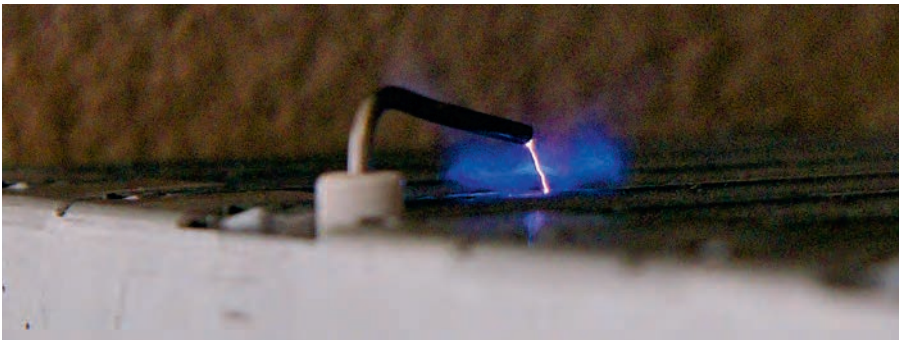
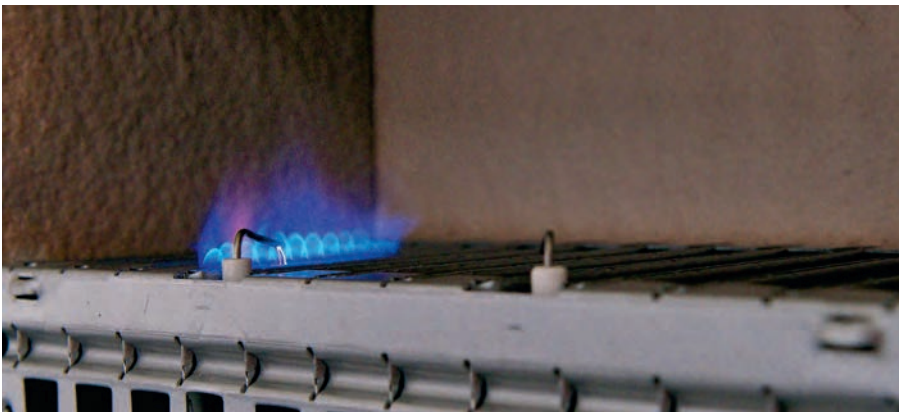


Pilot ignition on a flame rectification system



Flame rectification systems operate on the principle that a flame can conduct and rectify a small electric current

There is a probe attached to the burner that transmits a current from the control box, creating a spark and in turn causing a flame on the burner to light.



The current is then conducted by the flame and passes through it, becoming a half-wave rectified AC via the earth route of the metal mass of the burner. It then travels back to the control box where the solenoid valve is opened at the gas valve, allowing gas to flow to the burner. In this way the main flame is established.



Pressure differential valve

KEY POINT

Diaphragms can split causing the process to fail, resulting in no or intermittent ignition.

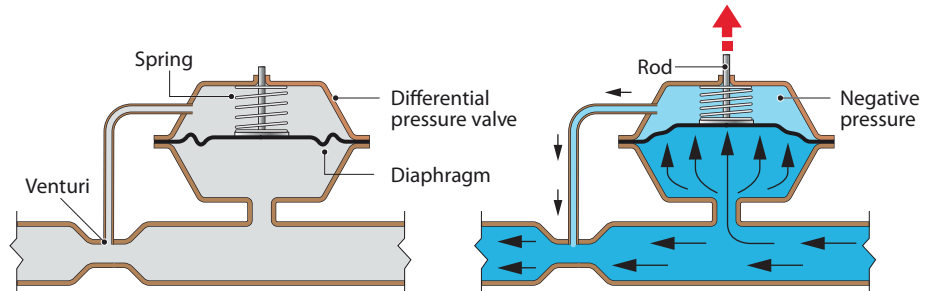
Venturi principle

A Venturi operates on the principle that by reducing the bore of a water pipe for example, the flow of water will increase in velocity after that point. The process is similar to putting a finger over the end of a hose pipe or nipping the end of it which results in increased velocity.



Pressure differential valves

The image to the left is a pressure differential valve. It is found in instantaneous hot water heaters and combination boilers. It comprises a diaphragm with a rod connected to it which opens the flow of gas to a burner when the diaphragm rises and vice versa. The valve works on the **Venturi principle** and the integrity of the neoprene diaphragm is essential for efficient operation.



When there is no water flowing through the water pipe there will be equal pressure on both sides of the diaphragm and there will be no movement

When water flows, ie the hot water tap is turned on, the diaphragm will lift because the pressure is reduced at the top of the valve because of the negative pressure created at the Venturi. This is the differential pressure which creates the movement of the diaphragm within the valve

Pilot assembly with thermocouple and spark igniter

The image to the left shows a typical pilot assembly, located on the front of the boiler. On the left-hand side is a pilot tube, in the centre is the spark electrode and on the right-hand side is the thermocouple connection.

The image below it shows a section of the pilot assembly on the inside of an appliance, with the pilot shroud, the spark igniter and the thermocouple next to the burner.



Pilot flame enveloping the tip of a thermocouple

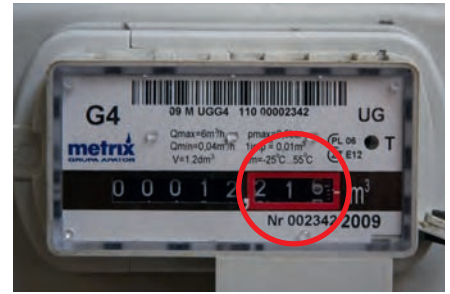
Rod-type thermostats

The principle of a rod-type thermostat is based on the coefficient of expansion between two dissimilar metals. The thermostat comprises

Gas-rating using metric meters

The meter displayed on the right shows 12.216 which means 12m³ and 216 litres of gas have been consumed by the appliances connected to the system.

During a gas-rating test only a very small amount of gas will be measured over a two-minute period. Once the appliance reaches its operating temperature the meter reading is then confirmed and recorded while the appliance is working. After two minutes the reading is taken again. For example, if we take the meter reading of 12.216m³/h in the first image as the first reading and 12.260m³/h as the second reading after two minutes then the volume of gas can be calculated.



A metric meter



An imperial meter

$$\begin{aligned}
 &12.260\text{m}^3/\text{h} \text{ (2nd reading)} \\
 - &12.216\text{m}^3/\text{h} \text{ (1st reading)} \\
 = &\mathbf{00.044\text{m}^3/\text{h}} \text{ (volume of gas passed in 2 minutes)}
 \end{aligned}$$

$$\frac{0.044 \times 3600 \times 10.76}{120} = \mathbf{14.20\text{kW}}$$

Seconds in one hour

kW of energy produced by 1m³ of gas (approx.)

Volume of gas passed after two minutes

The number of seconds in 2 minutes

kW consumed by appliance



A digital measurement display on a G4 meter

Once the calculations are complete they can be compared with the manufacturer's instructions to assess if they are acceptable. In the manufacturer's technical data permissible tolerances to any reading will be given.

In addition to gas rating many manufacturers require that a combustion analysis is carried out to confirm the efficiency of the appliance in accordance with their specifications.

Gas-rating using imperial meters

An older-style domestic U6 imperial meter will pass the same maximum volume of gas per hour as its metric counterpart such as a G4 or E6 which is 6m³. Instead of measuring m³/h, on an imperial meter the volume is measured in cubic feet per hour (ft³/h). Once the appliance has reached its operating temperature and the burner pressure is established, a reading can then be taken from the dial.



A manufacturer's technical data being used to assess the correct performance of an appliance

$$\frac{3600 \times 1040^*}{38} = \frac{3744000}{38} = 98526 \text{ BTU/h}$$

$$98526 \div 3412 = 28.87 \text{ kW (gross)}$$


$$28.87 \div 1.1 = \mathbf{26 \text{ kW net}}$$

*1040 is the imperial CV of gas measured in BTUs.

Gas Rating (part 1) Hot Notes

The main purpose of gas rating an appliance is to confirm the size and condition of the injector. If the inlet working pressure is correct the **operating** (burner) pressure should relate to the volume of gas being burnt by the appliance. If an injector is too small or partially blocked, the volume of gas passed at the meter will be less than that stated on the data plate or manufacturers info. If the volume of gas measured is more than the injector could be too large or be worn.

- Attach zeroed and tested Manometer to outlet of gas valve
- Read pressure & adjust pressure after 5-10 mins to the desired rate as per data plate or manufacturers instructions
- Calculate the volume of gas being passed at the meter.
- This is achieved as follows on **U6 meter** by using a stopwatch
- Time how long test dial takes to complete one revolution) 1ft³
- To obtain gas rate read off time taken to pass 1ft³ on the chart in the Study book – Allow tolerance of 10%



Time one revolution of test dial U6 Meter

If it took 70 secs to pass 1 ft³ of gas the calculation would be

$$\frac{3600 \times 1040}{70} = \frac{(3744000)}{(70)} = 53486 \text{ Btu's/h input}$$

i.e 3600 (seconds in 1Hour) x 1040 (calorific value gas in Btus/h) divided by the time it takes to pass 1 ft³ of gas in seconds

To convert Btu's to kW divide by 3412 eg $\frac{53486}{3412} = 15.7 \text{ kW}$

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Gas rating imperial

Gas Rating (part 2) Hot Notes

Metric meters measure gas in m³/h (cubic metres) and there are 1000 litres or dm³(cubic decimetres) in 1 m³ See Example below. A U6 / E6 or G4 Gas meter will pass 6 metres³ of gas per hour. All metric meters are to be read as follows

- Set the boiler operating pressure as previously mentioned
- Note **1st** reading on the meter while the appliance is running
- After two minutes take **2nd** reading – deduct this from the 1st
- Look in the **Metric Gas Rate charts** in the Study book in the column which shows the amount of litres passed over two mins

Charts also in Corgi Essential Gas Safety Book 3rd edition P173

EXAMPLE reading on a metric meter

00231.220.m³ 1st reading
00231.267.m³ 2nd reading after 2 mins

Therefore 0.047m³ or 47 litres of gas were consumed in 2 mins
The charts will show a heat input of 15.12kW and should relate to burner pressure on data plate & manufacturers info. Within a tolerance of 10%

CALCULATION for Metric Meter

$$0.047 \text{ m}^3 \times 30 \text{ (no of 2mins in 1 hour)} \times 10.72 = \mathbf{15.12 \text{ kW}}$$

Formulas

- m³/h x 10.72 = kW
- kW x 3412 = Btu's
- 1 litre = 1 decimetre³ (dm³)
- 1000 litres = 1 m³
- 28.3litres = 1 ft³
- 9.5 litres = 0.355ft³ approx

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Gas rating metric

KEY POINT

When converting a value from gross to net, divide the figure by 1.11. When converting a figure from net to gross, multiply by 1.11.

Simple memory aids such as Hot Notes can help an engineer to recall essential processes during testing. Smaller concise information could be more convenient to the qualified engineer than taking out a larger manual to refer to when working on appliances.

Conclusion

This chapter is just an introduction to give you an awareness of the world of gas. Hopefully this learning will encourage you to pursue work experience opportunities with a registered Gas Safe company to gain your professional ACS qualifications in this specialist plumbing craft category.