Vernal pools are seasonal wetlands, collecting water in the winter rainy season and drying out during the summer drought which is typical of Mediterranean climates. They may be particularly susceptible to high concentrations of TFA, if those concentrations occur.

stantial. The volume of saline lake water alone, 104,000 km^3, is almost as great as the volume of the world's fresh waters, 125,000 km^3. Arid land wetlands are also unique biogeographically, typically functioning as habitat islands in a sea of land. These wetlands are consequently often refuges for remnant endemic species, such as desert pup fish, fairy shrimp or rare plants, and a variety of other, often ecologically vulnerable, species.

Enhancement of solute concentrations is not limited to surface wetlands alone. Shallow groundwater in arid regions may also be solute-enhanced by evaporation. Evaporative concentration factors as high as 170-fold have been measured for perched groundwater in the Imperial Valley of southern California[7].

The effects of TFA on the Earth's biota, if any occur, are likely to be first observed in plants. TFA is highly mobile in xylem tissue and has been demonstrated to bioaccumulate by at least a factor of 30 in vascular plants[8]. In late 1993 and early 1994, TFA was detected in the atmosphere near Tübingen, Germany (at parts-per-trillion concentrations) and in spruce needles in Sweden (at parts-per-billion concentrations)[9]. The source of current environmental TFA is thought to be the atmospheric degradation of the anaesthetic halothane, a compound with comparatively minor annual emissions. Given the high ratio of rooted vascular plant biomass to water volume in the vernal pools of southern California, their proximity to the Los Angeles Basin airshed and the arid climate of this region, it seems possible that plants in these wetlands might ultimately accumulate TFA to concentrations in the parts-per-million range.

As of now, we have no idea what tissue concentrations in plants are harmful. Future areas of research, in my view, must focus on the potential of TFA to accumulate to toxic levels in the Earth's most susceptible wetlands and vegetation. Tissue toxicity levels and bioaccumulation factors for TFA in a wide variety of species must continue to be pursued. More information is also needed on the robustness of degradation pathways in different wetland settings. Sufficiently sensitive analytical methods should be developed and published, making it easier for investigators worldwide to track current concentrations of TFA in the environment, while concentrations remain toxicologically insignificant.

Clearly a transition away from CFCs must be made. As sometimes happens, however, the solution to one problem is not without unintended risks. TFA is likely to be an extremely persistent and globally distributed compound — but will it be universally benign when produced and released in kilotonne quantities? □

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1. Parson, E. A. & Greene, O. *Environment* **37**, 16–43 (1995).
2. Tromp, T. K., Ko, M. K. W., Rodríguez, J. M. & Sze, N. D. *Nature* **376**, 327–330 (1995).
3. McCulloch, A. *Envir. Monit. Assmt* **31**, 167–174 (1994).
4. United Nations Environment Programme *Environmental Effects of Ozone Depletion: 1994 Assessment* (UNEP, Nairobi, November 1994).
5. Visscher, P. T., Culbertson, C. W. & Oremland, R. S. *Nature* **369**, 729–731 (1994).
6. Sefchick, J., Skorupa, J. & Schwarzbach, S. *AFEAS Rep. No. CTR91-18.16* (1994).
7. Saiki, M. K. *Water Air Soil Pollut.* **52**, 41–56 (1990).
8. Thompson, R., Stewart, K. M. & Gillings, E. *AFEAS Rep. No. SP91-18.8* (1994).
9. Frank, H. *AFEAS Workshop Environmental Fate of Trifluoroacetic Acid* (Miami Beach, 3–4 March, 1994).

DAEDALUS

Washing the car

THE exhaust fumes from internal-combustion engines are increasingly resented, especially in cities. Yet they seem unavoidable. A flame in a closed cylinder is inevitably quenched on the cold surfaces, giving incomplete combustion. Daedalus now has a new approach.

Imagine, he says, a porous engine, in which air is pumped continuously into the cylinders through their porous walls. The flame would be swept back, and would never touch the cylinder walls; internal combustion would go completely to carbon dioxide and steam. The major problem is lubrication. Oil on the metal surfaces would block the pores, and act as a cold quenching surface for the flame. At first Daedalus hoped that the air itself would serve as a lubricant. Air bearings, in which compressed air emerges from many small holes in one surface, are widely used in ruling engines and low-friction mechanisms. But air is too compressible, and has too low a viscosity, to lubricate the violently and intermittently loaded bearing surfaces of a car engine. Very high pressures would be needed to stop the surfaces from touching; the resulting air flow would exceed the exhaust capacity of the engine.

So Daedalus will lubricate his porous engine not with air, but with a safely incompressible liquid: water. While being pumped through the pores of the hot structure, the water will boil. The bearings of the engine will be splendidly lubricated by boiling, expanding, steam-pressurized water, and its cylinder walls will exude steam. As well as keeping the flame away from these surfaces, the steam will 'crack' any incompletely reacted fuel to carbon monoxide and hydrogen, which will burn to completion. The expanding steam may even usefully augment the power of the engine, in effect capturing some of its waste heat.

Daedalus will make the porous bearing surfaces of his engine, not of metal, but of advanced ceramics. Ceramics resist thermal shock; many of them are inherently porous, and ceramic, uncooled 'adiabatic' diesel engines have already been tested for military use. Daedalus's water-cooled engine will be a far less demanding application.

The new engine should give motoring a welcome ecological respectability. Its clean exhaust, freedom from dirty polluting oil and lack of a radiator to boil, freeze or leak, should fully compensate for the need to fill up with water as well as fuel at every stop. It will also give journalists the chance to air once more that old canard of 'a car which runs on water'.

David Jones