COMMON GROUND FOR GOING GREEN

Effort to develop a **CHEMICAL INDUSTRY STANDARD** is driven by the need to share comparative data

STEPHEN K. RITTER, C&EN WASHINGTON

CHEMICAL COMPANIES large and small are eager to become greener. They want to be able to select greener starting materials and use cleaner chemical processes to make environmentally preferred products. But there are no authoritative marketplace criteria to identify green, greener, or greenest. And for those who think they are green, there's uncertainty over the best way to communicate the supporting information.

The solution: Develop a comprehensive voluntary industry standard that enables everyone from raw material suppliers and manufacturers to retail consumers and policymakers to exchange common information in a standard format on the environmental performance of chemical products and processes.

Government agencies, nongovernmental organizations, some chemical companies, and large retailers such as Walmart and Carrefour have already set out to develop assessment tools and enhanced metrics to achieve that ideal. But so far, these efforts are specific for individual classes of chemicals or market segments such as home cleaning products (C&EN, Jan. 25, page 12). In addition, the efforts tend to focus more on the consumer and less on the business-to-business world, where most chemical companies operate.

"There is a hunger in the marketplace for reliable, consistent, compelling information on which to base greener, more sustainable choices," says Neil C. Hawkins, Dow Chemical's vice president of sustainability and environmental health and safety. "Chemical companies need a life-cycle view—greenhouse gases, water, energy, renewables, waste reduction, recyclability—that encompasses all parts of the supply chain," he says. "A standard is needed that provides guidance on the different types of data required, who should be publishing the data, in what form, and in what quality, so that you end up with a robust decision-making apparatus that will allow businesses and consumers to make fair comparisons and better choices."

To that end, the American Chemical Society's Green Chemistry Institute (GCI) is spearheading an effort to create the Greener Chemical Products & Processes Standard. This standard will provide data to allow anyone to evaluate the relative environmental performance of chemical products and their manufacturing technologies.

Many green standards already exist and typically are highlighted by product ecolabels, notes GCI Director Robert Peoples. Those standards are usually issued by companies themselves, industry trade groups, or environment-focused nongovernmental organizations, he says. They tend to center on one or two attributes, such as volatile organic compound emissions or percent recycled content. In addition, the tools used to establish such standards focus on the final products but don't include the manufacturing process.

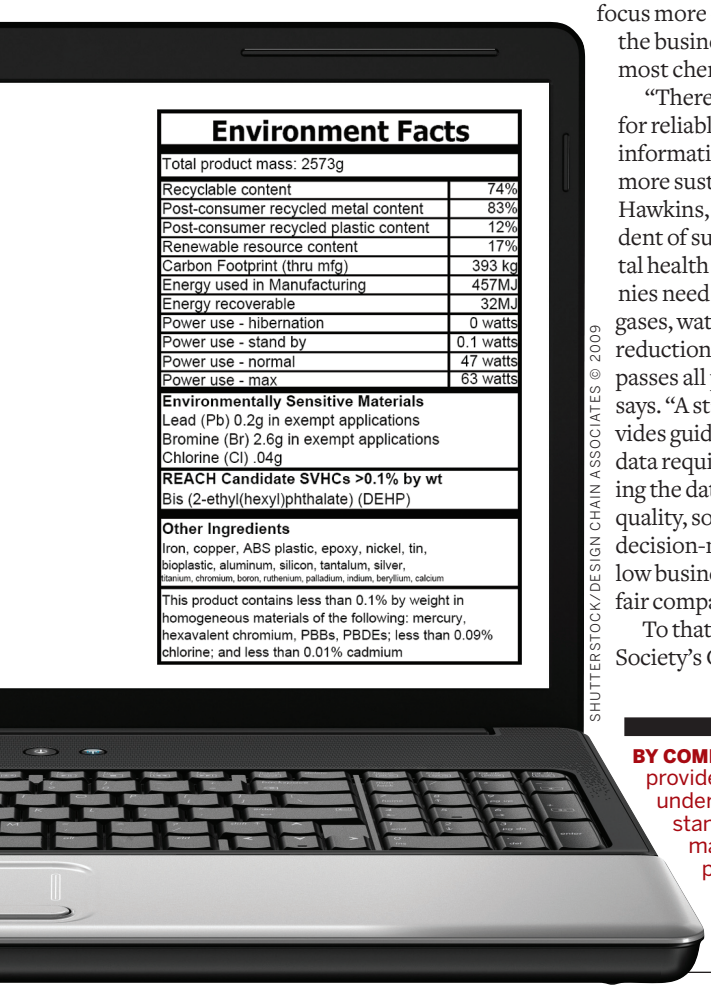
"We are building a multiattribute, consensus-based standard with third-party verification that a company can certify against to say that it has a greener product or manufacturing process than a competing product or a technology that it aims to replace," Peoples explains.

NEARLY 60 PARTICIPANTS, including stakeholders from chemical companies, academia, trade groups, federal and state agencies, and nongovernmental organizations, are providing a balance of opinions to help establish the standard, he adds.

The process is being administered by NSF International, a global expert in standards development. The end goal is to have the standard issued by the American National Standards Institute. A draft of the standard is nearly complete and is expected to be released for public comment over the summer. The plan is to have final approval by the end of the year.

Peoples notes that the effort to develop the standard is drawing inspiration from green chemistry initiatives already in place. A primary example is the Environmental Protection Agency's Design for the Environment (DfE) program, which encourages collaborative efforts between companies and environmental groups to screen chemicals and promote use of safer materials.

EPA staff develop DfE protocols for conducting screens of alternative chemicals based on threshold values for human and aquatic toxicity, bioaccumulation, persistence, and other parameters. Products that contain ingredients posing the least concern among chemicals in their class earn DfE certification and the right to use the DfE logo on the product label.



SHUTTERSTOCK/DESIGN CHAIN ASSOCIATES © 2009

BY COMPARISON Information provided by chemical makers under the new greener chemical standard could make it easier for manufacturers of consumer products to prepare information labels, like this mock-up for a fictitious laptop computer.

& MORE ONLINE Learn how a green standard could benefit the makers of chemicals and consumer products by clicking on this story at *C&EN Online,* www.cen-online.org.

This strategy, known as "informed substitution," is based on selecting chemical products that are fully assessed, have low hazard, and provide life-cycle benefits, notes Lauren G. Heine, science director at the virtual environmental nonprofit organization Clean Production Action. The goal of informed substitution is to move away from using the most hazardous chemicals, she says. Inherent in this model is an allowance for continual improvement by obtaining more data and a better understanding of what is greener and more sustainable over time.

THE SUBSCRIPTION online database CleanGredients is one business-to-business tool that uses DfE criteria to identify surfactants and solvents—and coming soon fragrances and chelating agents—that have optimal performance and environmental characteristics for making cleaning products. CleanGredients was created through a partnership between EPA and the nonprofit GreenBlue Institute, in Charlottesville, Va., where Heine previously worked.

CleanGredients encourages cleaning-product formulators to use greener chemicals and gives specialty chemical makers an opportunity to showcase their greener, safer products. Formulator companies don't manufacture chemicals but instead purchase ingredients from chemical companies and then use proprietary recipes to mix them.

Even with tools such as CleanGredients, cleaning-product formulators spend a considerable amount of effort trying to analyze the properties of ingredients they want to use, "and they are feeling pretty challenged when they don't have the resources of a large company like a Walmart," notes Anne P. Wallin, Dow Chemical's director of sustainable chemistry, who is participating in the GCI-led greener chemical standard-setting process. "They aren't necessarily chemists, and they likely don't have a toxicologist on their team. If we can give them reliable information in the form of a standard, it will be a huge leap forward for sustainability."

Taking the CleanGredients model one step further is the Green Screen for Safer Chemicals, one of the tools developed by Heine and her colleagues at Clean Production Action.

Green Screen is the first open-source method to rank chemicals according to a comparative hazard assessment, Heine says. The screening tool goes beyond cleaning-product ingredients to evaluate all types of chemicals, which are categorized into one of four quantitative benchmarks, from "avoid—chemical of high concern" to "prefer—safer chemical."

The benchmarks include hazard criteria that a chemical, its metabolites, and predicted breakdown products must pass, with a focus on the use and end-of-life phases, she adds. It also fills in data gaps with structure-activity relationship modeling data and expert judgment calls. Green Screen doesn't include process or energy use information, but it can be applied to chemicals at any stage of the supply chain.

"Comparative hazard assessment tools are becoming an important piece of the sustainability puzzle," Heine says. "People approach greening their chemical inventories by first moving away from chemicals of concern, perhaps driven by regulation. Once you start moving away from a known problem, you are pushed to the next level, where you have to consider more critically what is safer."

Stakeholders working to frame the new Greener Chemical Products & Processes Standard are being informed by the best elements of initiatives such as CleanGredients and the Green Screen along with federal regulations as they generate the standard, notes GCI's manager, Jennifer L. Young, who is representing the institute in the standards process.

The standard's first phase, which is currently under development, covers individual chemicals and the processes to make them, Young explains. But it's leaving out certain life-cycle elements such as sourcing raw

"Comparative hazard assessment tools are becoming an important piece of the sustainability puzzle."

materials and tracking the downstream use of the chemicals in making manufactured goods, an omission that's caused some controversy among stakeholders.

Some of the stakeholders believe the standard should start out covering a chemical's complete life cycle to understand its full environmental impact, from raw material extraction such as mining and oil and natural gas production to the end of a manufactured product's lifetime and its recycling. The decision to move forward without those elements is not being taken lightly, Young emphasizes. But the effort required of companies to immediately go out and gather the new data, which many of them have never tracked before, would delay getting the standard implemented, she notes.

LOOKING PAST the scope of the standard, the framework includes multiple parameters in three primary categories: chemical characteristics, chemical processing, and social responsibility, Young says. The chemical characteristics category covers physical properties, human health effects, and environmental impacts. The chemical processing category includes water usage, treatment, and recycling data; efficiency of materials use with a focus on waste prevention; process safety; and energy use, Young explains. The third category, social responsibility, takes a look at global corporate practices such as adhering to labor laws and complying with regulations, she says.

Within the chemical characteristics category, there are three classification tiers based on hazard level and the amount of information available on a chemical, Young adds. The first tier includes chemical characteristics that are well studied and for which there are data determined by validated methods. A pesticide, for example, might require chronic ecological toxicity data from a 14-day test on earthworms with the results reported in milligrams per liter.

The second tier includes chemical characteristics that don't have a lot of information and still may have cause for concern. In some cases, the data might not be available because the testing hasn't been done, or they may not be provided by the manufacturer.

Young says the standard has to provide a balance between providing transparent but useful comparative information without giving away proprietary information. But data that are withheld because they're considered confidential will be treated as missing data, she notes, which could lower the value of the chemical in the standard's hierarchy and possibly prevent the chemical from gaining certification.

The third tier includes chemical characteristics that are new, considered to be problematic, or have little or no data, Young notes. For example, no one knows yet if some types of nanomaterials could pose a problem or not, she says. The standard makes no provision for requiring disclosure of these characteristics.

Some stakeholders are eager for the standard to provide a rating index or points system for ranking chemicals, Young says. Such a system would identify the "greenest" chemical in a class of compounds and provide a reference point for a company to gauge its progress in improving the chemical's profile over time. But the initial version of the standard will leave it up to users to make their own comparisons, she says.

In addition, some members of the stakeholder group are dismayed that the standard is reactionary, rather than proactive, when it comes to addressing endocrine disruption, which is currently a polarized issue in science. Endocrine disrupters typically are man-made chemicals in the environment. They mimic hormones and can disrupt the endocrine system, potentially leading to negative health effects. Although scientists understand that people are susceptible to the effects of endocrine disrupters, it's still unclear to what degree and under which conditions, and EPA is just beginning a long-delayed screening program (C&EN, Oct. 26, 2009, page 7).

Validated tests and models to understand dose-response relationships in endocrine disruption are still being optimized. As a result, data on endocrine disrupters are not initially required for the standard, Young notes. However, if endocrine-disrupter characteristics are associated with a chemical, the expectation is that the manufacturer will report that information to the customer. In a qualitative way, knowing that a chemical has been fingered as a potential endocrine disrupter could help a user make a judgment, she adds.

Because the majority of truly green chemicals and chemical products haven't yet been invented, these criticisms point to a concern that setting a standard now could dilute the science of green chemistry by creating a "good enough" threshold. The concerned scientists say that such a threshold might allow chemicals that meet minimum qualifications to be certified, making it seem acceptable for some intrinsically dangerous chemicals to continue to be used, particularly if the standard is used to guide regulatory decisions. Given that possibility, some members of the green chemistry community have suggested that the word "greener" be struck from the standard's title.

"Standards-making is messy," Dow's Wallin says. "You are trying to get a broad group of stakeholders together with a diverse set of viewpoints to find some middle ground and build on it. The need and the potential for a standard are both tremendous, and it is definitely worth the effort. It will be very powerful if we can work through all these issues and create a standard that the whole group can get behind."

The science of sustainability and green chemistry is rapidly evolving, GCI's Peoples adds. He emphasizes that just because someone initially certifies a product or process against the standard, it doesn't mean it's 100% green. "We need to revise and improve the standard over time," Peoples says. "That means tightening the requirements and recognizing innovation as new science and technology are developed."

A natural question asked about green chemistry and developing screening tools and standards is whether or not they can make a difference in the chemical marketplace. It's still early in the sustainability game, but Peoples points to SC Johnson's Greenlist as a harbinger of success for the new green standard.

SC Johnson is the maker of many familiar brands of home cleaning, storage, and pest-control products, including Pledge and

Windex surface cleaners, Ziploc storage bags and containers, and Raid insecticides. In 2001, the company created Greenlist with EPA's backing as a methodology to rate the ingredients that make up its products. For Greenlist, environment and human health data are included alongside performance criteria and cost in the company's chemical formulary, an index of ingredients that scientists use when designing products. The materials are rated 0 for restricted use, 1 for acceptable, 2 for better, and 3 for best.

When the program started in 2001, 18% of listed materials were rated better or best. The most recent data reveal that this number has climbed to 47%. But more critically, the zero-rated restricted-use materials have dropped from 10% to 2% of the total.

At first, SC Johnson had to challenge its suppliers to create better rated chemicals, according to the study. Now, the shoe is on the other foot; companies are designing new chemicals based on Greenlist criteria and are pitching them to SC Johnson to add to the formulary.

AFTER THE GREENER chemical standard is approved, communicating the information behind the certification will move to the forefront, Peoples says. One outcome could be an ecolabel that can be used on packaging for products made with certified ingredients. Individual chemicals don't lend themselves to having an ecolabel because they are bought and sold mostly in bulk, he adds. Thus product documentation akin to a food nutrition label or a graphical label that shows sustainability attributes could be appropriate. For the business-to-business marketplace, information sheets and online reports for certified chemicals might be a format for communicating the standard's supporting information, Peoples says.

"The importance of the standard-setting process is that we and our families are all inhabitants of this planet," Peoples observes. "We don't want to have problems with the quality of the water we drink or the air we breathe. But at the same time, we need to compromise and be creative," he says. "There are billions or trillions of dollars of capital sunk into the ground in the chemical enterprise. Even if we wanted to, we couldn't wave a magic wand and suddenly replace it tomorrow with pure green chemistry. It will take time to increase the level of awareness about the standard and decades to transition. But we need to agree now on a path forward and start taking our first steps." ■