

Pollution scenario in 2050

Back in 2050, the planet was not doing so badly. The ozone layer was healing fast after the last rogue CFC factories in Asia had been shut down. And global warming had been moderated by planting a global network of "sink" forests to soak up carbon dioxide. The world population crisis had failed to materialise as Asians adopted Western family planning habits.

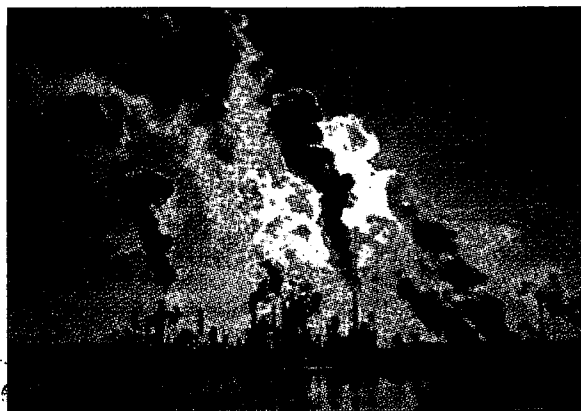
True, Asians had also adopted Western car-driving habits and smogs were spreading steadily across the northern hemisphere in the warm greenhouse air. But that had been predicted for so long that nobody paid much attention.

The watchword was wealth. On Indian highways, buffaloes had given way to sports utility vehicles. Indeed, with a third generation of the Bush family occupying the White House - after the 16-year hegemony of George W. and his brother Jeb - by 2050 the whole world was beginning to look and feel like Texas.

And then it hit. The environmental Armageddon nobody had expected. As Bob Zimmerman, the meteorologist who raised the alarm, remarked: "The little molecules that have cleaned pollution out of the atmosphere since before there was pollution - the planetary janitors with mop and detergent - never showed up for work."

The story came first from Oregon, where for decades Zimmerman and his colleagues had been sniffing the Pacific air looking for new compounds infecting the atmosphere. But this time it was what didn't show up that worried them. The hydroxyl radicals, highly reactive molecules which oxidise most common pollutants, had gone missing.

As every season passed, the air crossing the Pacific to Oregon contained less and less hydroxyl and more and more pollution. "Without the hydroxyl, there is nothing in the air to clean up the effluent from the factories and vehicle exhaust pipes of Asia," said Zimmerman. Hydroxyl is the atmosphere's detergent. It oxidises pollutants, making them soluble in water so that they wash away in the rain. And it was disappearing. Right across the northern hemisphere smogs were worsening by the month. Human civilisation was being en-



gulfed in its undigested pollution.

Hydroxyl

Before 2050, few people outside a small band of atmospheric chemists had even heard of hydroxyl. But suddenly the obscure molecule was on everyone's lips. At first, the new President Bush had a little trouble getting his tongue around the word.

"Hydra...hydractyl...hydraulic...?" he had stuttered. But as the smogs festered, he asked the big question: "Where the hell has this hydroxee stuff got to anyway?"

The scientists didn't have an immediate answer. They were panicking because, like the discovery of the ozone hole back in the 1980s, none of them had predicted what became known as the "hydroxyl holocaust".

Researchers had predicted that air pollution would become more and more prevalent. In 2001, the UN's Intergovernmental Panel on Climate Change had warned that methane emissions could soar by 50 per cent in half a century, and that the concentration of smog chemicals, such as carbon monoxide, nitrogen oxides and ozone, could double or triple. As it turns out, they were right on target.

They had also forecast a 20 per cent decline in hydroxyl levels by the year 2100, because of the heavy demands being made on the atmosphere's limited supply of oxidising chemicals by the mounting tide of pollution. The IPCC report even briefly considered "the possibility that future emissions might overwhelm the oxidative capacity of the troposphere". But that was just one sentence in a thousand-page report. Few people read it.

In any case, the feared decline didn't materialise then. If anything, hydroxyl levels seemed to be going up at the end of the 20th century, flushing away pollut-

ants in double-quick time. Hydroxyl radicals are mostly consumed by methane, carbon dioxide and nitrogen oxides - which are themselves destroyed in the encounter. Thanks to that extra whiff of hydroxyl, methane's typical lifetime in the air went down from 12 years to 10. And the concentration of the main pollutant that gobbles up hydroxyl - carbon monoxide - fell by more than a fifth in the US between the late 1980s and mid-1990s. Scientists briefly marvelled at this "breath of fresh air", without ever properly explaining it. By 2050, of course, their successors were angry at this missed opportunity to understand hydroxyl chemistry.

Some hope

New Scientist magazine published a whimsical doomsday scenario based around the hydroxyl holocaust in a supplement in April 2001. Madronich had told the magazine that "under high pollution, the chemistry of the atmosphere becomes chaotic and extremely unpredictable." There was growing evidence, he said, that many urban areas were already sufficiently polluted for hydroxyl levels to be locally suppressed. And he gave a stark warning: "If, in future, large parts of the atmosphere are as polluted as cities like Athens and Mexico City today, then we could anticipate the collapse of hydroxyl on a global scale."

Confusing

In more polluted areas, nitrogen oxides used up hydroxyl at a prodigious rate. What did most to keep hydroxyl's profile low, however, was the apparent harmlessness of CO - the pollutant that consumed half of all the hydroxyl in the atmosphere. Emitted mostly from forest fires and fossil fuels, CO had for many years been the Cinderella pollutant. Its presence in the atmosphere did not seem troublesome,

Pollution was once a local problem. Then came the thinning ozone layer, following decades of releasing CFCs and halons. Insecticides and PCBs turned up in the blood of Inuit people. Pollution had gone global. But that was just the start.

even though concentrations had tripled between 1800 and 2000 and carried on rising. It wasn't very long-lived. It didn't cause acid rain or global warming. It simply didn't show up on any major environmental agenda.

Until, that is, the catastrophic hydroxyl collapse of the 2050s. Suddenly the world was like a washing-up bowl piled high with greasy dishes, when the detergent runs out and the grease stays congealed on the plates.

Through the 2050s, the smogs got rapidly worse. Japan was choking in sulphur dioxide fumes from China that resolutely refused to convert into acid rain. South Pacific islands periodically disappeared beneath palls of smog from the Philippines. Asthma became the number one killer of the under-30s worldwide. The wheat fields of Siberia - whose emergence was one of the more beneficial results of global warming - wilted and died, triggering famine across Russia. Accumulating DDT, which was still in use to fight the growing plagues of malarial mosquitoes, caused a massive die-off of whales in the Atlantic and Arctic. The newly formed World Environment Organization flirted briefly with manufacturing hydroxyl using lasers, an idea first proposed by Japanese company Ebara in the 1990s. But even though it worked in the lab, it looked as though it wouldn't do a lot for the wider atmosphere. So in 2058, President Bush IV accepted the advice of scientists that nitrogen oxides would be the easiest pollutant to reduce. With American car makers finally ready to mass produce fuel-cell vehicles, Bush launched a massive effort to cut emissions of nitrogen oxides from vehicles. He threatened economic isolation - and worse - for any nation that didn't follow suit.

It didn't work too well. Bush's advisers should have read Madronich's 1993 paper more carefully. It had warned that, once past the

threshold when hydroxyl levels crash, reducing nitrogen oxide emissions wouldn't bring back the hydroxyl. It wasn't enough to go back to the point just below the threshold. Only something much more drastic would rescue the atmosphere. In 2060, it looked as if the end was nigh. The huge expanses of carbon-sink forests planted across the tropics began to die. Foresters had seen nothing like it since the trees of central Europe succumbed to the sulphurous fumes of Soviet-built factories in the 1980s. But this time the pollution was travelling thousands of kilometres and killing hundreds of times more trees. It was coming from everywhere, and there was nothing to wash it out of the atmosphere locally. Pollute in any one place and the whole planet now felt the effect.

The dying, rotting forests were releasing huge amounts of greenhouse gases into the air, accelerating global warming. Then, after an El Niño drought, the tinder began to burn. All across the tropics in 2062, millions of people fled their homes and headed for the West, closely followed by the smog from their burning forests. As gunboats turned back the refugees' boats, world war loomed. Then scientists made the most unexpected discovery of all. Most had by now accepted that Madronich's law of runaway hydroxyl loss explained the atmosphere's crisis. But some suspected another factor. They asked: what had changed most dramatically in the atmosphere in the 2040s? What finally triggered the hydroxyl meltdown?

False hope

The answer eventually came from a chance display of graphs of environmental trends in a popular science magazine. A reader wrote to point out that the timing of hydroxyl decline coincided almost exactly with the recovery of the ozone layer - as the last remaining long-lived CFCs finally disap-

peared. The penny dropped. It looked as though this successful environmental repair job had in fact triggered the hydroxyl holocaust.

It was all down to ultraviolet radiation. As almost every late-20th century schoolchild could have explained, the ozone layer shields the Earth from ultraviolet radiation. But we also need some UV to fuel the reactions that create hydroxyl. One of the unnoticed benefits of the thinning ozone layer was to let in more UV to create more hydroxyl and counter the pollution. This, as a few scientists pointed out at the time, might have explained the apparent revival of planetary cleansing processes in the 1990s - the so-called "breath of fresh air".

But the downside was that once the ozone layer recovered in the 2040s, UV radiation fell back and hydroxyl production in the atmosphere crashed. The breath of fresh air had gone. Reduced production of hydroxyl meant the atmosphere had ever greater difficulty in cleansing itself. Madronich's runaway collapse of hydroxyl and runaway rise in pollution had begun.

And that - for those of you who have never been outside the city domes that increasingly house us in the 2070s - is the truth of what happened to the Earth's natural atmosphere. I need not remind you of the decade of wars and disease that brought a billion or so of us here, to the safety of the great air-conditioned domes that make our environment habitable. Nor remind you that billions more live outside in the fetid public air, where life expectancy is 30 years at best, where they have to eat food grown on land exposed to a constant fallout of chemicals that the atmosphere can no longer neutralise. In time, the fleets of aircraft that have been spraying the stratosphere with CFCs will destroy the ozone layer, let through more UV radiation and increase atmospheric production of hydroxyl. In time, our technological efforts here on Earth will reduce pollution to the pre-industrial levels that scientists tell us will be necessary for this most precious molecule to continue doing its work. In time, clad in sunscreen, we will be able to venture back out into the air. (New Scientist)