Environmentally Friendly ... To Whom?

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Marketing trends follow social trends; the language of the marketers is shaped to appeal to the popular interest. Awareness has grown in recent decades about the influence of hazardous chemicals on the environment and on human health. Books such as Rachel Carson's "Silent Spring" made people aware of the hazards of pesticides and eventually led to the formation of the Environmental Protection Agency (EPA); and more recent books like Devra Davis' "When Smoke Ran Like Water" which focused on the impact of pollution on health. Labeling products as 'green' is a selling point, because many people associate 'green' and 'safe' as being almost synonymous, but in many cases the opposite is true.

Consider some compounds that are considered environmentally hazardous – elements like mercury, lead and chromium or chemicals like DDT and freons. One of the common characteristic features that make them harmful is that they are persistent in the environment. DDT was banned in the U.S. in 1972 and in the rest of the world under the Stockholm convention in 2001 because of its impact as a cumulative poison that is concentrated up the food chain. Similarly, freons were banned from most uses under the Montreal Protocol because of its impact on the upper atmospheric ozone. The low of reactivity of CFCs means that they can persist in the atmosphere over 100 years.

There are several approaches to make a product environmentally green. In some situations, 'natural products' can be used that function well but are readily biodegradable. An example of this is the use of citrus oils for cleaning purposes. Another approach is to use reactive chemicals that are rapidly destroyed in the environment after application. The third approach is to use milder chemicals that often do not function as well as those that they replaced, but well enough that people will still use them. In a healthcare environment, a suitable high level disinfectant or sterliant must be able to effectively destroy all microbial life that it comes into contact with, including stable forms such as sporoidal bacteria. In the rest of this article, the term sterilization should be read to include high level disinfection.

Heat or steam sterilization is the predominant method used in healthcare applications. However for those items that are heat sensitive, chemical sterilization is required. In healthcare, as in almost every other area of commerce, time is money and for sterilization in particular longer cycle time means higher inventory levels and slower throughput. Therefore, in addition to making sterilization products 'greener' there is competition between the sterilizer manufacturers to reduce cycle times. For effective sterilization weaker chemicals are not an option and there are not many 'natural' products that will provide broad based biocidal activity.

Rewind 30 or 40 years and the main gas sterilants used for heat sensitive items were ethylene oxide and formaldehyde (solution or as steam/formaldehyde as vapor). Both ethylene oxide and formaldehyde are alkylating agents, which destroy cells by alkylating DNA and other molecules. Formaldehyde solution has been largely replaced by newer high level disinfectants like glutaraldehyde, o-phthalaldehdye (OPA)

and peracetic acid. Ethylene oxide gas has been partially displaced by newer technologies using hydrogen peroxide, such as Advanced Sterilization Products' line of Sterrad® sterilizers and STERIS' V-PRO sterilizers. Ozone sterilizers such as the Sterizone® 125L from TSO3 Inc. and the new Optreoz 125-A, also from TSO3, use a combination of hydrogen peroxide and ozone.

The cycle time for an ethylene oxide sterilizer is several hours with up to another 10 hours needed for aeration, the time for any residual ethylene oxide to diffuse out. In contrast, the newer hydrogen peroxide sterilizers have a cycle time as short as 28 minutes. These new sterilizers provide the answer to the question of how to achieve a shorter cycle time with an environmentally friendly chemical; by using very high concentrations of highly reactive chemicals.

The highly reactive chemicals are considered environmentally friendly. If a highly reactive chemical is released into the environment, it reacts with the environment and disappears. For example, if someone pours 30 percent hydrogen peroxide onto the ground it fizzes, produces heat and releases oxygen. Within a few hours, there is no hydrogen peroxide remaining. Compare this behavior to an environmental villain like cadmium. If a solution of a soluble cadmium salt were poured on to the ground, the cadmium would probably be detectable at that site years later and appear in the drinking water of local communities for decades to come.

Not surprisingly, highly reactive chemicals present the most immediate exposure hazards to humans because they react rapidly with biological tissues, which is why they make excellent sterilants. Thus, the OSHA permissible exposure limits (PELs) for many reactive chemicals are set very low. The OSHA PEL for hydrogen peroxide is only 1 ppm calculated as a time weighted average over 8 hours, the same as the carcinogenic ethylene oxide. Ozone has a PEL of only 0.1 ppm (8 Hr TWA), which can be compared to better known hazardous gas like hydrogen cyanide OSHA PEL = 10 ppm (8 hr TWA). The ACGIH TLVs follow a similar pattern (hydrogen peroxide = 1 ppm, ozone = 0.1 ppm (light work), and hydrogen cyanide 4.7 ppm [ceiling]).

While many people consider the description 'environmentally friendly' to be synonymous to with "safe," in practice the two terms are almost contradictory. An environmentally safe compound is one that reacts quickly with the environment upon release, but such high reactivity makes the compound hazardous to anyone exposed to it. Thus some of the chemicals in common use in healthcare, particularly chemicals used for sterilization and high level disinfection, are selected for rapid cycle times and low environmental impact. These two characteristics are achieved through the use of high concentrations of reactive compounds. However, at higher concentrations these compounds are more hazardous and so they have lower OSHA PEL, ACGIH TLV and NIOSH Immediately Dangerous to Life and Health values. The take-home message is not to say that persistent chemicals cannot be harmful; some definitely are, but rather to illustrate that because a chemical product is labeled 'green' or 'environmentally safe' it doesn't mean it is safe for those exposed to it.

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