Air Quality Sweeper Testing

"Those who aren't motivated by research findings might be motivated by national standards"
by Chuck Satterfield

I'm a field service engineer for a company called Alzeta. We manufacture VOC abatement equipment for removing volatile organic compounds and toxic vapors from, typically, the silicon chip industry. In addition, I do consulting work on anti-icing, deicing, and anti-skid material and I conduct research studies for the street sweeping industry.

It's been my experience that most public works people do not understand sweeping at all. They don't realize that the old mechanical broom sweepers do not truly sweep. Broom sweepers can pick up big material off the roads but they can not pick up anything smaller than ten microns. I did a study which showed, conclusively, that mechanical broom sweepers have zero to negative efficiency in terms of their ability to remove fines from the roadway. What broom sweepers do is spray the area with water to keep the dust down. What this does is create a slurry of the fines. Then the broom comes around and spreads the slurry out. When the slurry dries, cars drive over it and it becomes airborne. So, from an air quality standpoint, 99% of the street sweepers that exist in the United States are worthless. You might as well not have them. They're good for removing bricks and dead cats and that's about it.

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Nowadays, a lot of independent contractors have small sweeper units mounted on a pickup truck. Basically, all they are is a vacuum cleaner. Everyone tends to look at those and snicker, though from an air quality standpoint they do more good than a broom sweeper. They're not stirring anything up, and they're getting up more of the fine particulates than the broom sweepers. Small vacuum units make perfect sense for parking lots and other areas where there's not a lot of packed-down debris, especially if they are swept every day or every other day.

One of the major problems with the existing technology is that 99% of the sweepers in the country are broom machines which were built from the early 60's until now. Making the capital expenditure available to replace existing technology with newer technology is nearly impossible, because the pie is only so big. And, before that can happen, we need to convince people that the good 'ol broom is not the best thing that ever came down the street. A major educational effort needs to take place and, even then, the transition to newer technology will take a long time.

Without this change in technology, we'll continue to struggle with air quality concerns. As an example, in areas where there is a lot of snowfall, like Colorado and Montana, etc., they have major problems with non-compliant areas. The Air Quality Boards say you can't use sand or cinders for anti-skid material because it creates too much dust. For example, in Mammoth Lakes, CA, where I live, we've shown that 40% of the air quality problem is caused by the dust that comes from using cinders as anti-skid material. During a snowstorm, they plow and sand like mad to prevent vehicles from crashing into one another. Then, immediately following the storm, a high pressure front moves in, the sky clears up and the temperature falls. Now you have a major temperature inversion which creates a new set of problems.

Since it's cold, everybody's got their wood stove fired up, and all the particulates from burning cause a major problem. Due to the thermal properties of the asphalt and the solar radiation etc., the roadway becomes bare even though the temperature has been below freezing. The sand and cinders are still on the road, cars are now driving over them and all the fines and particulates become airborne. Since there's no air movement because of the temperature inversion, it's basically trapped there. The area then becomes non-compliant, and the EPA imposes a big fine for that. Now the pressure is on to get the sand or cinders off the ground as soon as possible.

If you use a vacuum sweeper that doesn't use water-based dust suppression Ð like an EnviroWhirl [now Schwarze EV-series] Ð there's no problem. You can just sweep it right up. You can't use a sweeper with a water-based dust system in below-freezing conditions, however, for two reasons. One, if the sweeper uses it internally to suppress the dust, you'll get ice frozen in your vehicle. Two, if you spray water on the ground, you create an ice sheet, which is a major safety hazard to vehicular traffic. Ideal in this situation is to go to a totally vacuum sweeping system without water use. It works perfectly, with no problem whatsoever.

However, there are 100,000 old broom sweepers out there, and everyone wants to be able to use them. I did several tests to show that they don't work [in terms of PM-10 efficiency], then everyone came back and said; "Okay, but isn't there any way to make broom sweepers more efficient at removing the PM-10 particulates and allow them to work when the ambient temperature is below freezing?" What we came up with is a magnesium-chloride solution. You can operate a broom sweeper until the temperature is about 0° F to -10° F by using a magnesium chloride solution in its water system. When you put down a layer of it on the pavement, during the next storm cycle the snow doesn't stick to the street. The plows can then move it off to the side more easily and for a longer period of time before they have to apply anti-skid material. So it becomes a win/win situation.

When magnesium-chloride is introduced into the sand, your sand pile won't freeze. Then, the sand is injected with magnesium-chloride while it's being spread out of the hopper. By injecting sand with magnesium-chloride you use significantly less salt and sand, and the effectiveness of your sand is infinitely increased. When each one of the sand grains is coated with magnesium-chloride, they penetrate into the ice cap and stay there rather than bouncing around and rolling off of to the side of the road, or getting dusted off by vehicles passing over it. It sticks and creates a sandpaper-like effect versus the usual dough-like effect that sanding tends to produce.

Those aren't the only benefits of using a magnesium-chloride solution. The inherent properties of magnesium-chloride allow it to draw moisture from its environment, which binds the fine particulates together so the sweeper can pick them up. You increase the effectiveness of broom sweepers from 0% to 70-90% in terms of removing these particulates. When we tested vacuum sweepers that use water, their efficiency effectiveness range increased from between 40-60% to the 99% level. Fugitive dust became virtually nonexistent, based on visual observation. I don't believe this is a recommended technique for everywhere – for instance, downtown Seattle. Because, once again, you're very close to very sensitive waterways. You'd just be replacing one set of environmental consequences with the other.

The downside of this system is in the maintenance of your equipment. When you're finished sweeping for the day, you have to perform a very rigorous wash-down to get the residue of those ionic compounds off your vehicle. You also have to make sure to protect any exposed electrical components. You can coat them with a silicon gel compound or something similar. Encasing it in caulking will prevent the chlorine ion from attacking any of the bare metal parts. This change involves a bit more maintenance, but it allows the use of older equipment to accomplish your goals.

Out in the country and up in the mountains, they're putting a lot of very negative things on the ground. Heavily treated sand, for one. Most people don't realize that the sand they put on the road is at least 20% sodium chloride. This sand should be washed, and free of fines. Every single state I know requires their sand to be free of fines. However, I've taken samples from three different places, and with every set of samples, the regulations were on the books but the compliance was not there. It's part of the good 'ol boy network. You know, the "Old Joe has been providing us with sand for 40 years" kind of thing. They're not going to require their longtime supplier to spend an extra amount of money to start washing their sand to get the fines out of it.

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In terms of environmental concerns regarding magnesium-chloride in stormwater and soils, we have research data to show that it's diluted enough to be of no consequence. We use what works out to be about a 15% solution. The magnesium-chloride coming from the three major suppliers ranges from 26-30%, and we're diluting it 50%. As the sand comes out of the hopper on the spreader, it's injected with magnesium-chloride, so you use a tenth of the amount of sand and half the amount of salt or chloride solution. In areas where they use only salt on the road - for instance, in the Midwest where they have easy access to salt - the amount of magnesium-chloride needed to do the same job is about one tenth the amount of salt. So, even though magnesium-chloride has two chloride ions compared to the one chloride ion in salt, the total loading on the street is one fifth that of using sodium chloride (salt). Therefore, the total amount of concentration of negative and positive ions as it reaches the curb and storm drain (or shoulder of the road if you have no curb and gutter system on your street) is very diluted. Cost-wise, it works out to approximately 25 to 50 cents per gallon.

There are three major suppliers of magnesium-chloride in our particular area. Cargill, a major salt producer, has evaporation ponds on the San Francisco Bay. Dustchem, a subsidiary of North American Chemical, comes from Utah, at one end of the great Salt Lake. Reilly Wendover, also from Utah, is on the other side of the lake. Magnesium-chloride represents a new market for them, so they look at it as an opportunity. However, even though the two major producers of magnesium-chloride come from the Utah area, the local Utah government officials are currently not even interested. They have a "We've always used salt, we're always going to use salt," kind of attitude. "After all, what's the difference? This salt came from the lake and it's all going to go back there, right?"

Well, there are two major canyons right out of Salt Lake - Little Cottonwood and Big Cottonwood Canyons. When you go up to Alta, it is reported that the salt concentrations on the roads become so high that all the fish die in the streams in the spring. The fisheries have to go back and replant each year. In a few years they're going to have the Winter Olympics there, so the level of service they'll have to provide on those roads is going to have to be greatly increased. We're trying to get them to research the use of magnesium-chloride versus salt, which will not only increase their level of service but decrease the pollution in the stream at the same time. Recent research conducted in Missoula, Montana, confirms this.

At the North American Snow Conference in Salt Lake, I got into a debate with a guy regarding what was going on with the salt versus any other alternative chemicals. There are several others besides magnesium-chloride. There's an artificially-produced chemical that's even more environmentally friendly called CMA, which is calcium magnesium acetate. It's a refinery by-product, but it runs about $4 per gallon instead of 50 cents. That is significantly more expensive. They use it in Oregon, and in the Seattle area, too, where you have ice near sensitive waterways. At the conference, I made it a point to focus the debate on questions rather than being the person with all the answers. The guy from the Salt Institute wound up digging his grave deeper and deeper. They're still using salt in Utah, and in many other places, too.

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Some people never seem to be convinced by the latest research. I never understand why people or institutions do not want to see a product when it has been tested and shown to work better, cheaper, and have a less harmful environmental effect than the old product. It seems they have adopted the attitude of "Don't confuse me with the facts because my mind is already made up."

Perhaps doubters would be more accepting if there was a set of national standards developed from all the ongoing research. National standards would help in the street sweeper industry as

well. This industry has seen a series of specific tests performed around the country out of which some of the manufacturers have chosen to extrapolate results favorable to their equipment. This was evident from the sweeper tests performed at the University of California Riverside on desert windblown sand. At least one of the manufacturers represented at these tests claimed that results showed their sweeper was the best in the industry. These tests were only valid over a very narrow range of conditions for desert windblown sand and should not have been extrapolated into something that they weren't. The tests were very important, but it is quite disturbing when the results are misused by the manufacturing industry.

What this shows is that in two areas, street sweeping and anti-icing/deicing, national standards need to be developed. Too much misunderstanding still exists in both instances. If we had national standards in place, road and street departments across America could make better choices when it comes to addressing environmental concerns.