‘All fuel’ engine opens way for bio-fuels on farm

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The Cyclone ‘all-fuel’ engine is a compact modern steam engine designed to use a range of combustible gases, liquids and mixed fuels while maintaining effective performance and low emissions.

The range of fuels the Cyclone can use opens up a world of renewable biofuel opportunities previously thought unattainable at the farm scale and provides farmers with the security of being able to use conventional gas or liquid fossil fuels at any time.

The performance statistics of this 21st Century engine are compelling.

The Cyclone boasts a thermal efficiency of 33%, which is better than a petrol internal combustion (IC) engine and comparable to a common-rail diesel.

The ‘Mark V’ 100HP Cyclone produces an incredible 1050 Nm of torque at 1 rpm; about 10 times the torque of an IC engine of equivalent power.

Being a steam engine, the torque is instantaneous and uniform across the rev range, a big advantage where there is a load on the machinery at start-up, such as starting an auger that is already full of grain, or a pump already full of water.

The Cyclone’s high torque reduces the need for a transmission, further reducing cost and complexity, and its design is much simpler than that of an IC engine

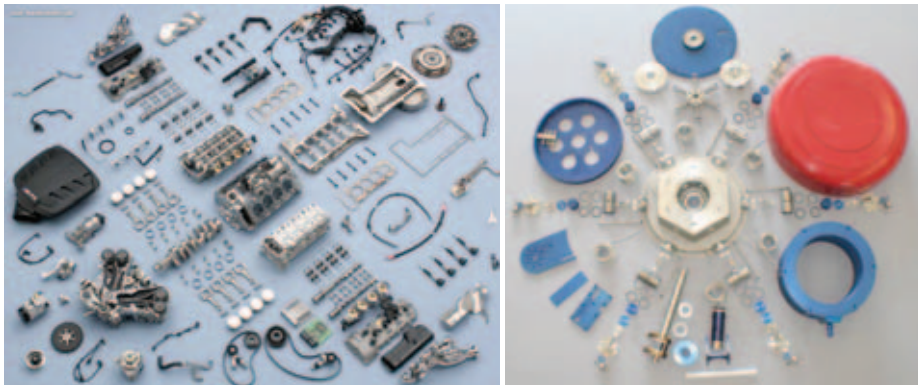


FIGURE 1: **THE PARTS OF AN INTERNAL COMBUSTION ENGINE (LEFT) AND THE CYCLONE ENGINE (RIGHT) ILLUSTRATE THE RELATIVE SIMPLICITY AND SERVICEABILITY OF THE CYCLONE.**

(Figure 1, above), so servicing should be relatively easy and able to be done by a farmer or an employee.

The Cyclone uses a sealed closed loop deionised water system and the working fluid self-lubricates the entire engine. No motor oils are used for servicing or lubrication.

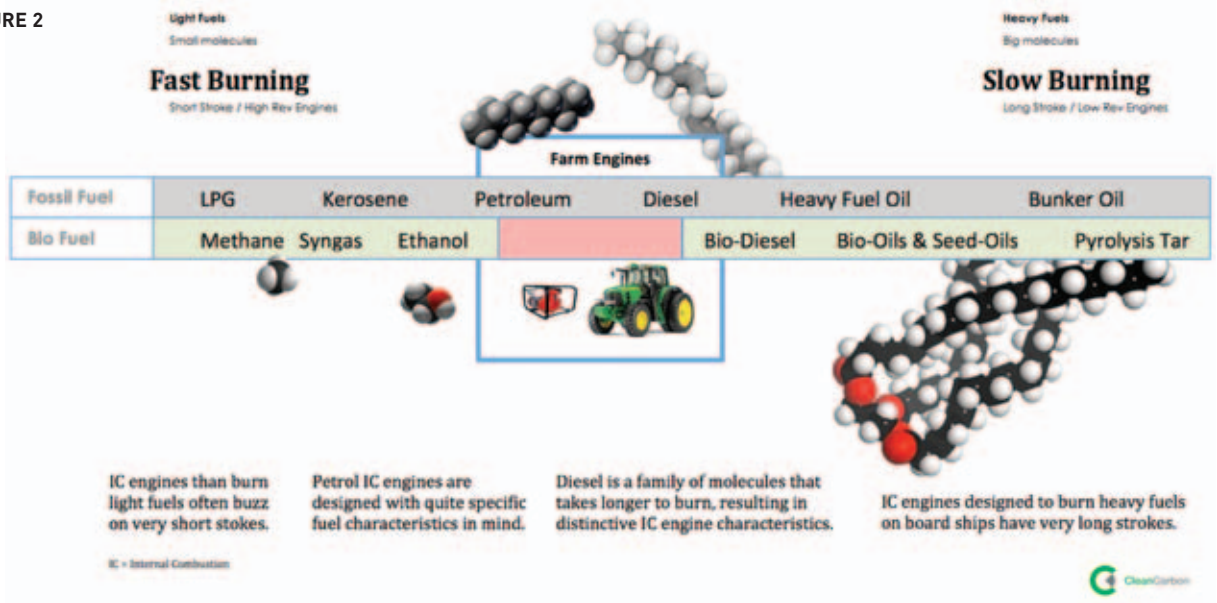
The exhaust of the Cyclone is inherently clean because the combustion chamber is not starved for oxygen as is the firing chamber of an IC engine. NOx gases virtually eliminated because of the lower temperatures and atmospheric pressures in the combustion chamber. Carbon particulate matter is significantly reduced due to the long time the fuel spends in the combustion chamber and the cyclonic action of the chamber that spins particles to the outer wall until they are completely burned.

Applications for the Cyclone Mark VI, a 330 HP model currently in development, could include use as a mobile power plant for a Harrington Seed Destructor at harvest time or for any number of purpose-built farm vehicles such as custom spray rigs or mobile field bins.

The most compelling case for applying Cyclone engine technology in a farming system is its ‘all fuel’ capability and the opportunities for farmers to embrace energy independence over the next decade.

The simplest farm-based ‘biomass to energy’ technologies tend to produce fuels that are either lighter or heavier than are

FIGURE 2



ideal for use in traditional engines designed for gasoline or diesel fuels (Figure 2, below left).

We often hear about new breakthroughs in the production of liquid bio-fuels, but in most cases the fuels produced from these processes need to be cleaned, modified, blended or upgraded if they are going to be used successfully in traditional IC engines, whether in vehicles or machinery.

Fuel upgrading processes are generally quite expensive and the inability to readily use bio-fuels produced on farm as direct substitutes for gasoline and diesel has meant many conceptual biomass-to-fuel projects have not been viable. This is not because the bio-fuels produced aren't any good but because they have characteristics that differ from gasoline and typical diesel fuels.

IC engines have very specific fuel requirements based on features such as the stroke and rev range of the engine.

The amount of time a fuel takes to fully combust is relative to the size of the fuel molecule, which determines how quickly oxygen from the air can combine with the carbon in the fuel. As an analogy, one kilo of wood chips will burn more quickly than a one kilo log of the same wood simply because the air can infiltrate around the chips.

A really fast-burning fuel like hydrogen would be completely expended in a conventional IC engine well before the piston has traversed a long-stroke cylinder, resulting in a loss of power and stalling at low revs. On the other hand, a heavy oil in a short-stroke engine would not fully combust during the relatively fast engine cycle, resulting in poor energy efficiency and lots of smoky emissions.

Many biofuels such as methane and ethanol burn too quickly for use in a standard IC engine, whereas the bio-oils produced from algae, chemical, thermo or catalytic processes can be too slow to burn.

A farm pursuing energy self-sufficiency might produce a range of bioenergy fuels, such as quick-burning methane, from a piggery, and a slow-burning vegetable oil from canola, but it is not practical to have a different type of IC engine for every possible biofuel opportunity.

An engine with the flexibility to efficiently use a range of fuels without the need for any modification opens the window to simple, farm-based bio-fuel production or being able to buy the cheapest fuel available in the retail market at the time.

The Cyclone 'all-fuel' engine is such an engine (Figure 3, left).

Extensive due diligence has been performed on the Cyclone engine by Raytheon Integrated Defence Systems for use in long-range unmanned submarines and the Cyclone will be used in an attempt to set a new 'in class' 320 km/h land speed record at Cape Canaveral with two-time NHRA racing driving champion Nelson Hoyos at the wheel.

SANTFA will seek to test the Cyclone Mark V engine in Australian agricultural applications during 2013. Anyone interested should contact carbon@santfa.com.au

FIGURE 3: **THE CYCLONE MARK V IS A REVOLUTIONARY 21ST CENTURY STEAM ENGINE.**

Cyclone Mark V 'all-fuel engine' specifications	
Max power @ 3,600 rpm	100 HP (75kW)
Max torque @ 1 rpm	1050 Nm
Thermal efficiency	33% (including fuel combustor)
Dimensions	66 x 66 x 60 cm (incl. combustor and condenser)
Dry weight	57kg (142 kg incl. combustor and condenser)
Lubrication	Closed loop deionised water
Required BTU @ 75 kW (full)	835,000/hr (approx. 21 L/hr petrol)
Required BTU @ 22 kW (cruise)	250,500/hr (approx. 6.3 L/hr petrol)

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companies are preparing to commercialise farm-scale or mobile units for bio-energy production.

Generating heat for use at a feed mill or processing plant is the cheapest and easiest form of bioenergy to produce. Making electricity is more complicated and more costly in terms of capital and operating costs, but it is nevertheless achievable with current technology.

The problem with producing electricity on-farm is that unless there is significant demand at the site for the power generated, the economics do not always stack up because electricity is difficult to store or transport. Selling electricity into the grid as it is produced has not usually paid enough to justify the capital of an electric bio-energy plant.

In cropping, and many other farming systems, producing transportable liquid or gaseous fuels to offset fossil fuel costs appears the most useful biofuel option.

Gaseous and liquid fuels can be stored and transported, so can be marketed more easily than electricity, but with current technology are harder to make, especially from Second Generation feedstocks.

US company Cool Planet Biofuels, which is backed by some of the biggest companies in the world including British Petroleum (BP), General Electric (GE) and Google, is developing a community-scale second-generation liquid biofuel plant that is scheduled for commercial release within the next three years. The plant will have a capacity of 4.5 million litres of a fuel a year, with the payback period for the purchase price calculated to be only two to three years.

However, 'fuels ain't fuels'. Many liquid biofuels have combustion characteristics quite different from those of petrol or diesel and so are not well suited to use in conventional internal combustion engines.

This has prompted development of the Cyclone 'all-fuel' engine that will run efficiently on a range of fuels with quite different combustion characteristics.