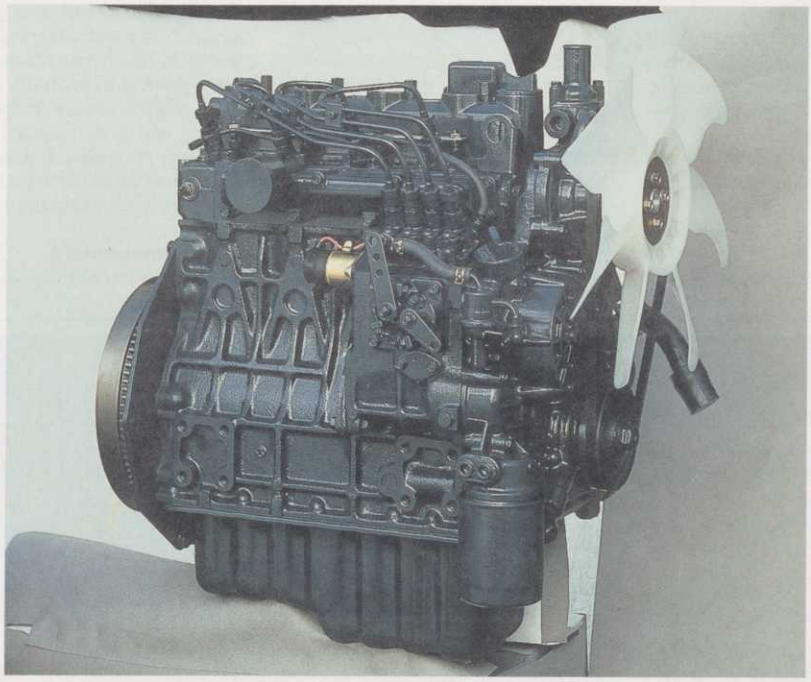
Roland Taylor looks the harmful gasses produced by the internal combustion engine and examines ways of ensuring damage to the ozone layer is minimised.

Smog warning



As we stand on the 18th green with a clear blue sky overhead, the sun shining down and a light breeze blowing down the fairway, it is hard to believe that all this fresh air is a myth and lurking out of sight is something sinister.

No, this is not the beginning of a thriller it is fact not fiction, air pollution throughout the world has become a major problem and one of the biggest culprits is the internal combustion engine. Four by-products result from the fuel burning process carbon monoxide, Hydrocarbon nitric oxide and particulates - all potentially harmful.

Carbon monoxide (CO)

High concentrations of this can affect the blood and nervous system and are generally considered to be the biggest threat to health. This pollutant is produced as a result of incomplete fuel combustion due to a lack of oxygen. The critical factor in its production is the fuel and air ratio (carburettor setting on a petrol engine, injector on a diesel). A rich mixture produces CO, while a lean one keeps levels down.

Hydrocarbons (HC)

Hydrocarbons react with nitric oxides in sunlight to form ozone, which can cause respiratory problems.

These are also formed due to incomplete combustion, but there is a difference in the case of a very lean mixture. Ignition is likely to become unstable or the engine misfires, then emission levels of hydrocarbon rise.

Another source of this pollutant that is often overlooked is fuel evaporation from spillage or containers.

Tests carried out in America showed that among all non-road combustion engines, small power units, especially two-strokes, contributed to about 4% of hydrocarbons from all sources. The emission tests were as follows: 67% from exhausts; 23% due to evaporation and 10% from spillage.

Nitric Oxide (NOx)

This gas is produced when nitrogen and oxygen are combined at high temperatures and its formation is once again dependent on the fuel and air ratio going into the combustion chamber. Lowering the engine temperature by retarding ignition timing and re-circulating exhaust gases does reduce NOx formation, but this tends to reduce power output.

Particulates (Black smoke)

Tiny particles of burnt or unburnt carbon are discharged from engine exhausts. These are thought to increase the risk of heart or lung problems. Diesels produce more of this than their petrol counterparts.

Carbon Dioxide (CO_2)

Even when fuel is burnt efficiently carbon dioxide is discharged. While this does not harm health it has been found to be a contributor to the greenhouse effect.

Smog warning

As far as pollutants are concerned there is little to choose between emissions from a diesel or petrol four-stroke engine. In the case of a two-stroke power unit the picture is different and indications are that even with all the latest technology they will not get through the next round of CARB regulations in America, hence the introduction over recent years of smaller four-stroke models.

Over the last decade the research departments of engine manufacturers have been working flat out to come up with design improvements that will enable them to comply with the California Air Resources Board (CARB) emission regulations. These came into effect in January 1995 and not only laid down engine performance levels, they also required manufacturers to establish facilities for measuring emissions from every unit supplied into the Californian market. Their introduction has become a benchmark for all engine production throughout the world.

Engines now coming onto the market have improved fuel economy, produce less noise, work at low temperatures and are said to have greater reliability and durability.

Most readers will have several engines in their fleet, so what measures can be taken to reduce pollution?

Engine maintenance

This needs to be carried out as laid down by the manufacturer. Not only will it help to reduce the emissions, it will ensure the engine continues to produce its optimum performance.

Cooling systems

Regardless of which system the engine has, the most important factor is keeping the airflow moving over the cooling areas. Build-ups of dried grass or dirt between the cooling fins around the compression chamber or in a radiator can dramatically reduce the system's efficiency. The temperature within the engine will increase resulting in a drop in performance and subsequently higher levels of pollutants.

Air filters

As we have seen, the volume pollutant gas produced is dependent on the correct ratios of air to fuel. Dirty and clogged up filters restricts air intake and change the mixture getting into the combustion chamber. Ignition is less effective and a high level of neat fuel is discharged into the atmosphere via the exhaust.

This also occurs if the carburettor setting is incorrect. Apart from the pollution aspect, more fuel is wasted and the engine's performance is only mediocre, thus placing more stress on both machine and operator.

Ignition

The correct spark or fuel injection at the right time is critical. A dirty or wrongly set plug in the case of a petrol engine, or faulty injector on a diesel, will upset the balance.

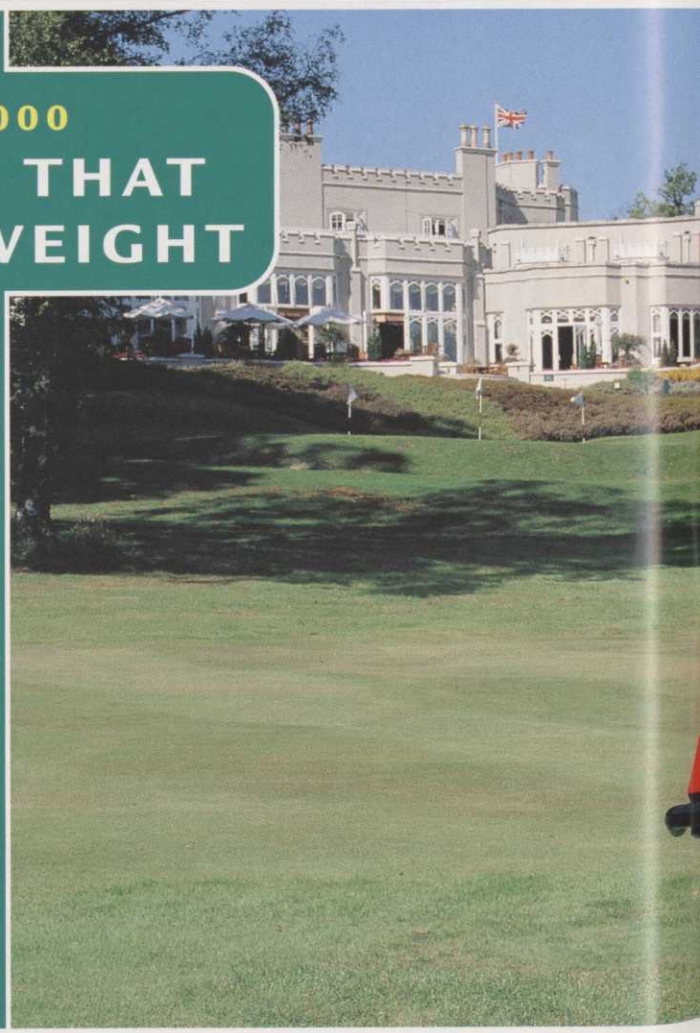
Spark plugs should be the correct type for the engine and have an adequate heat range.

Lubrication

Oil reduces friction and dissipates heat. If in short supply hot spots develop and unless oil levels are topped up immediately a costly bill will be incurred. Top quality lubricants should always be used. For two-stroke mixtures there are available smokeless based oils. These only produce carbon dioxide and water vapour from the combustion process and no carbon residues are deposited in the engine, so internally it is kept cleaner.

Fuel management

Modern petrol has a shelf life and the



Previous page and far left: Eco-friendly engines from Briggs & Stratton come with a variety of Horsepower options

Immediate left: A Kubota engine undergoes regular maintenance as an integral part of Environmental concern on the Golf Course

formula is likely to be changed about three times a year. This is to reduce the vaporisation rate during hot spells and increase it when the temperature drops. Because petrol has a limited life, any machinery not being used for long periods should have all the fuel drained off, or a fuel stabiliser can be added to the tank.

When experiencing starting problems, it is worth first checking the fuel is not stale, especially if the equipment has been laid up for some time

Fuel should be stored in a cool place and needs to be kept in an approved and labelled container, which is fitted with an airtight cap.

Clean up any spillage as quickly as possible to stop hydrocarbons being released into the atmosphere.

General

Drives, transmission and cutting systems need to be maintained and set up correctly so that minimal stress is placed on the power unit. It is important it is to ensure the engine is running correctly and the rest of the machine's components are not causing overloading.

Manufacturers, instruction books will give details of servicing and adjustment routines.

Repower an attractive option

There comes a time when an engine's performance is well below par.

At this stage it is likely to be spewing out plenty of gas emissions becoming difficult to start; more likely to break down and running costs are escalating.

A decision has to be made whether to invest in a complete new machine. As most course managers and greenkeepers are faced with financial constants, this may not be a very practical solution. There is another possibility that is worth exploring - re-powering. This has some distinct advantages and the cost compared to a new machine will be very attractive.

The new engine incorporates all the latest technology. Features like reduction in fuel consumption can represent considerable savings over a period of time. Lower noise and emission levels contribute to the environmental issue and the engine carries a warranty. It may be an advantage to change from a petrol engine to a diesel unit.

Providing all the other components of a piece of equipment are okay, repowering is an option worth investigating. Your local engine supplier will be able to advise on suitable replacements and can carry out the work.

The future on a global basis indicates that legislation in some countries is becoming increasingly stringent and engine manufacturers design teams are being pushed to the limits of technology to comply. Other forms of fuel are being tested such as natural gas. At present this is mainly on applications where a stationary engine is used, mobile applications are on the drawing board.

Electric power has already been introduced on golf machinery. Everyone is out to seek acceptable solutions, but it is also up to those responsible for using engines to ensure they are maintained to a standard that minimises unwanted gas emissions.

Pollution is a growing problem that has to be addressed it will not go away.

Next time you are out on the course and take one of those deep breaths just ponder for a few seconds on how much poison the engines under your care are discharging into the atmosphere.