
P215/75R15 M/S

DOWN WITH ROAD DUST

Background, tire: Photodisc; truck inset: Julie Reinitz/Iowa Waste Reduction Center

There are more than 3.9 million miles of roadway in the United States, according to the Federal Highway Administration, and, depending on the area of the country you're in, as much as 70% of that road mileage is unpaved. The 1997 U.S. Environmental Protection Agency (EPA) *National Air Quality and Emissions Trends Report* states that those unpaved roads—which can cover a wide range of compositions, from compacted dirt to shale/slate to gravel—are responsible for more than 10 million tons of particulate matter emissions each year. Economic, logistical, and even aesthetic realities indicate the impossibility of paving every mile of unpaved roadway in America. The goal, then, is to minimize the generation and spread of dust particles.

To help control dust, road builders can either mix something into the roadway as it's built or they can apply something after the fact, but many traditional dust suppressants have serious flaws. One new approach is Dust Stop, a proprietary formulation of natural starches produced by the Canadian firm Cypher International that may prove both healthier and more effective than traditional suppressants.

The Trouble with Dust

A 1993 U.S. Department of Transportation study by civil engineering professor Thomas Sanders and then–graduate student Jonathan Addo of the Colorado State University cites a 1983 Forest Service estimate that for every vehicle traveling one mile of unpaved roadway once a day, every day for a year, one ton of dust is deposited along a corridor extending 500 feet out on either side of the median. In the 1 December 1999 issue of *Environmental Science & Technology*, Ann Miguel and Glen Cass, environmental engineering professors at the California Institute of Technology, identified at least 20 different human allergens, including molds and pollen, in dust stirred up from paved roads. Miguel says results would be similar, if not worse, on unpaved roads, especially if it's a frequently traveled unpaved road in an agricultural area, where pollens and other plant matter would be prevalent on roadways. Other substances found in lesser amounts include rubber breakdown particles from tires and asbestos particles from brakes.

"Particles of the roadway itself will be continually ground smaller, until they approach the ten- to fifteen-micron danger size where they can more easily penetrate deep into the lungs," says Miguel. This is also the ideal size range for particles to stay airborne for longer periods of time—larger than this, they tend to settle more quickly and are less of an immediate hazard, although they are still subject to the same grinding/regrinding phenomenon.

Particles larger than 2.5 microns can lodge in the upper respiratory area, where they may cause severe irritation. Effects may be especially pronounced in infants, the elderly, and those with preexisting conditions such as asthma. Particles this size may also be linked to some respiratory cancers.

Particles smaller than 2.5 microns go deeper into the lungs, where they can damage epithelial cells and even pass into the bloodstream. "Small dust particles, some of which may derive from . . . dust as well as combustion sources, have even been found in the heart material of some subject animals," says John Watson, a research professor in the division of atmospheric sciences at Nevada's Desert Research Institute. Dust particles this small can elude all but the most specialized of filters. So those who live near unpaved roads aren't the only people at risk from these particles—vehicle passengers also are exposed, even if they ride with their windows rolled up.

Some studies indicate that human health isn't the only thing that suffers in the dispersion of road dust. Watson points out that near unsurfaced roads, plants are typically dusty, and anecdotal evidence suggests that crop yields can be reduced. According to a 1996 technical report by the U.S. Army titled *Dust Control Material Performance on Unsurfaced Roadways and Tank Trails*, dust on leaf surfaces increases leaf temperatures and water loss, and decreases carbon dioxide uptake. This may make vegetation susceptible to chronic decreases in photosynthesis and growth, eventually leading to accelerated erosion in areas such as roadsides from lack of adequate stabilizing vegetation.

And the dust impacts not only the air, but the water as well, as it settles into nearby streams and rivers. In February 2000, researchers led by biology professor Dennis Murphy of the University of Nevada, Reno, released an assessment of California's Lake Tahoe citing a 30-year decline in clarity from 102 feet to 66 feet. Much of the problem was attributed to increased algal growth triggered by atmospheric deposition of phosphorus compounds associated in part with road dust.

Further, as Sanders and Addo point out, "the generation of dust means the loss of [fine aggregate material], which act as road surface binders. This represents a significant material and economic loss." According to their report, Iowa's 99 county secondary road departments spent more than $32 million for aggregate replacement in 1978 alone. Tim Trumbull, an environmental specialist with the Iowa Waste Reduction Center at the University of Northern Iowa, further points out that dust can cause low visibility on unpaved roads, abrades mechanical equipment, and damages electronic components such as computers.

Traditional Dust Suppressants: A Mixed Blessing

Traditional dust suppressants generally fall into one of six generic categories: surfactants, which are short-term wetting agents requiring frequent application; adhesives such as lignin sulfonate (tree sap), which act as binders to form a seal over the surface; electrochemical stabilizers derived from sulfonated petroleum, which expel water from the soil and increase compaction; petroleum products, which bind fine particles together; chloride salts, which both attract moisture from the atmosphere and retard its evaporation; and miscellaneous other products including microbiological binders and polymers.

But some of these products pose environmental hazards that are worse than the dust itself, and the effects of others are unknown. Thomas Piechota, an assistant professor of civil and environmental engineering at the University of Nevada, Las Vegas, is part of a task force looking at road dust suppressants and their use and regulation. Piechota and colleagues recently completed a water quality impact study in Clark County, Nevada. The researchers tested 11 different substances (representing the major suppressant categories) by applying them to unpaved roads, then simulating sufficient rainfall to create runoff. Then they analyzed the runoff for organics, inorganics, metals, and other substances.

"The summary of that study indicates that no matter what suppressant was used, you would see some sort of water quality impact," says Piechota. "Some compounds, like the petroleum compounds, contributed more metals, volatile organic compounds, and the like, while others, like magnesium chloride, had a less noticeable environmental impact." Another point that he says doesn't get raised often is the fact that any suppressant is going to create a more or less impervious surface. "So when you do get rainfall," he says, "you'll get increased runoff, which has a hydrologic impact of its own."

Human health effects also are a concern. According to the 2000 handbook *Unsealed Roads Manual: Guidelines to Good Practice*, published by Australia's ARRB Transport Research, "petroleum-based products present the greatest environmental risk with potential hydrocarbon contamination of vegetation, water courses, or groundwater if applied excessively or washed from the roadway before curing."

Aside from the environmental and human health effects, many traditional dust suppressants simply aren't that effective. Trumbull conducted a year-long test in 2000 in which he looked at the effectiveness

It's a dusty job, but somebody has to do it. University of Northern Iowa researchers sample the effectiveness of dust suppressants in keeping road runoff from entering nearby water sources.

Julie Reinitz/Iowa Waste Reduction Center of a number of dust suppressants. He applied six different suppressants along an unpaved roadway—magnesium chloride, calcium chloride, lignin sulfonate, asphalt millings, new soybean oil, and used fryer oil (which, unlike the other five, is not as commonly used as a dust suppressant).

Trumbull's tests indicated that the lignin sulfonate was effective, yet tended to adhere to passing vehicles and was difficult to remove from painted surfaces. The chlorides worked less well and tended to break down more quickly, while the oils also worked well but lost their effectiveness quickly when the road surface was bladed during maintenance.

Stopping dust safely. A sprayer is used to apply the starch-based Dust Stop suppressant to a rural roadway.

Cypher International

"One of the things that strikes me about dust suppressants as a whole," says Watson, "is the lack of detailed studies on their effectiveness and their impact on both the environment and human health. We haven't really looked at how they impact soil and water, and the mechanisms by which they move through soil into subsurface and nearby water supplies." Watson also points out that many suppressants are proprietary materials, so there's not a lot of publicly available information about them. "Most of the statements I've seen don't constitute rigorous proof. There is very little rigorous verification of effectiveness, lack of toxicity, et cetera," he says. "The general position seems to be 'Well, it's not on anyone's toxics list, so it must be okay.'"

The Starch Solution

According to Cypher spokesperson Todd Burns, the need for a new type of dust suppressant was obvious from the logistical and environmental problems rife among traditional suppressants. Then, he says, Cypher discovered starch derivatives as a tackifier for hydroseeding applications—mixing mulch, seed, fertilizer, and water into a slurry that is sprayed on the ground. "The basic ideas are the same: spraying a substance over the top of a surface and having it stay there for a designated period of time," says Burns. "So we figured if the starch could bond to the soil surface, it should be able to do so on a road surface as well."

Burns says Dust Stop can be used on gravel, limestone, dirt, sand, or any other unpaved roadbed. According to Burns, the liquified starch forms a chemical bond with the particles on the surface of the road, and the larger the particle size, the more efficiently the product will function. "Smaller particles will allow Dust Stop to leach a little farther from the surface," he says, "while material with larger particle sizes will help contain Dust Stop closer to the surface and help it form a thicker layer of binding protection on the top."

Dust Stop promotional materials say the product has been designed for high-, moderate-, and low-temperature applications, and that it is available in a citronella scent, which the company claims repels rodents, small animals, and insects, significantly lowering roadkill incidents and deterring disease-carrying insects around treated roads.

Dust Stop is made entirely with natural starches that are completely biodegradable. While the exact composition of Dust Stop (as well as its cost information) is proprietary, the company's material safety data sheet identifies it as a "modified polysaccharide," a "somewhat alkaline" substance (pH 10.8–11.5) that is a mild skin and respiratory irritant. The firm PSC Analytical Services performed the rainbow trout 96-hour pass/fail toxicity test (a test that measures the effect of exposure to a test sample on the survival of young rainbow trout over a 96-hour period) on Dust Stop, and test results showed 0% mortality after 96 hours.

Dust Stop has been tested on unpaved roadways in China, Canada, and other countries, and is currently being tested on a heavily traveled dirt road outside of Prescott, Arizona. While only time will tell if Dust Stop is indeed a viable alternative to traditional dust suppressants, preliminary results suggest that the starch solution may bring about a healthy resolution to the problem of dusty unpaved roads.

Lance Frazer

Suggested Reading

Dust Stop: Multiple-Use Environmentally Friendly Dust Suppressant [company website]. Winnipeg, Manitoba: Cypher International. Available: http://www.cypherltd.com/duststop.php [accessed 17 November 2003].

Gebhart DL, Hale TA, Michaels-Busch K. 1996. Dust Control Material Performance on Unsurfaced Roadways and Tank Trails. USAEC/USACERL Technical Report SFIM-AEC-ET-CR-96196. Aberdeen Proving Ground, MD: U.S. Army Environmental Center. Available: http://aec.army.mil/usaec/technology/dustcontrol.pdf [accessed 17 November 2003].

Sanders TG, Addo JQ. 1993. Effectiveness and Environmental Impact of Road Dust Suppressants. MPC-94-28. Fargo, ND: Mountain Plains Consortium [for the U.S. Department of Transportation]. Available: http://www.ndsu.nodak.edu/ndsu/ugpti/MPC_Pubs/html/MPC94-28.htm [accessed 17 November 2003].

Watson JG, Chow JC, Pace TG. Fugitive dust emissions. In: Air Pollution Engineering Manual, Second Edition (Davis WT, ed). New York, NY: John Wiley & Sons, 2000:117–135.