

CHEMICAL COMPONENTS OF DETERGENTS AND THEIR IMPACT ON ENVIRONMENT

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ABSTRACT: Detergents can contain several chemical compounds that have negative environmental effects. Phosphate-containing laundry or dish detergents can react adversely when they finally reach the water table. The nitrogen in these detergents reacts with phosphorus in the water, creating nutrients that stimulate the growth of algae in freshwater. **According to Lenntech**, a company from the Netherlands, this type of algae uses up the oxygen in the water in a process called eutrophication. Over time, this slowly depletes the oxygen in a body of water, ruining the ecosystem. Other detergents contain surfactants, or surface-active agents, which are chemicals that reduce the surface tension of oil and water. For the detergent, these surfactants help dirt to “lift off” and stay out of clothing. The problem is, they also happen to be **highly toxic** to aquatic life. According to the **U.S. Environmental Protection Agency (EPA)**, surfactants break down the mucus layer that coats fish, protecting them from parasites and bacteria.

They also reduce the surface tension of water, making it easier for waterways to absorb pollutants and pesticides. Heck, they don’t even break down well or dilute. Instead, surfactants only breakdown further into more toxic byproducts.

KEYWORDS: detergents, chemical, impact, environment, pollution, ecosystem, eutrophication, toxic

I.INTRODUCTION

Besides the above-mentioned effects on aquatic life and ecosystems, laundry detergents come with a laundry list of other environmental problems. Though many companies are trying to do away with the thick, **plastic containers**, many detergents still come in non-reusable, non-recyclable packaging. Considering that detergent is a bi-weekly or monthly purchase by most American households, this means that hundreds of thousands of these containers are ending up in landfills every, single week, creating even more **pollution**. Detergents contain all sorts of chemical ingredients, many of which are considered even mildly toxic to people or pets. They can contain chlorine, phthalates, formaldehyde, and in some cases, something called **1,4-Dioxane**. Found mostly in paints and varnishes, as well as detergents like Tide, the EPA considers this chemical solvent to be carcinogenic if ingested. High levels of the stuff have been known to vertigo, drowsiness, headache, anorexia, and irritation of the eyes, nose, throat, and lungs in humans. [1,2] It’s also been known to cause cancer in some rats. Detergents are cleaning products manufactured from synthetic chemical compounds, as opposed to soap, which originates with natural substances like lye and plant saponins. Detergents figure in an extensive array of industrial and home cleaning applications, including laundry and dishwasher detergents. Released into the flow of wastewater coming from the home, these detergents can have far-reaching environmental impacts.

Phosphate-containing detergents can create algae blooms in fresh water. These in turn use up the oxygen available for aquatic life, according to Lenntech, a water treatment facilities corporation affiliated with the Technical University at Delft, the Netherlands. This problem occurs because phosphorous and nitrogen from detergents are nutrients that stimulate excessive growth of algae and other aquatic vegetation, reports the Indiana University News Room. Nutrient loading with phosphates from laundry and dishwasher detergents, as well as from suburban lawn chemicals, can lead to eutrophication, a process by which a freshwater aquatic

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ecosystem slowly dies due to continual oxygen depletion. Phosphate-containing laundry detergents are banned in most states, and about a half-dozen states have banned phosphate-containing dishwasher detergents as of mid-2010.

Surfactants, or surface-active agents, are chemicals that reduce the surface tension of oil and water; in detergents, surfactants help dirt to drop out and stay out of clothing or other items being cleaned. Surfactants in detergents are toxic to aquatic life, persist in the environment and break down into additional toxic byproducts, according to the U.S. Environmental Protection Agency. In a freshwater environment, surfactant-containing detergents break down the protective mucus layer that coats fish, protecting them from parasites and bacteria, according to Lenntech. The reduced surface tension of water also makes it easier for aquatic life to absorb pesticides, phenols and other pollutants in the water. The EPA also advises that surfactants can disrupt the endocrine systems of humans and animals; Lenntech notes that surfactants decrease the breeding rates of aquatic organisms. Laundry and dishwasher detergents come in plastic containers that are generally non-reusable and non-recyclable, according to the EPA. The volume of detergent packaging heading to landfills, given the weekly purchase of detergent-based household products by a significant portion of consumers, creates an enormous environmental impact. The European branch of the International Association for Soaps, Detergents and Maintenance Products announced in 2009 an industry-wide initiative to reduce detergent packaging by manufacturing smaller packages of more concentrated detergent products. American consumers have also noticed smaller laundry and dishwashing detergent packages on their supermarket shelves. The industry association notes that, to be successful, this packaging-reduction strategy will require consumers to carefully read the labels and cut down on the quantity of detergent used; significantly less is required for the same cleaning ability because of the new concentrated formulas.[3,4]

II.DISCUSSION

Since they are used on a large scale, detergents are partly responsible:

- for eutrophication of rivers:

The phosphorus and nitrogen compounds in detergents get concentrated in rivers. These two nutrients enable increased growth of aquatic plants (algae) that invade the entire aquatic area. When plants die, their decomposition consumes oxygen from the aquatic environment. Added to this is the consumption of oxygen due to the decomposition of the surfactants present in the detergents. Fish and invertebrates do not find adequate oxygen and die by asphyxiation. All this contribution of organic matter continues to decompose nevertheless but this time without oxygen. This is anaerobic fermentation that releases hydrogen sulphide and that smell of "rotten eggs";

- for the contamination of groundwater by contributing nutrients (surfactants) and mineral salts such as phosphates, nitrates, ammonium, boron, etc.;
- for the decline of coastal plants subjected to polluted spray;
- for the cloudy water phenomenon. Very surprising in the late 50s when large foam ponds due to excessive foam appeared on rivers. It was the alarm bell!
- for the disturbance of aquatic organisms:

- o When not treated fully in water treatment plants, the surfactants in detergents affect the natural defences of these organisms (their skin, scales, shell, walls of the plants or the bacteria) against chemical substances and pathogens.
- o Finally, some surfactants such as ethylene glycol disrupt the hormonal system of aquatic animals.

Reduction of impact is in process[5,6]

Fortunately, the law has developed considerably since the 70s. EU rules have been progressively strengthened.

Current legislation calls for:

- an obligation to treat waste water;
- a ban on foaming surfactants;
- facilities for placing biodegradable products on the market;

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- enhanced biodegradability requirements.

Currently, the biodegradability criteria of surfactants are derived from the European EC 648/2004 regulation(link is external). All surfactants must degrade more than 60% in 28 days under aerobic conditions.

Good to know: contrary to popular belief, foam reduces washing efficiency. The goal is to mix grease (dirt) with water and not to mix water with air, if in the end we really want to clean up!

However, a large room for improvement is still possible. The FAQ will tell you more about it.

FAQ

Biodegradable surfactants, really[7,8]

This new standard of rapid degradation of the surfactants is a real improvement over previous requirements. However, it can be further improved.

On the one hand, biodegradability is measured at 28 days and in the presence of air. During this time, molecules of the surfactants have ample time to escape from sewage treatment plants and spread in the environment. Some surfactants are strongly attracted to limestone and tend to settle in the sediment at the bottom of rivers. Thus imprisoned, they degrade with greater difficulty.

On the other hand, the level of optimal biodegradability of 60% in 28 days is not ideal. Even though 60% of the degraded product is in the form of carbon dioxide and water, in what form is the remaining 40%?

Finally, tests are conducted on each individual component. However what is required is the biodegradability of the complete product. In addition, tests are conducted under very different conditions from those that exist in the environment (temperature, salinity, biological activity). Laboratory results show little of what is actually happening in the environment and this is the real difficulty of carrying out these tests.[9,10]

Therefore, there is still room for improvement. New generation products are now made with 100% biodegradable surfactants (in 28 days). Industries are developing less toxic products. Most successful formulae from the viewpoint of their efficiency and the environment can get the European Ecolabel(link is external).

And phosphates

Phosphates are non-toxic by themselves. In fact, phosphorus is an element necessary for living organisms and even a limiting factor that determines the amount of life that can develop in a given habitat. Excess phosphate causes proliferation of plant organisms and aquatic plants. It is the cause of eutrophication. Highly eutrophic waters, i.e. rich in organic matter, are very poor in oxygen, and not very favourable to biodiversity. In addition, they promote the proliferation of pathogens.

In Belgium, phosphates are prohibited in household detergents since 2003. This standard has been applicable throughout Europe since 1st July 2013. In 2017, this ban will also cover products for dishwashers.

It is important to note that phosphates perform several essential functions in detergents that contain them. They must be replaced to ensure effectiveness of the detergents. These alternative substances must also be evaluated to ascertain whether the elimination of phosphates is really benefiting the environment and poses no health problems.[11,12]

III.RESULTS

Laundry detergent is far more than just a basic cleansing soap. It contains a huge number of harmful chemicals that have a serious impact on our environment. Some of the most concerning ones are:

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1. Phosphates - linked to cardiovascular (heart) disease as well as osteoporosis. These toxins are particularly damaging to the marine environment when dispersed in wastewater from your wash.
2. Bleach - often used to brighten whites, its toxic fumes cause respiratory distress and on contact with skin and eyes it is able to cause caustic burns.
3. Formaldehyde - A chemical usually associated with the preservation of dead bodies. This toxic ingredient as classified by the EPA, is a class B1 probable carcinogen. This means it has been linked with an increased risk of cancer.
4. Ammonium Sulfate and Ammonium Quaternary Sanitizers - harsh cleansing agents that are corrosive and toxic. They can cause eye, skin and lung damage even with minimal exposure.
5. Dioxane (1,4 Dioxane/ Diethylene Dioxide/ Diethylene Ether/ Dioxan) is quite possibly one of the worst additives. Dioxane is also a carcinogen and has been known to pose a combustion risk. Exposure to this toxin can damage your kidneys, lungs, central nervous system, eyes, skin and respiratory function.

Packaging Effects

Up to 1 billion plastic detergent jugs are purchased in the US alone each year, with only 10% of these ever being successfully recycled. It stands to reason that this waste has to go somewhere, right? Sadly it most often ends up in landfills where the residues of the detergents leech into the soil and the plastic remains for hundreds of years. This is probably the most harmful and concerning effect of detergent on the environment.[13,14]

Negative Effects of Detergents On The Environment

Aquatic Life

The presence of phosphates in laundry detergent run-off causes algal blooms which starve aquatic life of oxygen. The same chemical compounds that can burn our skin, cause cancer or hormonal issues also affect marine life. This means unnecessary cruelty and also impairs the function of the necessary ecosystems that we rely on.

Pollution

Synthetic surfactants contained in laundry detergent reduce the tension of the water's surface, making it susceptible to pollutants such as car exhaust and pesticides. This further impacts the aquatic environments and makes it even harder for the marine animals in these environments to flourish.

All this combined with the plastic waste just goes to demonstrate how laundry detergent may clean your wash, but it is seriously doing the dirty to our environment! [15]

What Kind Of Laundry Detergent Is Least Harmful

Liquid

Liquid detergent is considered one of the worst offenders, not necessarily due to its ingredients, but as it is always sold in a heavy-duty plastic bottle. These bottles are rarely recycled despite being advertised as recyclable. In reality, billions of detergent jugs end up in our oceans, waterways and landfill every year all around the globe.

Most liquid detergents are also heavily watered down. This contributes to a waste of water as well as a larger carbon footprint due to the added weight.

Powder

Don't be fooled, it may come in a cardboard box, but inside there is a plastic scoop and a litany of toxic ingredients. Powders are also known to leave long-lasting marks on dark clothing. Like liquid detergents, powder can easily make a huge mess in your laundry room. Spilled powders tend to infiltrate every crevice on the floor and can be a pain to clean up. [11]

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Pods

No mess, easy to use, but sadly still very toxic and not only to the environment. Alarming according to reports 'between 2012 and 2013, poison control centres reported over 7,000 cases of young children eating laundry pods, and ingestion of Procter & Gamble laundry pods had resulted in six deaths by 2017.'

This is largely in part to their bright colours and appealing fragrances, they are easily confused by children as a sweet treat. With pods being susceptible to splitting due to their dissolvable casing, they are most commonly stored in plastic tubs to seal them from the moist environment of the laundry room.

Sheets

Sheets are an ingenious and relatively new laundry detergent option. Thankfully, the majority of laundry sheets available are eco-friendly with a focus on biodegradable and plant-derived ingredients. In addition, laundry sheets require minimal packaging and are able to be stored in cardboard. It is important to note that some brands of laundry sheets will use filler ingredients such as starches that build up in your washing machine.

What Other Choices Do You Have?

If making your own detergent from natural ingredients such as borax, washing soda and essential oils doesn't appeal, how do you skip the toxins, plastics and protect our environment?

The answer is to choose a laundry detergent that uses minimal, plant-based ingredients and completely biodegradable packaging. The eco-friendly laundry detergent sheets developed by Kind Laundry offer exactly that.

Just 5 concentrated, plant-derived ingredients that are safe for marine environments and packaging that can be composted or recycled in full. Kind Laundry makes it easy to be kind to the environment without sacrificing clean washing. Shop laundry sheets today and experience the Kind Laundry difference. [12]

IV.CONCLUSIONS

Almost every family uses laundry detergent to clean and sanitize linen but detergents can be very harmful to the environment. The German magazine Öko-Test, in one of its latest analyzes, tested 26 powder detergents for laundry, sold in supermarkets and discount stores. The objective was to verify the washing performance, in terms of stain removal, and their environmental impact.

From the results of the test, only 15 percent of detergents achieved a good score, while most products reached only sufficiency, including well-known brands and low-cost products such as Aldi's and Lidl's powder detergent.

Washing performance is often convincing, but the impact on the environment of many detergents that present polluting ingredients such as synthetic polymers and fragrances precipitate the score. The **plastic compounds** used, in fact, are soluble in water but poorly degradable, so that the purification plants are unable to filter them and end up directly in the irrigation systems of the fields and, subsequently, in the sea.[13]

According to several manufacturers, there is currently no alternative to synthetic polymers in detergents for intensive use. These have, depending on the polymer, different functions but generally they are used in the composition of the detergent because they reduce the foam and ensure that the dirt is better eliminated during washing. However, 4 of the 26 detergents analyzed in the test do not contain controversial plastic compounds.

Other polluting ingredients are the optical brighteners contained in 22 detergents. These should make the laundry white but they are harmful to the environment as they are difficult to eliminate. Furthermore, if they pass from fibers to the skin, they can cause allergic reactions in combination with sunlight.

Even the fragrances used to perfume the laundry have proved to be harmful to the environment. Above all, to obtain a negative result was the Lilial fragrance, which is suspected to affect reproduction. Many fragrances are not

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biodegradable and some have even proved toxic to aquatic organisms. A real problem if you consider that producers and consumers consider it essential that the laundry smells good.[14]

According to the research conducted by Öko-Test, the best powder detergent is Sonett, which has no fragrance, optical brightener or plastic compound. Followed by Ecover Universal Waschpulver, Shetlan Vollwaschmittel Super Compact (sold by the Penny supermarket), and Tandil Ultra-Plus (sold by Aldi Süd). The worst, however, is Ariel, which contains synthetic polymers and optical whitener, has no complete label and the washing performance is medium.

The German magazine recommends buying ecological detergents, without synthetic polymers. The problem is that the consumer can hardly understand if these substances are contained or not in a product, since on the label they hide behind complicated chemical names. The other advice is to use detergent dispensers that allow you to balance the use of the products based on the quantity of laundry and the hardness of the water.

If you were hoping it would be as simple as avoiding pods or powder, unfortunately, it isn't. While they may differ in their delivery their chemical composition is often very similar. There are a few factors to consider when deciding which is the most or least harmful kind of detergent to the environment. [15]

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