Combination and High Efficiency Boilers – Introduction

Welcome to this BPEC training and assessment scheme for domestic plumbing and heating engineers.

This short programme is designed to enhance the skills and knowledge you require to install, maintain and repair modern high efficiency and combination gas appliances. It has been designed with practising plumbing and heating engineers in mind and therefore concentrates mainly on:

- High efficiency and combination boiler installation
- High efficiency and combination boiler system components
- High efficiency and combination boiler fault-finding

The training material is presented as a series of sections which can be studied individually or in their entirety. The material has been developed to support delivery in approved training centres and the course contains a significant element of practical work.

Assessment

A very important part of the course is the assessment that will occur at the end. The assessment process will take approximately 2 hours and will include both practical and written assessments which must be completed within set time limits.

Whilst there are no specific entry requirements for this course you should have a working knowledge of domestic plumbing and heating systems (ideally with nationally recognised qualifications to back this up) and you should be physically able to undertake the work required.

You may also wish to seek guidance from a medical or ophthalmic professional if you have any significant colour vision defects as working with cables and electrical equipment may be hazardous if you cannot recognise different colours.

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Introduction

This section is designed to give a brief overview of exactly what combination and high efficiency boilers are. It's likely that most will already be familiar with these types of appliance, but revision of the basic operating principles involved will still be useful for later in the course.

Combination boilers

The combination boiler (also referred to as 'combi' boiler throughout this manual) represents an increasingly popular domestic heating and hot water solution in UK homes. First introduced in the early 1980s combis now account for well over half of all the new domestic boilers installed in the UK every year.

Current combi boilers are designed for use in sealed systems, although it should be noted that some early models were designed with an option to be used in open vented systems – they provide central heating and priority instantaneous hot water. Combis are in essence, high-efficiency water heaters and central heating boilers, combined within one compact unit (hence the name). The major difference between combis and other types of boiler is that with a combi, there is no need to store hot water. Therefore the installation of a combi boiler can result in significant space saving benefits as there is no need for a hot water storage cylinder, cold water storage cistern or other components associated with conventional heating systems.

Direct and indirect combination boilers

Combination boilers can be classified as either direct or indirect depending on the method used to heat the domestic hot water within the boiler.

Direct combination boilers are so called because the domestic hot water is heated by passing through or in close proximity to the primary heat exchanger.

With **indirect** combination boilers, hot water from the primary heat exchanger flows to a three way diverter valve which channels the flow of hot water either to the radiators or to the internal calorifier (also called a water to water heat exchanger). Cold mains water is then fed through the coils of this vessel and picks up heat before being distributed to the hot water system. In essence, this internal calorifier acts as a miniature indirect hot water cylinder, as shown in figure 1 b). (Note: These components will be covered in more detail during Section 4).

Types of combination boiler

There are numerous combination boiler models available today (both direct and indirect), but there are two main types:

A **combi (instantaneous)** boiler is the most widely used type and directly heats incoming mains cold water to supply hot water to taps, showers and other draw off points.

A **combi (storage)** boiler is a variant of the instantaneous type and is designed to give better hot water performance via the use of an integrated hot water store. Dependent upon the make and model, the improvement in hot water delivery will depend upon the size of hot water store, and this can vary considerably. In general, the principle of operation is that the stored water will give up its heat to provide an improved initial hot water delivery. Once the stored heat has been given up, the boiler then operates as an 'instantaneous' type.

Combination boilers may be open flued, room sealed or fan assisted appliances, incorporating either permanent or intermittent pilots. Most combination boilers are available in high efficiency condensing models.

Basic principles of operation

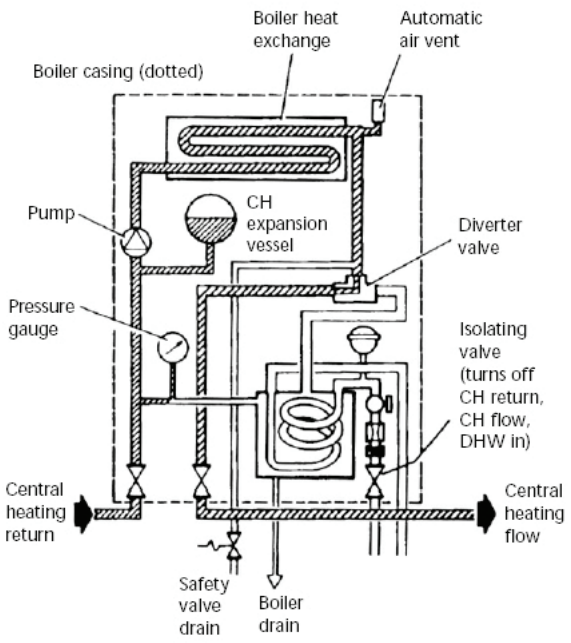
A traditional heating boiler supplies hot water indirectly to the storage vessel, which is usually sited on the first floor level. A combination boiler supplies domestic hot water directly from the boiler via a special heat exchanger.

Combination boilers are designed to heat up mains fed cold water as it passes through the hot water heat exchanger, providing a supply of instant hot water at the tap, on a similar basis to that of an instantaneous water heater.

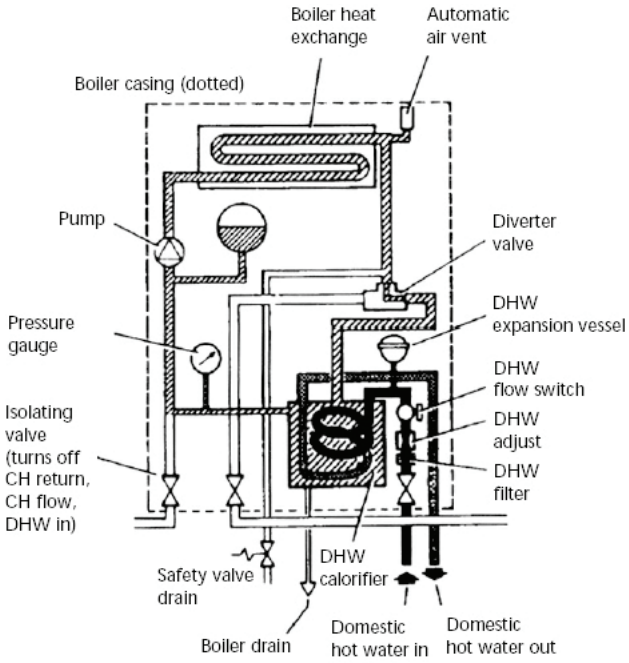
The systems are generally sealed and require an approved filling loop, although some types will work on an open system. The integral components are very similar to that of a traditional sealed boiler with the addition of a three way diverter valve and hot water heat exchanger.

Figure 1 Indirect combination boiler operation

a) Central heating (CH) water circuit



b) Domestic hot water (DHW) circuit



With no call for CH, the boiler fires only when DHW is drawn off. When there is a call for CH, the heating system is supplied at the selected temperature until DHW is drawn off. For the boiler shown in Figure 1, the full output from the boiler is then directed via the diverter valve to the calorifier, to supply a maximum DHW draw off (e.g. hot water taking priority over central heating).

The essential gas/electric safety controls operate following a similar principle to traditional central heating boilers. The boiler may, however, use a modulating multifunctional control valve. This allows the amount of gas supplied to the main burner to be varied according to heat demands of the system.

Advantages and disadvantages of combination boilers

Combination boilers have become extremely popular in the UK, but they are not suitable for all house types/ situations. A key factor in ensuring combination boilers operate successfully is that they require good cold water mains pressure. If the mains pressure is not up to the standards required by the appliance manufacturer, an alternative heating/hot water solution should be used.

The following table gives a basic general guide as to situations in which it would be appropriate to fit a combination boiler.

Situation	Most suitable boiler type
You want to use your loft space for a room conversion or other purposes	Combi
You live in a flat or bungalow (i.e. have very little or no roof space)	Combi
Your home has more than 2 bathrooms	Regular or System
Your mains water pressure is low	Regular or System
You want to replace an old boiler to improve an existing conventional central heating system	Regular, System or Combi
The number of people in your household means that there is regular demand for hot water on tap, but waiting for the tank to constantly refill and heat up is, or would be, inconvenient	Combi

The following lists indicate some basic advantages and disadvantages of combination boilers:

Advantages

- Hot water cylinder not required
- No external control system required
- Tanks in roof space not required (for sealed systems)
- Hot water available on demand 24 hours per day

Disadvantages

- No stored hot and cold water
- Possibility of low hot water flow rates
- Priority for hot water in larger properties
- More space required than for traditional boilers
- Cooling of radiators if there is excessive hot water draw off

High efficiency boilers

The term 'high efficiency' in reference to central heating boilers relates to how efficient appliances are in terms of getting the most out of the energy they consume. This is a very important issue as central heating boilers in the UK tend to be powered by fossil fuels (primarily natural gas), these appliances have traditionally also produced high levels of Carbon Dioxide (CO_2) as a by product during operation. The production of CO_2 is seen as being harmful to the environment and a strong contributing factor in the phenomenon of global warming. As a result of this the UK Government has laid down strict guidelines to reduce the amount of CO_2 we produce as a nation – a key strand of this policy is to improve the energy efficiency of fossil fuelled heating appliances.

The efficiency of central heating appliances in the UK is measured using a system called the 'Seasonal Efficiency of a Domestic Boiler in the UK' or SEDBUK.

SEDBUK is an indicator of the average annual boiler efficiency determined by the amount of heat delivered into the primary heating circuit. It's assumed that the boiler is installed in a fully pumped system, correctly designed with adequate controls.

In practice SEDBUK provides a rating system that can be used to assess the energy efficiency of different appliances. The rating system is summarised in the following chart:

Band	SEDBUK Range
A	Above 90%
B	86% - 90%
C	82% - 86%
D	78% - 82%
E	74% - 78%
F	70% - 74%
G	Below 70%

In an effort to improve national energy efficiency and reduce the 'carbon footprint' (amount of CO_2) produced by each home, the government has stipulated through Part L1 (A and B) of the Building Regulations that new and replacement domestic central heating boilers must have a SEDBUK rating of either A or B. As a plumber/heating installer this means that you'll be seeing a lot more of 'condensing' boilers.

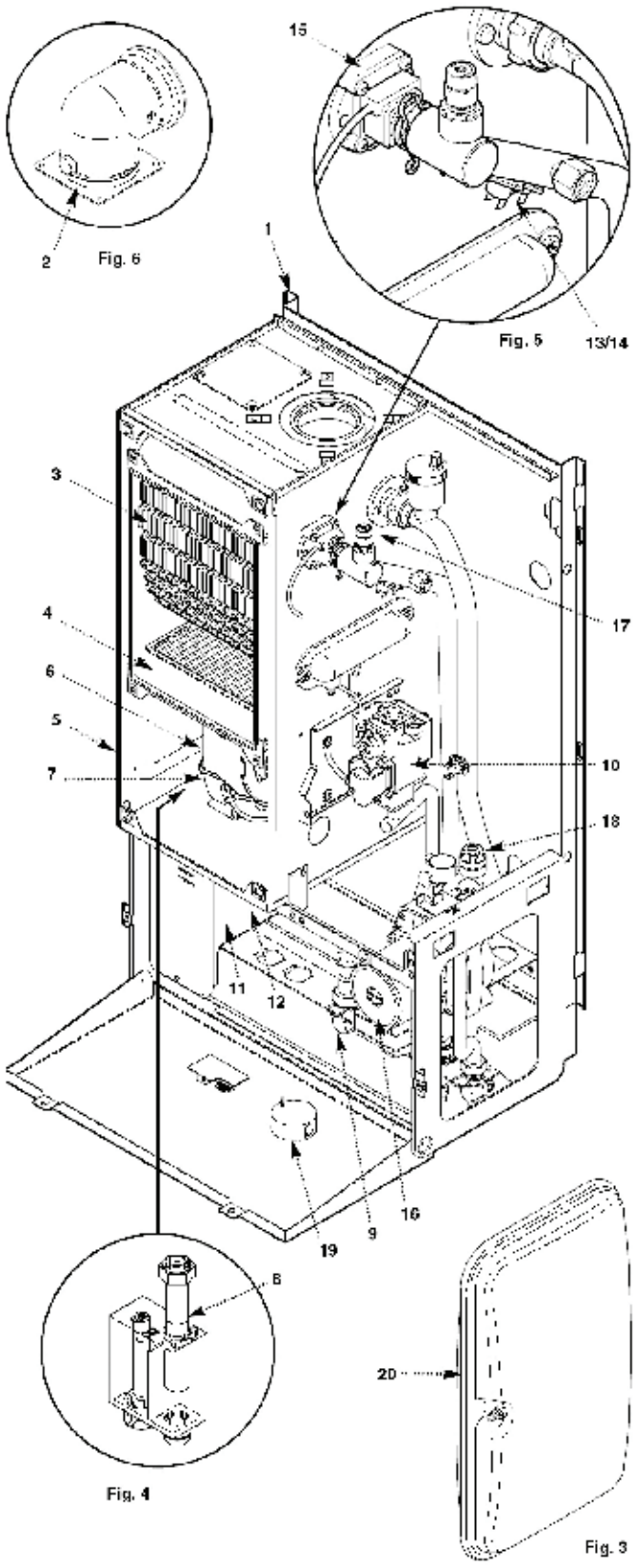
Condensing boilers

Condensing boilers are the most energy efficient boilers currently on the market. The efficiency of a typical non-condensing boiler is around 78% (SEDBUK rating), whereas a condensing boiler usually has an efficiency of over 86%. Condensing boilers have larger heat exchangers than those found in non-condensing boilers, and utilise every scrap of energy from the consumed gas i.e. both latent heat and sensible heat.

Condensing boilers are available as combination boilers, or system boilers. Flue options include room sealed fan flues, and twin flue pipe options. Heat outputs range from 13 kW to 25 kW with most makes having a modulating gas valve. The SEDBUK rating for condensing boilers is A to B.

An exploded diagram of a condensing boiler is shown below.

Condensing boiler



1. Wall Plate
2. Flue Elbow
3. Heat Exchanger
4. Burner
5. Air Box
6. Fan Protection Thermostat
7. Fan Assembly
8. Condensate Trap
9. Gas Tap
10. Gas / Air Ratio Valve
11. Electronics Housing
12. Transformer
13. Flow Temperature Safety Thermostat - Black
14. Flow Temperature Thermistor - Red
15. Flow Switch (dry line protection)
16. Circulation Pump
17. Automatic Air Vent
18. Pressure Relief Valve
19. Water Pressure Gauge
20. Expansion Vessel

Module 5

Mechanical and electrical fault finding processes for combination and high efficiency boilers