

Calorific values of fuel

Introduction

Higher heating value (HHV) is the heat released by the perfect combustion of a unit quantity of fuel. The resulting water condenses (releases its evaporation heat) and is in a liquid state.

Lower Heating Value (LHV) is the heat released under the same conditions as HHV, but the water produced is in the form of vapour. The calorific value is therefore lower than the heat of combustion due to the heat of evaporation of the water.

$$LHV = HHV - \frac{2441,5}{100}(W + 8,94H) \quad (1)$$

LHV ... lower heating value [kJ/kg]

HHV ... higher heating value [kJ/kg]

W ... water content [wt. %]

H ... hydrogen content [wt. %]

The heating values can also be approximated from the elemental composition of the fuel using empirical formulae. However, these formulae are generally only applicable to a particular type of fuel. Calorific values are one of the essential fuel parameters. LHV is mainly influenced by the moisture content of the fuel, as shown in the following figure.

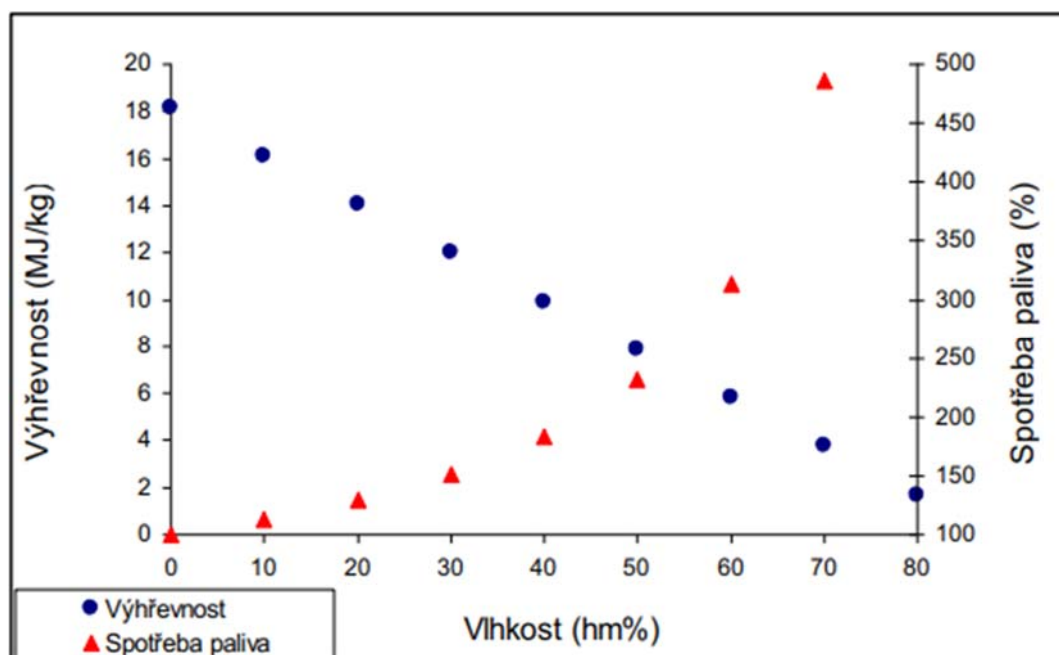


Figure 1 Comparison of LHV (blue dots) and fuel consumption (red triangles) to moisture content (x-axis)

Instructions

Measurements are made on the IKA 2000 (Fig. 2), where all analyses are automated. There is no need for calibration of the instrument as it has already been calibrated (calibration is every six months). It is also possible to determine the combustible content of sulphur, chlorine, fluorine and bromine in the samples, in addition to the determination of the heat of combustion and the calorific value.

1. Turn on the water-cooling system (at least half an hour before the measurement is taken). Check the water level. It should be almost overflowing. Top up if necessary (use demineralised water).
2. Switch on the device and release the oxygen pressure valve on the oxygen cylinder when the cooling water temperature falls below 20°C.
3. Weigh 0.5 - 1 g of sample into the metal crucible.
4. Rinse the calorimetric flask with distilled water and rinse the lid and electrodes. Dry the electrodes and the ignition wire with cellulose. Add 11 ml of NaOH (0.1 mol/l) to the calorimetric flask.
5. Thread the ignition cotton onto the ignition wire and insert it under the sample. Assemble and seal the bomb.
6. Press the key under the heading "Sample", enter the weight of the sample and press OK (the bomb without the strip is No. 1 and the bomb with the strip is No. 2). Place the bomb in the holder in the calorimeter head. The word "Start" should appear on the display. Press the button below the sign, the head will drive the bomb into the bath and measurement begins.
7. The measurement will take about 30 minutes. Then the head will lift up and the higher heating value will appear on the display. Be careful of the weight of the bomb when removing it from the calorimeter head and use both hands.
8. Calculate LHV from equation (1).
9. Depressurise and open the bomb.

Measure HHV for a given sample at least 3 times and calculate the confidence interval of the results.

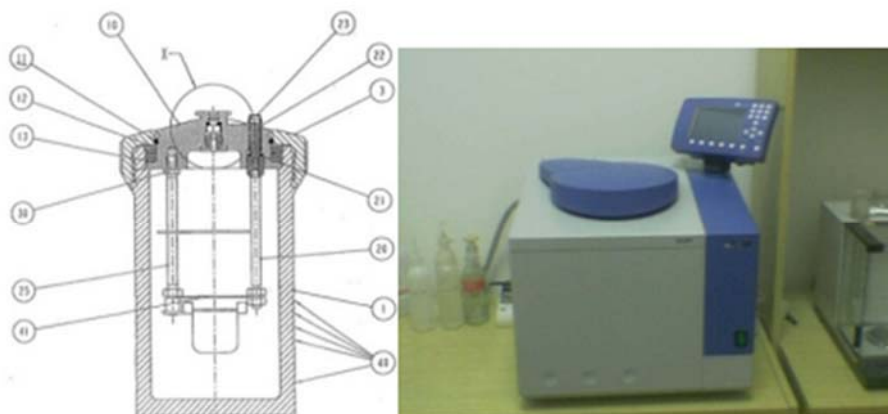


Figure 2 IKA 2000

Questions

Answer the following questions. Use the Internet to explain unknown terms and missing values.

1. Calculate the confidence interval for HHV of the sample according to the Student's distribution.
2. Calculate LHV of the measured fuel (including the confidence interval). ($H^d = 6.1$ wt%, $W = 10$ wt%).
3. What is HHV of the fuel in J/kg and cal/kg?
4. Work out the relationship between the MJ and the MWh. Express LHV in kWh/kg (including the confidence interval).
5. What is the heat output of a boiler with a fuel input of 2 t/h of measured fuel? The thermal efficiency of the boiler is 85%.
6. Assume that this fuel is available on the market for 110 CZK/GJ. What will be the daily fuel cost of this boiler (if it runs at full power all day)?
7. The municipal heating plant has 3 boilers, 2 x 1.8 MW (80% efficiency) and 1 x 2.5 MW (85% efficiency). The average efficiency of energy transfer to customers is 95%. How many households with an average consumption of 15 kW can be supplied by this boiler plant at full capacity?