EXPERIMENT: Boys Gas Calorimeter

OBJECTIVES:
To determine the calorific value of L.P. gas

APPARATUS:
1. Boys gas calorimeter
2. Regulator
3. Gas meter
4. Measuring cylinders
5. Thermometers

NOTATIONS:
\( \theta_{in} \) Inlet water temperature (°C)
\( \theta_{out} \) – Outlet water temperature (°C)
\( V_w \) Volume of the water collected (ml)
\( V_a \) Volume of gas burned (m\(^3\))
\( T_a \) Ambient temperature (°C)
\( P_a \) Ambient pressure (mmHg)
\( Q_1 \) Heat given by Burning (J)
\( Q_2 \) Heat absorbed by circulating water (J)

THEORY:
Under the steady heat transfer,
(Heat given by burning gas during the observation period = Heat absorbed by circulating water during the observation period)
Assumption

Heat loss from Boys gas calorimeter to the surrounding is given by the latent heat of steam produced by the combustion reaction.

\[ Q_1 = Q_2 \]

By neglecting every small discrepancies,

Heat given by burning gas under the standard condition

\[ = \text{Heat absorbed by circulating water under ambient or standard condition} \]

According to the assumption,

\[ Q_1 = Q_2 \]

But \[ Q_1 = C.V_s \]

Where \[ C = \text{Calorific value of L.P. gas} \]

\[ V_s = \text{Standard volume} \]

But \[ Q_2 = mc\theta \]

Where \[ m = \text{Mass of the circulating water (g)} \]

\[ c = \text{Specific heat capacity of water (cal/g°C)} \]

\[ \theta = \text{Temperature difference between inlet and outlet water (°C)} \]

But \[ m = V_wD_w \]

Where \[ V_w = \text{Volume of circulating water (ml)} \]

\[ D_w = \text{Density of water (g/ml)} \]

From equations (1), (2) & (3)

\[ C.V_s = mc\theta \]

\[ = V_wD_wc \theta \]

\[ C = \frac{V_wD_wc\theta}{V_s} \text{ (Joule constant)} \]
Units

\[ C = \text{[ml],[g/ml],[cal/g°C],[°C],[J/cal]/[m}^3] \]

\[ C = J/m^3 \]

To find the standard volume \( V_s \) of L.P. gas,

Using the equation

\[ \frac{P_s V_s}{T_s} = \frac{P_a V_a}{T_a} \]

Data

\( P_s \) = Standard pressure = 760 mmHg

\( T_s \) = Standard temperature = 300 K

\[ V_s = \frac{P_s V_a T_s}{P_a T_a} \]

Gas meter is used to measure the volume of burned L.P. gas.

One revolution of gas meter = 2 dm\(^3\) (liter)

\[ \therefore 100 \text{ divisions of gas meter} = 2 \text{ dm}^3 \text{ (liter)} \]

But

1 m\(^3\) = 1000 l

\[ 1 \text{ l} = 1 \times 10^{-3} \text{ m}^3 \]

\[ 2 \text{ l} = 2 \times 10^{-3} \text{ m}^3 \]

\[ \therefore \text{One revolution of gas meter} = 2 \times 10^{13} \text{ m}^3 \]

\[ \therefore \text{100 divisions of gas meter} = 2 \times 10^{13} \text{ m}^3 \]

\[ \therefore \text{One division of gas meter} = 2 \times 10^{13}/100 \text{ m}^3 \]

\[ = 2 \times 10^{15} \text{ m}^3 \]
PROCEDURE:

1. Level the meter by the screw and spirit level.
2. Fill it water until the point in sight box is slightly under water level.
3. Lift out calorimeter coils and place into the alkaline bath.
4. Turn on gas cock and allow gas to pass until the meter is free of air.
5. Light burner and then adjust the gas rate to approximately 135 liters/hour (i.e. one revolution of the meter hand in about 66 seconds). Adjust water level while meter is running, by opening drain cock alongside the sight box, until the point just pricks the water level.
6. Turn on water to the overhead funnel so that there is a small overflow the front tube (leading to sink), previously on top of the calorimeter and fixing with the bored corks supplied.
7. When the flow is established through the calorimeter, lift the coils from the alkali bath and allow to drain for a few moments and then slowly lower into the calorimeter casing. Pour water through one of the holes in the wooden cover until an overflow shows at the small drain spout heat the bottom.
8. Allow to establish a steady heat transfer between gas flow rate and water flow rate. Unchanging thermometer readings indicate the establishment of steady heat transfer.

The instrument should now be ready to measure the calorific value of L.P. gas.
9. When meter points is approaching "O" at top of dial of gas meter, read the inlet and outlet thermometers, when pointer reaches "O" switch change over funnel to collect the water in to beaker (Which previously has been completely emptied and drained) for 1000 ml simultaneously. Count the number of divisions of gas meter to calculate the amount of gas volume which is burned.

CALCULATION:

Find the calorific value of L.P. gas.

DISCUSSION:

1. Explain gross calorific value and net calorific value.
2. Point out the practical applications of calorific value.
3. Explain source of errors.
4. What are your suggestion to improve this practical?

REFERENCES:

1. Applied Thermodynamics for Engineering Technologists ï T.D. Eastop
2. Heat and Thermodynamics ï Brij Lal Subrahmaniyam
3. Basic Engineering Thermodynamics in S.I. units ï Rayner Joel
**OBSERVATIONS:**

**EXPERIMENT:** BOYS GAS CALORIMETER

**EXPERIMENT NO:**

**ADMISSION NO:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Inlet water temperature ($\theta_{in}$)</td>
<td></td>
</tr>
<tr>
<td>Outlet water temperature ($\theta_{out}$)</td>
<td></td>
</tr>
<tr>
<td>Volume of water collected ($V_w$)</td>
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<tr>
<td>Volume of gas burned ($V_a$)</td>
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Boy’s Calorimeter