# A Scientific and Fact-Based Critique of the Article

## *"Aquatic Toxicity and Green Cleaning – What are the Facts?"*

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From time to time, I have been invited to contribute to *Sanitation Canada* as a guest writer on topical issues important to the industry all of us serve. It is always my intent to give an unbiased and balanced view of an issue. Infection Control is my target audience and this group demands certain standards when receiving information. They insist on facts, references, high ethics and creditability as they have an enormous task to ensure the safety of a facility when choosing products. Typically, my material is third party generated by industry experts and published in peer-reviewed journals (peer-reviewed, meaning it is anonymously scrutinized by a group of learned peers prior to publication). These standards are met in the dozens of presentations I make each year, the symposiums I attend, and the documents I prepare. Transparency is crucial and all my material can be viewed on line at the company web site.

It is incumbent upon all those invited to write for a publication such as Sanitation Canada that authors consider the standards mentioned above. It is with that in mind that I became very concerned these standards were not being met in the article *"Aquatic Toxicity and Green Cleaning – What are the Facts."*[1] Consequently, such spurious data can lead one to the wrong conclusion. While I agree with Mr. Darling's statement that most people do not give much thought to what happens to cleaning products when they are poured down the drain, I feel that much of

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the content of the article was somewhat one-sided and lacking in relevant information to ensure an unbiased perspective could be reached by the recipient. When presenting data it should be conclusive and substantiated, not left open to misinterpretation. It is incumbent upon authors not to sway readers to conclusions that lead to a self-serving agenda. Statistics and data can be manipulated in many ways. For instance, the chart shown in the article promotes a negative toxicity profile of certain ingredients, when the actual in use concentration is, in fact, completely non-toxic. The truth is, MOST raw materials in concentrate form would be outside the scope of what would qualify as non-toxic.



Furthermore, to call into question the credibility of all "eco-labelled" products is unprofessional and offensive. Within Canada, chemical manufacturers rely on the Environmental Choice Program to provide guidance with respect to accrediting environmentally-friendly cleaning and janitorial products. In fact, the mandate for the Environmental Choice Program is to support a continuing effort to improve and maintain environmental quality by reducing energy and material consumption, and by minimizing the impacts of pollution generated by the production, use and disposal of goods and services available to Canadians[2]. To this cause, the program addresses these challenges by establishing strict limits on a number of different chemicals used in the manufacturing of cleaning and disinfecting products such as phosphates, alkylphenol ethoxylates and chelating agents. The program also puts a strong emphasis on the formulations' aquatic toxicity and biodegradability profile. Products that are awarded certification under the Environmental Choice Program must demonstrate environmental leadership throughout their life-cycle and undergo a rigorous review by an impartial third-party panel. It is this certification process that lends to the credibility behind the Environmental Choice Program. As manufacturers submitting products for certification we have to believe that the requirements have been thoroughly researched and based on scientific substantiated facts. Consumers, upon seeing the EcoLogo symbol, should feel confident that they have chosen a safer alternative.

Additionally, to reference the chart included in the article that was designed and generated at the request of the writer, is again self serving. What's more, this is being used as the very basis of the misleading theme of this article. In fact, the article fails to include the very conclusion this report generated. I obtained the actual report and this is the conclusion written word for word:

*"Based on an assessment of their relative toxicity, substitution of naturally occurring compounds for commonly-used surfactants* ***will most likely*** *result in a more 'environmentally-friendly' option. The use of cleaning products without surfactants is* ***likely to*** *ensure a substantial reduction in aquatic toxicity."*[3]

Hardly a profound and definitive statement, and a quite obvious summation to say the least. Certainly not a conclusion to form the basis of an argument for an article. What this fails to state is that, although being environmentally-friendly is important, so is product performance. A balance must be struck. This is especially true with disinfectants where a standard of efficacy must be met. Detergents, of course, presuming they are eco-labelled, will be judged by the end-user for their cleaning efficacy. All things being equal, I presume cleaning performance will be of the utmost importance versus degree of "green." If we now create a scenario where, although the same regulatory body, such as Terra Choice, have approved the products, then do we perpetuate a back and forth on who is greener… or greenest? Are there levels or shades of green within the eco-labelled system? I think not, nor should there be. A fundamental flaw in the positioning of this article can be found in the chart itself. Let me draw your attention to this thinking:

• The final column to the right contemplates an "average" toxicity factor. This would ONLY be relevant if all ingredients listed are in equal proportions in a given formulation. Generally, they are not. In fact, as it relates to cationic and anionic surfactants, due to issues with compatibility, they are not generally combined in the same formulation. Furthermore, should one not consider the possible toxicological implications from such a mixture should they be combined?

• Comparing surfactants to other chemicals such as citrates, carbonates, etc., has no scientific basis as they perform very different tasks, to do so, again, is misleading.

The only conclusion I can draw when considering such data is that the presenter is attempting to skew my interpretation to serve a hidden agenda.

If, for example, I had been asked to prepare an article on this topic, I would have approached it quite differently (keeping in mind the standards we strive to meet). I also would not lead the reader to presume that toxicity can be determined by one measure alone. There are many facets to evaluating toxicity. We cannot isolate or focus solely on aquatic life. The purpose would be to help the reader understand the

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ingredient families that are typically used in today's cleaners. Perhaps it would have gone something like this:

### Toxicity Profile of Typical Chemical Ingredient Families in Common Cleaners and Disinfectants

Health and environmental concerns have an increasing impact on products in the cleaning industry. Chemicals that damage the ozone layer, toxic materials and those causing cancer are restricted. The trend is moving towards the use of less toxic chemicals that are environmentally-friendly and do not compromise the performance of the product.

The majority of chemicals are considered to be toxic to some extent in their pure form based on their nature. However, the toxicity of a chemical usually varies with its concentration. Some chemicals are toxic in high concentrations, for example when purchased as a raw material or ingredient, while the same are not considered toxic in lower concentrations or once diluted for use. Acetic acid, phosphoric acid and sodium hydroxide can be included among hundreds of such chemicals. These three chemicals are toxic in high concentrations. However, all three of these well known chemicals are considered safe in lower concentrations. Their profile and thresholds for use are all listed in the FDA GRAS list (Generally Recognized As Safe), which allows their use as direct food additives. That said, while choosing a chemical for a formulation, the in use concentration toxicity should be the focus rather than the pure form. But, there are some exceptions. For example, aldehydes, phenols and quaternary ammonium compounds are generally toxic even in low concentrations, again due to their nature.

In developing a cleaning formulation, the following criteria must be considered:

- Performance of the product
- Human toxicity
- Aquatic toxicity
- Biodegradability
- Euthrophication
- Skin and eye irritation
- Combustibility/flammability
- Volatile Organic Compounds
- Fragrances

Therefore, a great care should be taken in choosing safer ingredients for the formula. Regardless, there should be a fair balance between a product's toxicity and a product's performance. Successful products are those that do not compromise performance for safety, but rather strike a good balance between the two.

Cleaning products, in general, are made of a mixture of surfactants, complexing agents, and optionally solvents, fragrances, optical brighteners, etc. In this document, as in the aforementioned article, we will focus on the toxicity profile of surfactants in cleaning formulations.

Surfactants (or surface active agents) are the main part of a cleaning formulation. Surfactants lower the surface tension of water and let it spread out and penetrate the soil. Soil and dirt are hydrophobic (water hating) meaning water by itself cannot surround them. Soap is a common example of a surfactant. In fact, up to the 1940s, soap was used as the primary cleaning agent but it suffered from some inherent disadvantages. For example, its effectiveness is reduced when used in conjunction with

hard water.

Surfactants are divided into different groups based on their charge in the solution:

**Anionic Surfactants:**

These are surface-active agents that negatively charge the solution. In this class, the main groups are alkyl sulfates, alkyl ether sulfates, linear alkyl benzene sulfonic acid, secondary alkane sulfonates, $\alpha$ - olefin sulfonates and sulfosuccinates. Here, we focus on linear alkylbenzene sulfonates as the most important class in this group.

In the early 1950s, alkyl benzene sulfonate (ABS) was the most widely used surfactant. However, due to its branched structure, it was not readily biodegradable. Because of this, in the mid-sixties, ABS was replaced by linear alkyl sulfonates (LAS), which has a simpler straight-line molecular structure. LAS is easily broken down through biological activity and, therefore, is readily biodegradable.[4] LAS degrades to carbon dioxide and water in a matter of days, and does not accumulate in the environment. Consequently they do not cause any environmental issues. To further highlight its safety, in 1987, LAS was included on the FDA food additive list for use in commercial detergents for washing fruits and vegetables. The tolerance has been set to 0.2 per cent in wash water. LAS is also used in teat-dip formulations (to disinfect the udders of milking cows) at about two per cent or lower. The average dose per teat is assumed to be about one-millilitre of the product, which equals to 80 mg of LAS per cow milking.[5] The oral toxicity of LAS is favourable, with the Oral LD(50) values ranging from 404 mg/kg and 1575 to 1950 mg/kg respectively.[5] In the Committee for Veterinary Medicinal products' report[5], it is concluded that LAS is not a mutagen, and does not show any carcinogenic effects.

**Non-ionic surfactants:**

These are surface-active compounds that do not have a charge in the solution. In other words, they are neutral. Most commercial non-ionic surfactants are considered to be alcohol ethoxylates, alkyl phenol ethoxylates, alkyl glycosides and fatty acid amides. Alkyl phenol ethoxylates have very good cleaning performance, however, they are hormone-disrupting agents.[6,7] They have also been demonstrated to be toxic to both marine and fresh water species.[8,9] Additionally, their biodegradation intermediates (alkyl phenols) are more toxic than the parent surfactants.[10] As a result, many countries are now banning usage of these chemicals and the trend is toward substituting them with other non-ionics.

Linear alcohol ethoxylates are one of the most important classes in this group. They are readily biodegradable.[11, 12] Their by-products are acutely non-toxic[12] and they are classified as non-mutagenic.[14] They are not included in Annex I of the list of dangerous substances of the Council Directive 67/548/EEC.[13] Although, alcohol ethoxylates in concentrate are skin irritants, it is important to understand that at their in use levels (0.01 to five per cent) they are considered to be a non-irritant to skin. They also appear in the EPA inerts list for pesticides, which allows their use in pesticide formulations. They are cleared by Green Seal, EcoLogo and similar green care or eco-label-type regulatory bodies, which confirms their non-toxic nature at in use concentrations.

**Cationic surfactants:**

These surface-active compounds carry positive charge in

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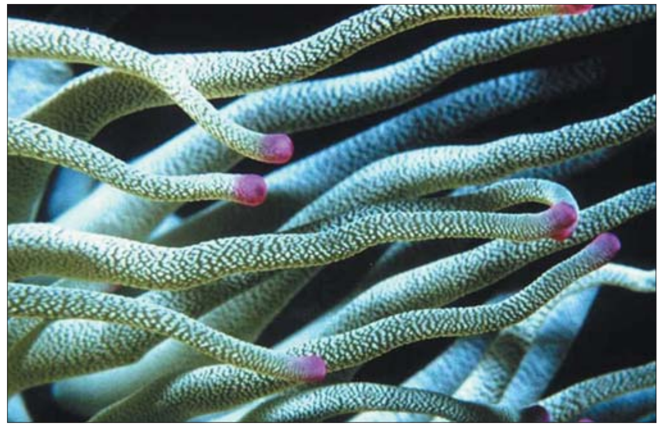
the aqueous solution. They are being used in different applications such as fabric softeners, hair conditioners, emulsifiers, wetting agents and biocides. Quaternary ammonium compounds (quats) are a sub-category, which are widely used in commercial products, especially in disinfectant formulations. They have poor primary biodegradation and no evidence of ultimate biodegradation has been observed.[15] Quats are very toxic to aquatic life. Their $LC_{50}$ for some fish species is even less than one ppm.[16] Green regulatory bodies, such as EcoLogo, prohibit the use of quats due to their unfavourable environmental profile.[2]

Discussed above is the toxicity profile of the most commonly-used surfactants in their pure form. However, in practice, surfactants being used in most cleaning formulations are in very low concentrations (usually less than 0.2 per cent). Therefore, to calculate the toxicity of a formula, the in use dilution factor has to be taken into account. That is why the green regulatory bodies focus more on the toxicity of the whole formula and set their toxicity criteria for the in use product rather than the raw materials. Otherwise, undoubtedly, we couldn't find a single chemical in the market for any application. Focusing on the toxicity profile of chemicals in their pure form or high concentration can be misleading as mentioned earlier. Therefore, in order to responsibly choose a "green" product, the toxicity profile of the product has to be considered, since the toxicity profile of the raw materials has already been scrutinized by related governmental agencies such as Environment Canada, European Union, the United States Environmental Protection Agency (EPA) and the USA FDA among others. Chemical companies should strive to formulate their products with a view of creating an effective balance between product performance and resultant toxicity profile. Toxicity profiles being equal, it is performance that will differentiate products. Those products that compromise safety for performance, or performance for safety, will ultimately be replaced by products that were able to strike the balance we speak of.

In the 1990s, when the green movement was in its infancy, end users would actually pay a premium for products considered green. However today, with regulations, restrictions, general awareness and massive recycle initiatives, it is largely presumed by clients that companies will offer them products that are friendly or friendlier. Also the premiums paid in the past are all but gone. Green is no longer a differentiator, it is a responsible and necessary component of any chemical company strategy. Finally, those that choose to use an eco-labelled product should do so with the confidence and assurance that an arms length body has performed due diligence and accepted the product. Then let performance be the judge.





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