Analysts Can Find Anything

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Imagine one dime in a stack reaching from the Earth to the Moon and half-way back. This is equivalent to one part in 10^{19}, a detectability level for one atom of cesium in the presence of argon atoms reported by Oak Ridge National Laboratory scientists.[1]

These days scientists can find any thing in anything and this leads to a problem. The minute that something is found in food, in someone's blood, etc., some folks get very concerned and start creating a lot of fuss. The very act of being able to measure something can give the impression that if it's quantifiable, it's dangerous.[2]

Todd Seavey observes, "When regulators began looking for traces of potentially harmful substances to ban a half-century ago, scientists were capable of finding traces as small as parts per million. Unfortunately, activists continue to panic - and make news - each time science improves our ability to detect minuscule traces, even if there's no new evidence that these smaller and smaller traces can harm us. Now it isn't hard to find traces of virtually any substance on the planet in virtually any place on the planet."[3]

Here's a great example of selectively picking data to arouse panic. Bill Moyers did a PBS special on plastics in January 2002. During the program a scientist reported that a sample of Moyers' blood had been analyzed and about 400 chemicals were found that would not have been found in his blood 40 years ago. The inference was that all of this had come from big, bad industry. No mention was made of concentration levels. No mention was made of the fact that 40 years ago we were analyzing in the parts per million range (equivalent to finding 1 second in 12 years), whereas today we routinely report in the parts per trillion range (1 second in 32,000 years), and even greater as mentioned in the opening sentence of this column. No mention about the 1000 natural chemicals in coffee, no mention about the 2000 natural chemicals in chocolate.

Another naysayer, Lewis Smith, reported, "Traces of a cocktail of toxic chemicals linked to cancer and fetal deformities are being eaten even in the healthiest of diets. Man-made pollutants and chemicals were found in every one of 27 food products, including staples such as bread and eggs, that were tested by experts in further tests carried out by WWF, formerly the World Wide Fund for Nature. Every one of 352 people who provided blood samples over the past five years was found to be contaminated with toxic chemicals. All the contaminants found in the samples were at low levels, well within legal limits, but there are serious fears for long-term health."[4] Smith provides no mention of concentration levels (parts per million?, parts per trillion? parts per quintrillion?; nor any references other than mention of WWF, an advocacy group well known for its chemophobia leanings.

Joe Schwarcz points out, "Evidence for the presence of a substance is not evidence of harm. After all, we don't avoid apples even though their seeds harbor the deadly toxin cyanide; we happily eat strawberries although they contain acetone, a known neurotoxin; and we are not deterred from toast by the presence of 3,4-benzopyrene, an established carcinogen. The toxic properties of these chemicals are indeed real. When test animals are exposed to high doses of acetone or 1,4-dioxane, they certainly show neurological damage or tumor growth. But that doesn't mean small doses in humans over a longer time will have a similar effect. In fact, they may have a significantly different effect."[5]

Improved analytical techniques help drive regulations. The case of dioxin is a good example. Hugh Crone notes, "Before 1957 the contamination of the herbicide 2,4,5-T with dioxin was not an issue because dioxin was unknown. When it was established that the ability of 2,4,5-T and related chemicals to cause the skin disease chloracne was a result of contamination of those chemicals by dioxin, it was still not possible to estimate the quantity of dioxin in the 2,4,5-T. This was changed in 1966 with the development of a gas-liquid chromatography method to separate and measure dioxin. This method has been further refined, so that the detectable limits of dioxin have been progressively decreased as the sensitivity of the method has improved. The regulatory limit for dioxin content in 2,4,5-T has closely followed the downward trend in detectable limit - 10 ppm to 1 ppm to 0.01 ppm. The regulatory authorities have had to follow the analysts. You cannot set a permissible limit to the concentration of an impurity which is below the concentration you can detect." So, if you're a regulator, you let the analyst do it for you. They will tell you what level can be detected and if you wait a while they will cleverly be able to find mind bendingly smaller amounts and you can change your regulations accordingly.[6]

Regulators and activists aside, advanced analytical techniques are helping promote many interesting advances.

Mark Plotkin reports, "Just a few decades ago, chemists would need pounds and pounds of a plant species to isolate a new chemical compound. Now they do it with a few twigs. Robochemistry—the automation and refinement of much of the drudge work of laboratory analysis - is speeding up much of the drudge work of laboratory analysis - by as much as 50% and, in some instances, reducing costs by up to 90%. Given the advances in analytical techniques and the robotic automation of many mindless (but time-consuming) repetitive tasks, a cutting-edge laboratory can test over ten thousand compounds in a week. Dr. Gordon Cragg of the National Cancer Institute notes that his office screened over thirty thousand plant samples for their anti-cancer potential between the years 1958 and 1980. Now they are able to test that many samples in a year. In some cases, a single scientist can now analyze in a month what she or he would have been able to examine in an entire career just a few decades back."[7]

Innovative air sampling machines developed by a UC Davis research group allow researchers to collect airborne particles continuously and to analyze them in short time steps and over multiple size ranges, to resolve relationships between pollutants and weather

in much greater detail. This work reveals that air pollution blows across the Pacific Ocean from Asia to North America far more than was previously thought.[8]

Researchers at Woods Hole Oceanographic Institute found that two brominated organic chemicals accumulating in the tissues of marine animals and suspected to be man-made pollutants actually come from natural sources. The chemicals, methoxylated polybrominated diphenyl ethers or MeO-BDEs, found in whale blubber, raise questions about the accumulation of both natural and industrial compounds in marine life, and are causing researchers to rethink the sources and fates of many chemical compounds in the environment. Researchers took advantage of the fact that natural sources have a detectable radiocarbon signal while human produced sources do not. However, it was far from a simple analytical task. It took 18 months to conduct the experiment. This is another example of advances in analytical techniques that are helping find chemicals preciously impossible to analyze.[9]

Forty years of nuclear resonance spectroscopy (NMR) progress has positioned scientists with the ability to listen in on the chemical phone conversations that are going on invisibly between the world's creatures all of the time. Thomas Eisner, professor at Cornell University, says, "Eavesdropping on the chemical communication of single insects is a major breakthrough."[10]

Lastly, have you heard about the asserted link between hurricanes and global warming? A recent paper in *Science* throws some cold water on this assertion. The authors report that modern technology is enabling us to locate and measure the full strength of hurricanes that would have escaped detection as recently as 20 years ago. What's so different today? Only two geostationary satellites tracked hurricanes in 1975. Eight substantially more powerful geostationary satellites track and measure hurricanes today.[11] The new technology not only locates more hurricanes out at sea that would have been missed in the past, but more importantly, is able to pry deeper into the hurricanes themselves to measure maximum wind speeds that escaped detection in the past. As a result, hurricanes measured at Level 3 a few decades ago will now be measured at Level 5 in many cases today. P&SF

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Editor's Note: We would like to mention that Mr. Dini is having so much fun providing these columns that he is churning them out at a rate faster than we can publish them on a monthly basis. Indeed, he has created a blog at http://myblogscience.blogspot.com. If you wish to see more of Mr. Dini's provocative works that might not have appeared in Plating & Surface Finishing, check it out.

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The lab

An inventory of chemicals and reagents should confirm stock requirements and isolate any items that are past their date of use. Equipment such as hoods, thickness testers, pH meters and other such related for analysis and quality control may need calibration. Data and records should be up-to-date and saved in case of computer malfunction. Analysis methods may be updated to comply with any new requirements. Analysis schedules should be reviewed and adjusted. Suppliers should be helpful with regards to proprietary processes. The lab staff may need updated training with regards to safety and methods of analysis. NASF is a good source for educational materials.

Waste treatment

Our industry is very dependent on functional waste treatment systems. In fact, citations, fines and possible shutdown may result if discharge compliance is not met. We are dealing not only in low parts per million measurements, but in some applications, parts per billion become critical as well. Therefore a checklist should be very important, monitored for progress and updated or amended as conditions require. Waste treatment process lines should be evaluated for modifications and improvements. Equipment such as tanks, filters and pumps need regular inspection for serviceable performance. pH and ORP meters should be calibrated often. Chemicals used in the process should be properly dispensed at the optimum dosages. Don't shock the system with rapid, bulk solution dumps. Suppliers of waste treatment processes and chemistries should offer expert recommendations and service. It is a big relief to customers knowing their metal finishing vendor shops are compliant and in many instances officially certified for compliance.

Get ready for action. 2008 can be a very good year. An effective checklist can be very helpful. Consult your staff and regional suppliers for their input. Most important, be organized and stay the course.

Best regards for a Happy and Successful 2008. P&SF