Nylon production discovered to represent major source of atmospheric "laughing gas"

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NYLON PRODUCTION REPRESENTS MAJOR SOURCE OF ATMOSPHERIC "LAUGHING GAS"

Both the "greenhouse effect" and the depletion of the ozone layer of the atmosphere are being aggravated from a previously unrecognized and unlikely source -- the manufacture of nylon.

According to a study published in the February 22 issue of Science, the journal of the American Association for the Advancement of Science, large quantities of nitrous oxide (N20) are being released into the atmosphere as a byproduct of nylon manufacturing.

In the upper reaches of the atmosphere, nitrous oxide -- known as "laughing gas" when used as an anesthetic by dentists -- not only contributes to the destruction of the earth's protective layer of ozone but also acts as a potent agent of global warming.

The discovery provides the first example of how industrial activity is influencing atmospheric nitrous oxide, a gas that helps regulate our climate.

"There are only a few identified, manmade contributions to global atmospheric problems," said William C. Trogler, an inorganic chemist with the University of California, San Diego.

"There's CO2 from burning and there's chlorofluorocarbons (from spray cans and refrigeration) and now there's nitrous oxide. So this is fundamental information."

Trogler, who coauthored the Science paper with Mark H. Thiemens, an atmospheric chemist with UCSD, cautioned that more work was needed to fully assess the potential damage caused by atmospheric nitrous oxide.

"It remains to be seen," he said, "but it's being released in a large enough amount to represent an appreciable fraction of the atmospheric increase."

Although most nitrous oxide in the atmosphere is produced naturally by algae and bacteria, a study published in 1981 suggested that the overall concentration of the chemical was increasing at a rate of about 0.2 percent each year. The study triggered concern among atmospheric scientists, since nitrous oxide is a stable chemical that could persist in the atmosphere for centuries. If a tiny quantity of nitrous oxide were released into the atmosphere today, about half of it would still be present about 150 years from now.

Because of this long half-life, N20 gas molecules survive long enough to leave the troposphere we breathe and enter the stratosphere, about 18 miles above the earth's surface. In the stratosphere, nitrous oxide can react

with oxygen atoms before they form ozone, and produce nitric oxide in the process. Nitric oxide can serve as a catalyst, helping to trigger the destruction of large numbers of ozone molecules.

"It's similar to chlorofluorocarbons in this respect," said Trogler, "in that it is a stable molecule, that it sticks around a long time, and does definite damage to the ozone layer."

However, nitrous oxide also absorbs infrared radiation from the sun, making it a potential greenhouse gas.

"Even though there is less of it that CO2, it (nitrous oxide) absorbs infrared radiation about 200 times as effectively as CO2," said Trogler. "So you don't need as much of it to get an effect there."

Trogler and Thiemens began collaborating on the project following a workshop sponsored by the National Science Foundation focusing on new chemical processes that could avoid industrial byproducts or find uses for byproducts. During the workshop, a chemist from Monsanto Chemical Co. provided the case of nitrous oxide, a nontoxic byproduct released in the synthesis of adipic acids, one of the ingredients used in the manufacture of nylon.

Following the workshop, Trogler and Thiemens began to examine whether nitrous oxide produced as a byproduct of nylon synthesis was large enough to influence atmospheric conditions. The two chemists simulated the industrial process and showed that one molecule of nitrous oxide could be produced from each molecule of adipic acid used to synthesize nylon fibers and plastics. They also showed that manmade nitrous oxide was slightly lighter than natural nitrous oxide, providing a means to distinguish the source of the chemical in the atmosphere.

Using worldwide production estimates for adipic acid of 5 billion pounds, the two calculated that nylon manufacturing may contribute 10 percent of the observed increase in atmospheric nitrous oxide.

The source of the remaining 90 percent is still unknown, although some scientists speculate that fertilizers and the burning of biomass might be responsible.

"Although nitrous oxide production from adipic acid synthesis does not completely account for the budgetary mismatch, it does bring attention to a previously unrecognized and potentially significant source," the two wrote in Science.

Trogler added that current technology exists to prevent the release of nitrous oxide into the atmosphere. Monsanto already is using this technology in its manufacturing plant in Pensacola, Fla.

"You won't have to worry about giving up nylon products," Trogler said. "But emissions controls do add costs to the product."

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