Better mixing for better roads

Road-building and maintenance are not environmentally friendly activities — just spend a day with a road crew amid the dust, noise and unpleasant chemicals. In some areas, bituminised roads add to air pollution. Asphalt is commonly thinned with kerosene or petrol distillate solvents that evaporate as a road surface is sealed or repaired, contributing to the formation of photochemical smog.

A recent study by the Victorian Environment Protection Authority estimates that bitumen use in the Melbourne and Geelong regions contributes 540 tonnes of volatile organic compounds (VOC) a year to the urban atmosphere. The pollutants emitted are especially high in summer, when bitumen use in Melbourne can be a greater source of daily VOC emissions than its six major airports.

Road-repairing is costly work too. The Victorian authority, Vic Roads, spends $100 million annually on the maintenance of main roads, freeways and highways, while the national maintenance bill for main roads approaches $500 million a year. Now, thanks to a small research project by CSIRO and Vic Roads, it's possible to make them last a little longer, saving money and bitumen and cutting the consumption of a potentially polluting chemical.

Making a bituminised road last depends heavily on ensuring good adhesion between bitumen and gravel during construction. To get the best adhesion, road crews typically coat the gravel with diesel fuel oil in a rotating drum. The coating process consumes a lot of fuel oil — one crew may use 3000 litres a day — and it does not always work well, resulting in dry or oily patches in the road. Dry patches suffer poor adhesion causing the road surface to crumble. Where oily patches occur, the bitumen bleeds into the surface, making the road slippery.

Vic Roads sought the advice of CSIRO's Division of Mineral and Process Engineering in improving the coating process. The research team, led by Dr John Hall, examined the operation of the rotating drum, known as an aggregate loader, which uses a spiral screw to lift gravel from the roadside into waiting trucks. The fuel oil is sprayed onto the gravel from nozzles near the top of the drum.

A series of tests established that the fuel oil did not mix efficiently with the aggregate because the gravel layer nearest the drum wall was not exposed and remained dry. As the drum turned, the material appeared to slide down as if in a chute, with very little tumbling over or cascading. On the other hand, the gravel on top usually received too much oil.

In order to get more efficient mixing, the researchers built an experimental loader with a series of plates and bars, set at varying angles inside the drum, to lift the gravel as they rotated and facilitate cascading. As a result, says Mr Dennis Siroky, a Vic Roads engineer, it is not only coating the aggregate more evenly, but uses less oil to do the job. The improvement in the operation, he says, has been outstanding. Since the completion of the experiments, Vic Roads has incorporated the changes into one of its aggregate loaders and is modifying two others.

Illustration: Brian Gosnell

Tales from the warm pool

El Niño events are today among the best-studied climatic phenomena, and with good reason. These complex events, signalled by an abnormal warming of the sea surface on the eastern edge of the South Pacific Ocean, are able to influence weather conditions over much of the Southern and parts of the Northern Hemisphere, causing droughts in Australia and India, and severe storms in the United States.

Yet despite the high level of scientific scrutiny, El Niño events remain hard to predict and even harder to assess in terms of their likely impact on agriculture, fisheries and people living in cyclone-prone areas. The limitations in predictability stem from a variety of causes, but the chief problem is the lack of weather reports from the oceans. Until the relatively recent advent of meteorological satellites, almost all of what we knew about the weather out there came from passing ships. Even with the satellites we have today, scientists could fill an enormous black box with what they don't know about how events below the sea surface affect climate. In particular, researchers hoping to provide useful information on possible climate change are struggling to separate real change from fluctuations in climatic conditions due to air–ocean interactions that occur over a period of years.

All this is set to change, thanks to a $42 million meteorological experiment planned for late 1992 in the western Pacific Ocean. Here, between Papua-New Guinea in the west and Nauru in the east, and 10° north and south of the Equator, is the world's largest pool of warm water. Variations in the way this pool exchanges heat energy with the atmosphere appear to affect climate throughout the Pacific and beyond.

The Coupled Ocean–Atmosphere Response Experiment (COARE), which includes a 4-month period of intensive observations starting in November, is aimed at gathering an unprecedented amount of data on ocean mixing near the centre of the pool and the water's interaction with the atmosphere. The Experiment involves the use of nearly 20 ships and aircraft, 700 scientists and support personnel from 15 countries, weather satellites and hundreds of moored buoys, weather balloons and other sensing devices.

Australia is contributing two upper-air weather stations (one in eastern Papua-New Guinea, the other in the Solomon Islands), meteorological data from northern Australia, data analysis, and oceanographic measurements taken from the air and the CSIRO research vessel, *Franklin*. Agencies taking part include the Bureau of Meteorology, the CSIRO Divisions of Oceanography and Atmospheric Research, the CSIRO Centre for Environmental Mechanics, four Australian universities and the Australian Institute of Marine Science.

Forming part of a research program on tropical climate funded by the United Nations, the World Meteorological Organisation and the International Council of Scientific Unions, COARE will continue until the middle of 1993.