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HEMP sea Trial, summary of results

	Conventional Diesel drive	Serial Hybrid
Propulsion	28hp, Marinised industrial diesel with shaft drive via a reduction gearbox	Serial hybrid using a 13hp industrial diesel generator and electric motor drive.
Max speed in calm conditions	6.9kts	6.6kts
Fuel consumption @ 2.5kts	4.5 Miles / Liter	9.2 Miles / Liter
Fuel consumption @ 3kts	4.2 Miles / Liter	7.3 Miles / Liter
Fuel consumption @ 5kts	2.1 Miles / Liter	3.4 Miles / Liter
Fuel consumption @ 6.0kts	1.5 Miles / Liter	2.55 Miles / Liter
Fuel consumption @ 6.6kts	1.35 Miles / Liter	1.35 Miles / Liter
Max speed, rough conditions (estimated)	5.7kts	3.5kts
Max shaft speed	1,800 RPM	1,000 RPM
Propeller size	14"/9"	18"/11"
Prop efficiency at 5kts	57.6%	61.5%

Table 6, sea trial results for a 32' moderate displacement auxiliary sailing craft

Comments on results

At a speed of 2.5kts the hybrid shows a massive 105% improvement in fuel consumption. This can be understood as follows. At 2.5kts Apple has the engine running at approximately 1,400RPM and it is consuming fuel at a measured rate of 0.53L/hour. If the gearbox is put into neutral and the engine allowed to idle, then the measured fuel consumption is 0.49L/h. So it can be seen that the vast majority of the fuel is being used to turn the engine over and most of the energy is being lost as heat. The Hybrid system generates and stores it's energy with the engine running at high load and high efficiency. Despite the extra transmission loss the hybrid is able to return this power to the propeller shaft with much higher efficiency than the standard system.

Characterization of engine fuel performance indicated the potential for a hybrid to double the M/L @ 5kts. The extra losses in the hybrid drive chain together with the increased propeller efficiency has resulted in a 62% increase in fuel economy. The conventional diesel could use higher gearing and a larger prop and this would narrow this gap.

Smooth water top speed performance is similar but rough water speed is much lower for the Hybrid. This is mainly due to the smaller engine plant employed .

The hybrid uses a much smaller engine than the conventional craft. It should therefore be expected that better fuel economy will be seen regardless of the technology used to get power from the crankshaft to the propeller. For a detailed analysis of how different technologies can be expected to effect the efficiency of identical engine plants then refer to report "Technology evaluation.PDF".

Conclusion.

The purpose of this research program is to investigate the feasibility of using Hybrid technology in small ocean going craft. Hybrids, under certain conditions, can offer improvements in fuel economy but this is not the only factor to consider in evaluating the technology. The average leisure yacht uses its engine for only 60 hours a year (BMF). Regardless of the fuel savings provided the economic or environmental benefits of the Hybrid will be very small for this market. It is the other advantages a hybrid can provide that will define it's market acceptance.

This program has developed a flexible serial hybrid drive train. Many unique methods have been employed. The system provides sophisticated control of power sources and this has resulted in a very usable system (Hawk,2005). The sea trials have taken this technology into it's intended environment and proven that Hybrid technology is a feasible option. Apart from giving sufficient power for propulsion , with good fuel economy, many other powerful features are provided.

The considerable amount of stored energy in the batteries can be used for more than propulsion. Powerful electric appliance can now be used in a craft usually considered too small for this luxury. Maud has a 3.5kW inverter driving an standard ring main circuit. On board you will find :

1. An electric kettle
2. A microwave oven
3. Computers.
4. A powerful ark-welder
5. The ability to drive any domestic appliance.

With the large battery bank then energy can be accumulated from solar panels and wind generators. In the next stage of the project a 200W solar array and two 400W wind generators will be installed. This is expected to provide approximately 3.5kWh a day of energy. This energy can be used for propelling the vessel for two hours at just below 5kts or for powering the appliances. In this way environmentally friendly resources can be allowed to drastically reduce the use of the engine. The hybrid is a technology that enables this to happen.

Taken as a whole hybrids have a great deal to offer. There are many Hybrid configurations and each one has it's own unique benefits for any individual application. In the next stage of this development the cost/ feature trade off of each possible implementation will be analyzed with the view to developing commercial products.