1 Kg of fuel, expressed in kJ/Kg. There are two type:

- Higher Calorific Value (HCV)
- Lower Calorific Value (LCV)

Delong's formula provides an approximate HCV, but the most accurate method is through experiment using a calorimeter.

Bomb Calorimeter determines the higher calorific value of solid & liquid fuels by burnin the fuel at a constant volume & high pressure in a closed bomb made of acid-resistant stainless steel.

Composition & working of the calorimeter:

- The bomb contains an oxygen valve for combustion & a release valve for exhaust gases.
- A silica crucible holds the fuel sample, supported by a cradle on a carrier ring.
- An ignition wire (platinum/nichrome) ignites the fuel using an external battery.
- The bomb is emerged in a known quantity of water inside a copper vessel.
- Heat from combustion raise the water temperature, measured preciesly using a Beckmann-thermometer (accuracy 0.01°C).

The heat absorved by the water, bomb, & vessel is used to calculate the higher calorific value of the fuel.

Theoretical HCV of a fuel:

$$= \frac{(m_w + m_e) \times (t_2 - t_1) C_w}{m_f} \quad \text{--- (1)}$$

Where, m_w = Mass of water filled in calorimeter in kg.

m_e = Water equivalent of apparatus in kg

C_w = Calorific Value of water.

m_f = Mass of fuel burned in the bomb in kg

t_1 = Initial temperature of water & apparatus, °C

t_2 = Final temperature of wate & apparatus, °C

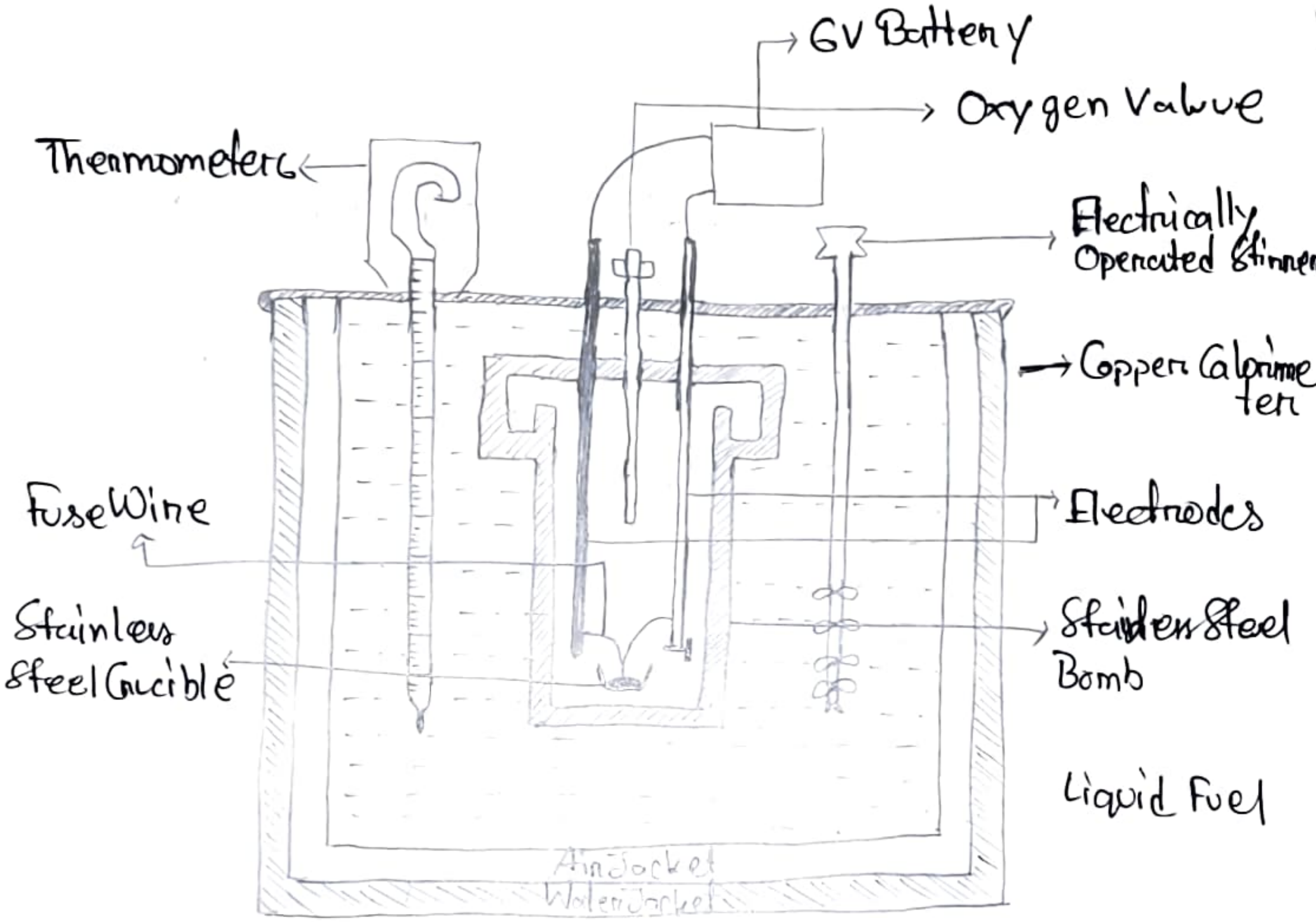

Figure: Bomb Calorimeter

And experimenta HCV is,

$$H.C.V. = \frac{w \times (t_2 - t_1)}{m_f} \quad \text{——— (2)}$$

Required Apparatus:

1] Bomb Calorimeter. Parts:

a) Small Cup, container of the sample
b) Oxygen
c) A stainless steel bomb
d) Water
e) Stirrer
f) Thermometer
g) Ignition circuit, wire

2] Fuel, Diesel

3] Power Source

Working Procedure:

- A small amount of diesel was taken in a small cap, & the ignition wires were immersed into the fuel.
- The cap was placed in a sealed vessel, which was then immersed in a cylindrical drum filled with water.
- The outer cylinder was tightened to prevent heat transfer to the environment.

- Oxygen was filled into the fuel-containg vessel at high presseure through the oxygen valve.
- The initial water temperature was recorded using a thermometer after ~~ensur~~ stirring to make sore the waters temperature is even everywhere.
- After electric ignition and constantly stirring, the final water temperature was recorded.

Data:

Mass of fuel, $m_f = 1\ gm = 1\times10^{-3}\ kg$

Mass of water, $m_w = 2\ kg$

Water equivalent, $m_e = 0.39\ kg$

Initial temperature, $t_1 = 22.8°C$

Final temperature, $t_2 = 27.2°C$

Length of fuse wire $= 10\ cm$

Pressure of oxygen $= 35$ PSI

Calorific value of water, $C_w = 4.2\ kj/kg\ K$

Calculations:

$$H.C.V. = \frac{(m_w+m_e)\,C_w(t_2-t_1)}{m_f}$$

$$= \frac{(2+0.39)\times4.2\,(27.2-22.8)}{1\times10^{-3}} = 44167.2\ kJ/kg$$

Theoretical value of HCV of diesel = 44500 kJ/kg

$$\text{Error} = \left| \frac{44167.2 - 44500}{44500} \right| \times 100\%$$

$$= 0.747\%$$

Result:

Theoretical H.C.V. of diesel = 44500 kJ/kg

Experimental H.C.V. of diesel = 44167.2 kJ/kg

Error = 0.747%

Discussion:

The calorific value was determined using a bomb calorimeter to understand its working principle. Minor errors occured due to incomplete combustion & heat loss despite insulation. These errors are inevitible in practical application.

Precaution:

- The fuel ~~veltsel~~ vessel cap must be tightly secured.
- The bomb must ~~be~~ not be overcharged with oxygen.
- the ignition wire must not touch the fuel cap.
- ~~The~~ The bomb must be fully submerged & the electrodes properly connected.

Conclusion:

The calorific value is crucial in selecting fuels for heat engines, A higher calorific value ensures better fuel Efficiency. This experiment provides a reliable method to measure the energy content of fuels.

Date: 14/1/25

Roll: 2010025

Exp: 03

Group: 04

Exp name: Determination of higher calorimetric value from Bomb Calometree

Data:

Water = 2 Kg

Fusewire = 10 cm

Fuel (Diesel) = 1 gm

Oxygen = 35 PSI

—

Initial Temperature, t_1 = 22.8° C

Final Temperature, t_2 = 27.2° C

Temperature difference, Δt = 4.4° C

19.01.25

Calculation:

$$\frac{m_w \cdot m_e \cdot C_w (t_2 - t_1)}{m_f}$$

m_e = 390 g