Radiator fans going electric

Prototype of a re-designed fan assembly.

'Within 5 years nearly every new car on the road will have an electrically driven radiator fan', says Mr Martin Welsh of the CSIRO Division of Energy Technology.

Times change. At present such fans are mainly sold as bolt-on kits for the automotive enthusiast who wants to save petrol or promote his car's performance.

They cost more than the simple belt-driven fans they replace, but car-manufacturers are now responding to demands from their customers for higher fuel economy. In urban driving, fuel economy can be improved by as much as 15% by their use, according to a study by the Department of Mechanical Engineering at the University of Melbourne.

A major Australian car-manufacturer is presently evaluating a CSIRO-designed electric radiator fan on one of its passenger car models. It was designed by Mr Welsh and his colleague Mr Colin Chan, using special computerized test equipment available at the Division of Energy Technology. Davies, Craig Pty Ltd, manufacturers of electric radiator fans, sponsored the research.

Many factors must be taken into account in designing an efficient fan — number of blades, its diameter, blade profile, rotational speed, fan pressure and flow rate, and so on — and optimizing them is not easy. Some commercial units Mr Welsh and Mr Chan tested showed a fan efficiency of only 20% (this means that only one-fifth of the power applied to the fan blades was available to provide cooling air for the radiator). The researchers produced a fan design that consistently allows fan efficiencies of 60% — close to the theoretical maximum — to be achieved.

Reducing the energy required to operate the cooling fan is achieved by increasing its efficiency and by switching it off when adequate cooling is obtained from natural air flow. With belt-driven fans it is difficult to incorporate these features without the inclusion of complicated mechanisms.

In contrast, an electric fan switches on only when a thermostat indicates that extra cooling is needed and, since it operates at approximately constant speed, the fan is always operating near maximum efficiency. These features are the main source of its fuel-saving ability.

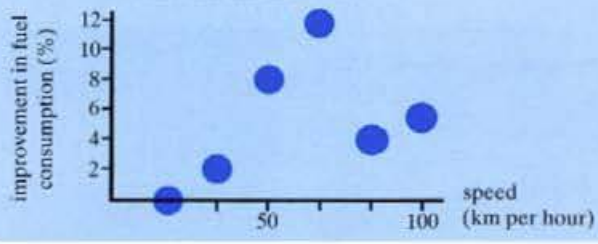
The CSIRO-designed fan has found favour from a number of quarters. A local car-manufacturer was impressed by the way it performed in a test in Death Valley, Arizona. The fan — complete with prototype car — was flown there for summer tests during our winter. It passed all the required engineering tests.

One big car-manufacturer in the United States is already using a fan developed by Davies, Craig in conjunction with CSIRO in its 1985 models. A Canadian supplier of fan assemblies has asked CSIRO (through Davies, Craig) to improve the design of another of its current production fans. In the latter case, the scientists were able to create 8% more air flow using the same size motor. Noise was also reduced.

The most important aspect of this CSIRO–industry collaborative project is the establishment of fan design procedures and design data using the latest technology. It has enabled Davies, Craig Pty Ltd to design fans for other applications such as air-conditioning as well as for automotive applications.

Andrew Bell

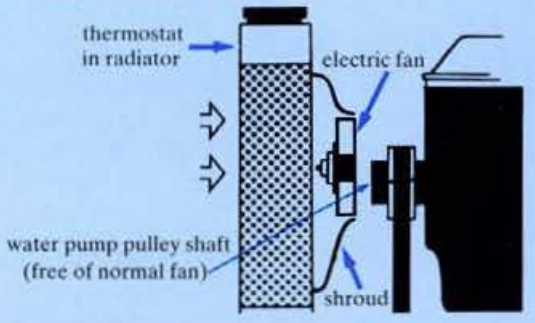
How an electric fan can save fuel



Melbourne University engineers tested a Falcon XB station wagon with and without an electric fan and obtained these fuel savings with the electric fan installed.

The electric fan, thermostatically controlled, replaces the fan that would otherwise operate continuously on the water pump pulley shaft.

Where an electric fan fits



What comes out of car exhausts?

Over the last 30 years, Sydney's population has increased by about 60%; during the same period, its car population has increased by 500%. One impact of the

Looking like a cloud-hidden Oz — Sydney's skyline sitting in haze.

burgeoning vehicle fleet is a familiar set of air pollution problems — airborne lead, carbon monoxide, photochemical smog, and fine suspended airborne particles.

At the moment, motor vehicle emissions in Sydney contribute nearly all the lead in the atmosphere, nearly all the carbon monoxide (650 000 tonnes a year), almost half the non-methane hydrocarbons (80 000 tonnes a year), about three-quarters of the oxides of nitrogen (which can react with hydrocarbons in the atmosphere to form photochemical smog), about one-fifth of the particulate matter (especially the fine particles responsible for Sydney's 'brown haze'), and much of the smell, fumes, and griminess of the metropolitan area.

In 1972, recognizing Sydney's growing pollution problem, the State government amended the *Clean Air Act* and introduced a motor-vehicle emission-control program. This is managed by the State Pollution Control Commission.

For its air-pollution control program to be successful, the Commission needs to know the contributions made by each of the major sources. Studies by CSIRO have suggested that motor-vehicle emissions are responsible for up to 30% (half of this from diesel-powered vehicles) of visibility degradation in the Sydney metropolitan area, while incineration, including backyard burning, is responsible for a further 30–40%.

To assess more accurately the contribution of motor vehicles to urban haze, CSIRO, in collaboration with the Australian Institute of Petroleum's Environmental Conservation Executive, recently undertook a preliminary study of exhaust emissions from a representative range of diesel and petrol-fuelled vehicles. Mr John Milne, Mr Doug Roberts, and Mr David Williams, of CSIRO's Division of Fossil Fuels, together with Mr Mike Kimberlee from Emtech Associates in Sydney, have so far tested the exhaust output of 10 diesel and 11 petrol-fuelled vehicles.

The cars and small commercial vehicles came from rental agencies, commercial and government organizations, and 'the man in the street'. The researchers tested them at the Commonwealth Department of Transport's vehicle-emission testing facility at Zetland, Sydney. For the tests they used a chassis dynamometer — a sort of exercise bike for cars. The cars, sitting on rollers, were driven to match a standard urban driving pattern, 'covering' a total run of 12 km over 20 minutes.

The dynamometer coupled to a test car.

A sampling duct attached to the exhaust was modified to allow very large particles, such as rust, to settle out and to allow enough time for the rest of the particulate matter, initially emitted as very fine particles, to join and build up to diameters of 0·1 to 1 μm. This is the main size range of particles from vehicle exhausts found in the atmosphere. It also happens to be the size range that has the greatest effect on visibility, as it corresponds to the wavelengths of visible light.

The researchers ran the cars from both hot and cold starts. On average, the diesel vehicles emitted 3·54 g of particulate matter per kilogram of fuel consumed, more than five times the amount emitted by the petrol-fuelled cars.

The diesel figures are comparable with results from similar studies elsewhere; but the emissions from petrol-fuelled cars were considerably higher than previous studies overseas had indicated. Mr Williams suggested that the extra emission may be from sump oil rather than fuel, a possibility that the researchers are investigating further.

The tests also revealed that the petrol-fuelled vehicles expelled more exhaust particulate matter as they aged, but diesel vehicles showed no such trend.

For both petrol and diesel vehicles, less than 5% of the exhaust particles measured more than 20 μm in size. In fact, more than 90% of emissions from both types of vehicles measured less than 1 μm, all of this contributing directly to urban haze.

The researchers plan to use labelled carbon-13 oil to gauge the possible contribution to brown haze by lubricating oil. They also plan to look at other factors such as the influence of differences in petrol composition — for example, does the aromaticity of the fuel affect the emissions? The tests will be extended to heavy trucks and other vehicles.

Even though almost all heavy vehicles are diesel-powered and so emit much higher levels of particles than the equivalent petrol vehicles, cars outnumber them and (based on the results to date) account for about three-quarters of the total emissions. However, tests of heavy-duty diesel vehicles have yet to be performed.

Mary Lou Considine

Particulate emissions from motor vehicles. J.W. Milne, D.B. Roberts, D.J. Williams, and M.C. Kimberlee. *Papers, 8th International Clean Air Conference, Melbourne, December 1983.*

'Pollution Control in New South Wales: a Progress Report.' (State Pollution Control Commission: Sydney 1983.)