

LUBE-TECH

NO.27

DIESEL-ENGINE MOTORCYCLES

INTRODUCTION

On initial consideration, the use of diesel engines in motorcycles would not appear to be an ideal application for this type of power unit. Due to space and size limitations, typical motorcycle power units are relatively compact, light and with high specific power outputs, whereas in the past the use of diesel engines has been generally been confined to relatively large and heavy commercial applications, off-road equipment, railroad use and a variety of stationary applications where size, weight and specific power outputs are not primary considerations.

However, times change.

Current developments in diesel engine technology for automobile use have resulted in power units of unprecedented refinement and fuel efficiency. Their use has escalated markedly over the past few years and their popularity is increasing. The Society of Motor Manufacturers and Traders estimates that this year 28% of all cars sold in Britain will be diesel-powered; i.e. doubling their market share in just three years. Concerns over the health aspects of diesel emissions are being overcome, with Audi now confident that their diesel cars will meet the latest round of stringent EU emission legislation, Euro IV, which will become mandatory in 2005.

The use of diesel engines in motorcycles is also now receiving renewed attention due primarily to two main driving forces, i.e. military use and environmental considerations.

However, the design of motorcycle power units and transmission systems have been developed and refined to such an extent that since they now bear even less resemblance to their automotive counterparts, even requiring their own specialised lubricants. The 'tailoring' of a diesel engine expressly intended for motorcycle use has only recently received serious consideration. Two examples of the successful application of diesel engines in motorcycles are covered in more detail below.

HISTORICAL BACKGROUND

With a few exceptions, the application of diesel engines in motorcycles in the past has been confined to a number of one-off 'specials' constructed by enthusiasts.

For example, in the late forties, F.E. Sidney of Rottingdean, took a prewar Norton model 18 and designed a direct injection diesel single to power it. Although it was rumoured that the motorcycle manufacturer had active interest in the project, in reality it amounted to nothing but a single bike that ran on diesel, and apparently quite well.

Other one-off projects, both historical and current, include the following:-

In the U.S. Harold Benich, of Albion, Pa spent over two years and \$15,000 building a Harley-Davidson Fat Boy motorcycle from mail-order parts and an old diesel engine. It is believed to be the nation's first motorcycle to run entirely on soybean oil, according to the National Biodiesel Board in Jefferson City, Mo.

In France, another promising dieselling phenomena which however came to nothing was the Boccardo, powered by the engine of the Citroën Visa AX, the successor of the famed 2CV, mated to a Guzzi Gearbox; this being the brain child of designer Louis Boccardo.

In Germany, Jurgen Schuster built a mammoth 1000 cc turbocharged Cortenbach motorcycle. The engine, developing up to 45 bhp, runs equally well on jet-fuel or vegetable oil at a rate of 3.4 l/100km. Planned developments included machines developing between 60-90 bhp and consuming 2-2.5 l/100km if sufficient funds became available.

Brian Hickson built a motorcycle using a Kubota diesel engine and other parts donated from a Mini, a Toyota Corolla, Honda and Suzuki. The machine reached 87 km/hour and costs less than 1p/km on fuel to run.

However, a name that will always be associated with the first truly successful commercial application of diesel engines in motorcycles is that of Ernie Dorsett, now retired but formerly a maintenance engineer at the Dairy Crest Creamery near Telford, Shropshire. Always a motorcycle enthusiast, Ernie, a skilled engineer, became interested in the possible application of diesel engines for two-wheeled use. In the late 1970's he obtained a Petter AA1

engine from a concrete mixer and, as a spare-time project over a number of years, built this into a mixture of cycle parts, including a frame from an Ambassador, a primary chaincase and gearbox from a BSA C11G, Honda wheels and forks, a fuel tank from a Matchless and a seat from a BSA. The 211 cc engine developed 3.5 bhp at a governed 3600 rpm, and would cruise comfortably at 35-40 mph. He proved the viability of the machine by travelling from John o' Groats to Lands End in 1984 with one overnight stop in Telford, averaging some 120 mpg for the journey.

This was a remarkable achievement considering the basic limitations and general unsuitability of the power unit. However, the ensuing publicity attracted the interest of the importers of the Fuji diesel engine, who donated a 300 cc 'Robin' engine for Ernie to use as the basis for his next project. This engine he incorporated into a Matchless rolling chassis, and this machine was even more successful, embarking on a number of overseas tours including Finland, France and Germany.

The Fuji importers then provided a 412 cc DY41 engine which he again incorporated into running gear from a Matchless. This machine was even more successful achieving some 230 mpg under steady riding conditions. It would cruise comfortably at 55 mph with a maximum of some 65 mph which could be extended to 70 mph under favourable conditions, the engine being governed to 3600 rpm.



Contrary to initial concerns, the machine could be kick-started easily in spite of the high compression ration, due to the inertia stored in the heavy flywheel. The engine could be turned over the compression stroke by using a valve-lifter, and a conventional kick-starting technique spinning the heavy flywheels over the next compression stroke, would be sufficient to start the engine. This machine, which is still in existence, has now covered over 100,000 miles without the engine ever having received any attention apart from the usual routine maintenance. Four more of these machines were built to special order.

With the demise of the UK motorcycle industry, donor machines of basic design were becoming in short supply, so Ernie turned his attention to using Royal Enfield Bullet motorcycles which were being (and are still) manufactured in India and imported into the UK. Initially, complete motorcycles were used as donors, with the engines being sold off, but later an arrangement was made with the importers to supply Ernie with the motorcycle less engine, for subsequent conversion using the Robin diesel power unit. The demand outstripped Ernie's limited home-based production facilities, so manufacture was outsourced, although Ernie personally inspected all machines prior to sale. Some 125 machines were so produced, with 20 being exported to Japan! Eleven MZ motorcycles were also used as donors in addition to the Enfields.

One notable achievement by one of his diesel-powered Indian Enfield was an entry into the Guinness Book of Records, when the machine was ridden 24 hours a day for one week from 22-29 June 1995 by a team of riders, covering 3609.88 miles and averaging 201.08 mpg. It was considered that even this remarkable fuel economy could have been bettered if the riders involved had had more experience in riding diesel-powered machines.

By this time, electric starting had become standardised, but even then, it was possible to downsize the battery from the recommended 35 amp/hr to one of 14 amp/hr which was still more than sufficient for cold-starting purposes. Also, the US manufactured 'Comet' CVT transmission units were incorporated into later production.

With the increasing popularity of the use of motor scooters, it was particularly interesting that at one point Ernie fitted an East German 'Simpson' scooter with a 250 cc Robin engine. However, this machine was sent back to Germany and there has been no further news of its success or otherwise. This type of vehicle could well meet the needs of the commuter in congested areas and would also be extremely cheap to operate.

The last machine to be so modified was a

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Harris Matchless, where the petrol Rotax engine was exchanged for an Italian Ruggerini 650 cc twin-cylinder diesel engine. This last power unit was rather disappointing, however, and failed to live up to its expectations.

Now just turned 75 and retired, Ernie still makes extensive use of his diesel-powered AJ's, which he prefers to more modern bikes for extended touring purposes. At one time, a diesel-powered Enfield, the 'Taurus', featured in that company's model line-up, but were withdrawn from sale some time ago. These machines are now becoming increasingly sought after by enthusiasts. It would seem that with the recent revival of interest in these vehicles, a suitably updated version could now be introduced.

THE MILITARY MOTORCYCLE

Military motorcycles are used both on the battlefield and for road work, such as convoy escort, policing and courier duties. An 'all-round' on/off-road performance capability is therefore required, and these motorcycles have to date been powered by conventional gasoline engines. However, it is a requirement that all NATO armed forces now operate their entire inventory of vehicles and other powered equipment on power units fuelled by diesel fuel or aviation kerosene. This requirement is dictated both by the major logistic advantage in obviating the need to carry other fuels to battle, also the fact that the lower flammability of these fuels, in comparison to petrol, greatly reduces fire hazards.

In view of this new NATO single fuel regulation, Dr. Stuart Mcguigan and his team from the Royal Military college of Silverham of the Cranfield University, in association with the Defence Research Agency, developed a diesel two-wheeler for possible Army applications. Dr. Stuart's team took the bottom end and the gearbox of a Cheney Enfield Bullet, strengthened the casing, fitted a new crank, piston, con rod and a four valve head with indirect injection and fitted into an Eric Cheney-made trail frame. The end result was a 542 cc-engined motorcycle producing 16 bhp at the back wheel, expandable to 18 bhp, which was sufficient to achieve a top speed of 75 mph and possess acceleration comparable to many conventionally fuelled machines, together with the all-important off-road capability.

Whilst this particular machine did not meet all of the requirements set by the military, it did generate sufficient interest to investigate further the potential for such vehicles. A programme of work was subsequently undertaken by the Royal Military College of Science [RMCS], Shrivenham, and Hayes Diversified Technologies [HDT] to design and develop a diesel motorcycle for military use under contracts sponsored by the United States Marine Corps [USMC] and the UK Ministry of Defence. This machine was subsequently unveiled at the Defence Evaluation & Research Agency's test facility at Chertsey on 1 May 2001.

The engine design was founded on a technical feasibility and 'technology demonstrator' programme instigated by RMCS in 1992 (Ref: Design and Construction of a Diesel Powered 'Technology Demonstrator' Motorcycle; S J McGuigan, J M Crocker and A C Arnott, SAE Paper No 982051, presented at International Off-Highway and Powerplant Conference, Milwaukee, Sept 14-16 1998.). This programme established that current automotive diesel engine technology could, with some development, be employed at low technical risk to provide a viable power output from a naturally aspirated engine unit suitable for packaging in a motorcycle.

The aim was to produce a motorcycle engine having realistic power output and performance characteristics for the duties outlined above. This was achieved by utilising state-of-the-art high-speed automotive diesel engine technology in the design of a single cylinder engine.

To achieve the required performance, the objective was to produce the best possible torque without resorting to turbocharging, which was considered impracticable for this particular application, and to run at the highest practicable engine speed to maximise the power output. To this end, this engine uses four valves and an indirect-injection combustion chamber. Indirect injection gives lower peak cylinder pressures enabling lighter engine construction, less 'diesel knock' and reduced particulate emissions.

The demonstrator programme led to the current collaborative project by HDT

and RMCS to provide a production military diesel motorcycle, which was in fact based on the running gear of a Kawasaki KLR650 petrol-engined trail bike, a military variant of which is already supplied by HDT for service with the USMC. The petrol KLR650 has established an excellent reliability record with the marines; the diesel machine utilises the same basic 'rolling chassis'.

The HDT-RMCS engine is a liquid cooled, 584 cc single cylinder four stroke, currently producing some 18 kw (24 bhp). It is a double overhead camshaft design, with a four-valve cylinder head. A multi-cylinder engine was rejected as unnecessary, on grounds of increased weight and because diesel engines work less efficiently in small cylinder sizes.

Though the engine unit has been designed specifically for this application, some standard Kawasaki components have been incorporated, to keep overall production cost to a minimum and thus facilitate a realistic selling price. The clutch and gearbox are basically Kawasaki assemblies, with modified gear ratios to account for the power delivery characteristics of the diesel engine. All other major engine components have been designed expressly for the diesel power plant. An extremely robust built-up crankshaft with a plain big-end bearing is employed. A special fuel injection pump, developed by Unique Injection, enables the desired power and throttle response characteristics to be achieved. Instant throttle response is an essential feature for a cross-country motorcycle. Starting is by conventional motorcycle electric starter and 'unspillable' battery, with the aid of a decompressor during cranking. A glow plug is provided to facilitate cold starting. A push-start is possible as a reversionary mode.

The motorcycle's suitability for military service has been assessed by the British Armed Forces and US Marine Corps. A special version optimised for air-portable service is planned for the Joint Rapid Reaction Force, as well as further variants for the Royal Military Police.

Design and Development

As currently configured, the motorcycle has a top road speed in excess of 80 mile/hour, and general levels of performance and acceleration are comparable to a conventional 250 cc petrol-engined machine. However, the low speed torque of the diesel engine is outstanding. The need and desire for gearchanging are thus much reduced, which aids cross-country riding over difficult terrain and also greatly facilitates the training of military riders who are new to motorcycling. Even experienced riders use the gearbox much less than with petrol-engined bikes. When the diesel bike and a more powerful petrol-engined machine are ridden cross-country at speed by the most competent riders, the petrol machine struggles to maintain the pace of the diesel. In the most arduous conditions, the torque characteristics of the diesel engine enable speed to be maintained where the petrol-engined machine is slowed considerably.

Another important benefit of the diesel bike is improved fuel consumption. The extent of the advantage, compared to a petrol bike, depends greatly on conditions. However, typical overall consumption will be some 30% superior to a typical petrol-engined motorcycle of comparable performance. This enables a reduced fuel tank capacity for a given range, so that although the dry weight of the bike is a little greater than a petrol-engined equivalent, the all-up weight, including fuel, will be similar. It is designed to run on a hybrid military diesel fuel that will be used in all NATO military battlefield vehicles. It can be equipped with infra-red headlights, as well as withstanding extreme temperatures. The motorcycle (JP8) can be used for reconnaissance and courier services and to transport documents and supplies. It has an over-sized fuel tank, reinforced handlebars and dark (camouflage) colouring. A series of pre-production motorcycles were extensively trialled and evaluated by the USMC, and were favourably received. Reliability to date has been excellent. Further trials took place as the specification was further refined to full production build standard. Delivery of production motorcycles to the USMC for service, and conversion of current in-service petrol-engined bikes, commenced some time ago. Machines have recently been supplied for evaluation to the UK Ministry of Defence and interest has also been expressed by the defence procurement authorities of several other NATO countries.



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Commercial Potential

HDT and RMCS see great potential for similar diesel engines beyond the military motorcycle application. Possible commercial development and marketing opportunities include:-

Motorcycles for the Third World and Lightweight All-Terrain Vehicles (ATVs)

The use of light four-wheeled ATVs ('quad bikes') in agriculture, horticulture, forestry and prospecting is expanding rapidly in many countries. The HDT-RMCS motorcycle engine would be ideally suited to ATV applications and would enable users to employ a common fuel with tractors, other vehicles and implements, achieve much improved fuel economy and take advantage of tax-free agri-diesel fuel.

Lightweight, High Output Industrial Engines

The motorcycle power unit would also form an ideal basis for a light industrial diesel engine for powering pumps, generators and similar portable industrial equipment. Such a unit would offer a power-to-weight ratio around twice as good as current small industrial diesels. Development of the engine for this type of application is already under active consideration by HDT and RMCS.

Engines for Unmanned Aerial Vehicles and Light Aircraft

A twin or multi-cylinder diesel engine based on the design principles adopted for the motorcycle power unit would be attractive for small aero engines. Though heavier than the two-stroke petrol engines currently used in this field, the superior fuel consumption would reduce the fuel load for a given endurance. The high reliability of the diesel engine and absence of a high-tension electrical system would be additional advantages.

Specification of the Kawasaki-based Military Motorcycle

ENGINE:

Type: 4-Stroke, IDI, DIESEL, single cylinder, liquid cooled.

Displacement: 584 cm³

Power: 24 PS [18 kw] @ 4800 rev/min

Torque: 33lbft [45 Nm] @ 2500 rev/min

Lubrication: Wet sump, compatible with MIL-L-2104, MIL-L-46152 & MIL-L-46167 lubricants.

Air Filtration: High capacity, 3-stage, oiled foam, reusable

Transmission: 5-speed, constant mesh, return shift.

Final Drive: Self lubricated, sealed, O-ring roller chain.

CONTROLS & INSTRUMENTATION:

Handlebar & Controls: Heavy duty with integral hand and control guard.

Throttle: Dual cable with auto & manual return, water & dust resistant.

Cables: Nylon lined, water & dust resistant.

Speedometer: Calibrated in MPH & KPH with resettable odometer, illuminated.

Instruments: Engine coolant temperature gauge, neutral, high beam, and turn signal indicators.

ELECTRICAL:

Battery: 12 volt, 545 CCA "Dry Cell" unspillable, maintenance Free

Alternator: 14 amp, 14 volt, AC, Single Phase

Standard Lighting: DoT/CE approved lighting system.

Blackout Lighting: Driving, Marker & Tail/Stop lights meeting MIL-STD-1179. IR driving light optional.

CHASSIS:

Frame: Welded steel main frame loop with removable rear section.

Front Suspension: Telescopic forks, hydraulically damped & sealed with non-reflective boots.

Rear Suspension: Swing arm with single shock Uni-Trak® multi-link system, sealed needle bearings at all pivot points.

Engine Guards: Skid plate with tubular engine & radiator guard.

Foot Rests: All metal, safety folding, spring return.

Fuel Tank: 3.8 US gal [3 Imp gal] capacity. Molded plastic, translucent - indicating fuel level.

Wheels: Heavy duty, wire spoked with high tensile alloy rims.

Tires: MT 21 Pirelli, Dual-Purpose (on/off-road) tires, DoT approved.

Brakes: Front, hydraulic disc. Rear, hydraulic disc.

Plastics: Headlamp cowl Air filter box Fenders Seat base Side panels Chain guards.

Tools: Full operator tool kit.

Equipment Rack: Heavy duty rear equipment rack, 50 lb [22.5 kg] capacity standard.

Equipment Case: Rear mounted, hard side equipment cases (panniers) & personal weapon scabbard optional.

WEIGHTS & MEASUREMENTS:

Dry Weight: 369 lb [167 kg]

Overall Width: 35.75 inches [908 mm]

Overall Length: 85 inches [2160 mm]

Wheel Base: 57 inches [1448 mm]

Ground Clearance: 10.7 inches [272 mm]

FUEL: DIESEL/AVIATION KEROSENE (JP8/AVTUR; JP5/AVCAT)

PERFORMANCE:

Acceleration: 0-30 mile/hr [48 km/hr]: 3.6 sec

0-60 mile/hr [97 km/hr]: 10.4 sec

Gradeability: 60% (31°)

Turning Radius: Less than 7 ft [2.1 m]

Maximum Speed: In excess of 80 mile/hr [130 km/hr]

Minimum Constant Speed: Less than 3 mile/hr [4.8 km/hr]

Forcing Depth: 24 inches [610 mm]

Fuel Consumption: 110 mile/US gal [140 mile/Imp gal, 50 km/l] @ 55 mile/hr [88km/hr]

Range: 400 miles [650 km] @ 55 mile/hr [88km/hr]

THE 'ECOLOGICAL' MOTORCYCLE

The commercialisation of cars with 'hybrid' power units incorporating both gasoline and electrical motors is already established, and these vehicles routinely achieve fuel utilisation efficiencies superior to those of conventionally-powered vehicles. The Toyota 'Prius' is currently available at £15,400 after deduction of the £1,000 Powershift grant, and the Honda Civic IMA will be available from May, superseding the present Insight.

The concept has not as yet been extended to motorcycle application; however, the situation is now changing since an American company, 'eCycle', is developing a 180 mpg motorcycle employing state-of-the-art mechanical and electrical design technology. The company was founded in 1995 and has been pursuing the development electric and hybrid electric technology for application in small motorcycles.

They have created a very efficient PM motor, a novel and innovative power conversion technology, and are now working with Yanmar Diesel Engine Company to produce a hybrid diesel/electric motorcycle. The motorcycle features a 219cc direct injected, multifuel engine (petrodiesel, biodiesel, kerosene) and an 8kW brushless motor drive. The weight is 230lbs, with a top speed of 80mph and acceleration of 0-60 mph in 6 seconds. It is intended to introduce this hybrid motorcycle sometime later this year.

The reasoning behind the venture is already well established in that vehicles for personal transportation generally spend more time cruising than they do accelerating. The enabling benefit of a parallel hybrid powertrain, such as that used by eCycle, is the separation of the vehicle requirements for acceleration and for constant speed, steady-state travel ("cruising"), and the subsequent separation of the energy storage requirements for acceleration vs. cruising. Since electric motors can deliver maximum torque at zero rpm they are ideally suited to accelerating a vehicle. However, the range of a fully electric vehicle is controlled by the need for practical, economical electricity storage. Internal combustion engines that are sized for both acceleration and average power loads (as are the engines in conventional motorcycles and automobiles) are too large and inefficient when providing just the average power required for steady-state cruising. They consume more fuel and create more pollution than an engine sized only for the average load. These vehicles benefit from a large range of travel that is only limited by the amount of fuel that can be carried.

Either type of power source (a motor or an engine) when used alone has inherent limitations and problems to overcome, but when combined into a single system the two technologies are complementary and these limitations and problems are eliminated. The eCycle powertrain provides maximum efficiency while supplying power for the average load. Acceleration of the motorcycle is handled by the electric

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motor. The resulting hybrid powertrain creates a low-polluting, high efficiency vehicle with performance, handling and range of travel that are superior to conventional vehicles. Designed along these principles, the eCycle hybrid motorcycle functions in the following manner:

To accelerate from a standstill, the control system senses the throttle input and then delivers torque to the electric motor. This causes the vehicle to begin moving forward and also causes the engine to begin spinning. At low speeds, no fuel is delivered to the engine, so the engine does not yet provide any power.

At approximately 12mph, or an equivalent engine speed of 1500rpm, the vehicle control system directs the fuel injection to begin spraying fuel into the engine. The motorcycle then receives torque input from both the diesel engine and the electric motor.

Once up to cruising speed, the electric motor no longer provides torque to the vehicle. Instead, since it is spinning in conjunction with the engine, the electric motor is used to very efficiently generate electricity to recharge the battery pack.

While cruising at a steady speed, if the control system senses more throttle input (for further acceleration to a higher speed), the electronics will re-engage power delivery to the electric motor. The torque added by the electric motor accelerates the vehicle. Once the desired speed is achieved, the electronics re-adjust and re-commence charging the battery.

The fully electronic power management of the eCycle allows the engine and electric motor to integrate seamlessly with each other. Only the sound of the engine starting and stopping (above/below 12mph) gives the rider any indication of the complex process that is taking place.

Front Suspension: 1.75" (44mm) Inverted Fork 7.5" (190mm) Travel
Rear Suspension: Penske Racing Coil-Over Mono-Shock, Ride-Height Adjuster 5" (127mm) Travel
Front Brake: Grimeca Single Four-Piston Caliper 12.6" (320 mm) Disc
Rear Brake: Single One-Piston Floating Wave Rotor 8.5" (215.9mm) Disc
Front Wheel: Grimeca 17 x 2.75" Aluminum
Rear Wheel: Grimeca 17 x 2.75" Aluminum
Front Tyre: Pirelli MT75, 110/70-17
Rear Tyre: Pirelli MT75, 130/70-17
Rake/Trail: 24.0 Deg./3.9" (98.3mm) Wheelbase: 52.0" (1321mm) Seat Height: 28.0" (711mm) Weight: 230lbs. (105kg)
The eCycle chassis is specifically suited to a hybrid propulsion system. It is made of steel and aluminum to minimize weight and to provide heat sinking for the battery pack and electronic components. The small engine fits easily within the confines of the frame. The battery pack is located low in the chassis to provide exceptional handling. The electric motor and driveline are engineered along the lines of a modern racing car - carrying loads and integrating as many functions as possible into the fewest number of components.

The tube frame used to carry the front fork and the battery pack is made of steel and joined by brazing and welding. The frame design was refined using FEA (finite element analysis). Zinc treated for corrosion resistance and powder-coated for durability, the frame is light, strong and tough.

The tube frame integrates with an aluminium box-section sub-frame that carries the rear suspension and driveline. The two main load-bearing members of the sub-frame assembly also perform other functions vital to the motorcycle - one side doubles as the main heat sink while the other side houses the transmission and picks up the rear suspension.

The front suspension is an inverted fork made by FAR. The rear suspension is a single sided swing arm with a built-in caliper and a coil-over Penske mono-shock.

Styling

The bodywork is a combination of parts specially designed and/or modified to suit the eCycle. The side panels are made of colour impregnated, thermoformed ABS plastic.

The lamps employed for the tail/brake light and turn signals are high flux density type LEDs (light emitting diodes). LEDs illuminate quicker, last much longer than a conventional light bulb (over 100,000 hours) and draw about 1/5 the average current of an incandescent bulb. It is attention to details such as this that make the eCycle a most efficient motorcycle.

Powertrain - Engine
While the 125cc rocker crank engine is still undergoing development, the Yanmar engine is being used, admittedly in modified form. This 219 cc, single cylinder, direct- injected, 4-stroke diesel engine provides high torque and

efficiency. It exceeded initial expected performance requirements as well as being very durable and readily serviceable.

Transmission

The eCycle transmission is a 2-speed, constant mesh, 3-shaft design utilizing ball and needle bearing construction with custom rolled gears. Low gear features an over-running clutch for smooth shifting and safety. The transmission drives the rear wheel via a Gates Polychain II belt.

Battery Pack

The hybrid battery pack utilizes ten 12V 5.0Ah sealed lead acid batteries. They are series connected to yield 120VDC nominal voltage. The total weight of the battery pack is only 44lbs.

Motor

The eCycle hybrid motorcycle uses the eCycle model MG24 motor with a special housing in its drivetrain. This is a 3-phase, permanent magnet, brushless motor rated at 5kw continuous and 15kw peak power. In the hybrid motorcycle, the motor sees up to 120VDC with a peak current of 70 Amps.

Vehicle Electronics

At the heart of the eCycle is the programmable controller. The controller serves as the comprehensive management system for all of the vehicle subsystems. Among the functions controlled are: throttle input from the rider; power electronics, which is delivery of electricity to the motor for power and from the motor (generator) for regeneration; regulation of the compression release mechanism and control of the electronic dashboard display.

Target Performance Specifications

Fuel Consumption: 180mpg Est. top speed: 80mph 0-60mph: 6.0sec
Weight: 230lb.

SUMMARY

The imposition of congestion charges in London, and their possible extension to a number of other cities and congestion blackspots, is already encouraging the increased use of two-wheeled transport, such vehicles being currently exempt from such charges. Even if charges are subsequently imposed on two-wheeled vehicles, there is no denying the fact that two-wheelers are an advantage in congested traffic situations, and in any case, are unlikely to attract the same level of congestion charges as cars. Increased parking facilities for two-wheeled vehicles within the charge area need to be addressed rapidly, however.

The increasing importance of environmental considerations places more and more emphasis on fuel utilisation efficiency. In the developed countries, sophisticated designs such as the eCycle could produce the ultimate in combining performance with economy. In less developed countries where motorcycles are widely used as essential means of every-day transport, the improved fuel economy of a more basic design of diesel bike such as the Royal Enfield Taurus would bring major economic advantages and conserve scarce fuel resources. Such engines could also be run on kerosene or bio-diesel, if required.

Military requirements have generated a whole new interest in the use of diesel-powered motorcycles, since the conveyance and storage of gasoline is a potential military hazard. Up until the development of the diesel-powered motorcycle, all other military vehicles apart from motorcycles were powered by conventional diesel engines or by gas turbines operating on low-flammable fuel. The development of a satisfactory diesel-powered military motorcycle thus became a priority.

Due to the differences in powertrain design between current 2-wheeled and 4-wheeled vehicles, there are significant differences in the lubrication requirements of the two types of vehicles; this topic has been covered extensively in previous issues of 'Lube'. A number of lubricant suppliers already specialise in meeting the requirements of current 2 and 4 stroke motorcycle engines; it could well be the case that in the not too distant future, bespoke lubricants could also be required to meet the specific needs of diesel-powered 2-wheelers.

David Margaroni