Thermodynamics LABORATORY

BOYS' CALORIMETER

Aim

This laboratory experiment is to experimentally determine the caloric value of a gaseous fuel. It works on the constant flow principle – each part of the calorimeter is at constant temperature when a test is proceeding. So the equipment's heat capacity (can be referred to also as 'the water equivalent' is therefore unimportant.

The Boys' Calorimeter has provision for measuring the amount of water produced by the combustion of hydrogen in the gas, enabling the determination of the lower as well as higher calorific value.

Method

Run water to waste from the top so as to clear all previous water which may have been warmed/cooled by the airconditioning of the building. This may take three or four minutes.

Connect the constant head tank to the tap and adjust to give a steady flow from the drain tube.

Lift off the calorimeter top, turn on the gas and light the burners. The flame should be symmetrical and about one inch high. Replace the calorimeter top, checking first that water is flowing through it. Adjust the gas supply until the flow indicates a flow of 20 grams in within 5 seconds of four minutes (approx 5 grams per minute).

Wait for half an hour or until the water temperature becomes steady. During this time, check that the water flow in four minutes is between 2000 and 2400 ml using the large measuring jar (approx 550 ml/min). Top up the water pool at the bottom of the calorimeter until overflow occurs at the outlet pipe. This is done through any one of the holes in the wooden top. Condensation from the combustion gases will continue to cause overflow which should be caught in a beaker for the moment.

On reaching steady conditions, carry out the following operations simultaneously at an instant when the weight measurement changes to a round number and record it:-

a) Swing the water outlet pipe so as to discharge into the measuring jar.
b) Place a small dry beaker under the condensate outlet.
c) Start a stop-clock.
d) Take inlet and outlet water temperatures.

Continue to take water temperatures every half minute for four minutes. At about the middle of the four minute period, read:- air temperature., and effluent gas temperature.

When the gas meter indicates that exactly 20 grams of gas have been used, swing the water outlet away from the measuring jar, remove the condensate collecting vessel and note the time.

Note the amount of cooling water collected and the amount of condensate, the latter by weighing or using a small measuring cylinder.

Barometric Pressure, mmHg

Gas tested……LPG

Period of Test (sec)	Gas used (gr)	Air Temp. ^oC (t_a)	Circ'g Water		Water coll-ected W (gr)	Water Condensed w_c (gr)	Gas effluent Temp ^oC (t_e)
			Inlet ^oC (t_i)	Otlet ^oC (t_o)			
0							
30							
60							
90							
120							
150							
180							
210							
240							

$$HHV = \frac{\text{mass water collected x specific heat capacity of water x temp rise of water}}{\text{mass of gas burned}}$$

$$\text{Weight of condensed vapour/gr gas burned} = \frac{\text{gm water condensed}}{\text{gm gas burnt}}$$

Allowing 2453kJ/kg for latent heat (corresponds to 20^{o}C) that would have been carried away by this vapour if it had not condensed
Energy associated with the condensed vapour = gm water condensed x 2453J/gr

$$LHV = \frac{\text{mass water collected x } C_{pH20} \text{ x temp rise of water - water condensed x 2453J/gr}}{\text{mass of gas burned}}$$

$$LHV = H.H.V. - \frac{\text{mass of water condensed x 2453 J/gr}}{\text{mass of gas burned}}$$

From the mass of condensate collected and the mass of gas burnt, the ratio n is calculated

$$CH_n + A\,O_2 \rightarrow CO_2 + \frac{n}{2} H_2O$$

Mario Farrugia, 4rth November 2016, Boys Calorimeter.