

Study on Detergent Pollution in River Chambal in the City Kota of Rajasthan, India

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Abstract: Contamination and pollution of water are serious problems today. Many of the chemical substances that are disposed in water bodies are toxic and hazardous. Disease-causing microorganisms such as bacteria and viruses are solely responsible for waterborne diseases in both humans and animals. Nonylphenol, a hazardous chemical present in detergents, is known to enter water bodies and the food chains. It bio-accumulates and can pose serious environmental and health risks.

It has been detected in human breast milk, blood and urine, and is associated with reproductive and developmental effects in rodents. It is recommended to find substitutes of nonylphenol.

The Bureau of Indian Statistics (BIS) has set the standard of phenolic compounds in drinking water {0.001 milligram per litre (mg/L)} and surface water (5.0 mg/L). The detergents contain suspected carcinogens, and ingredients that do not fully biodegrade.

Many laundry detergents contain approximately 35 to 75 per cent phosphate salts. Phosphates can cause a variety of water pollution problems. For example, phosphate tends to inhibit the biodegradation of organic substances. Non-biodegradable substances cannot be eliminated by public or private wastewater treatment.

Some phosphate-based detergents can also cause eutrophication. Phosphate-enrichment can cause the water body to become choked with algae and other plants. Eutrophication deprives the water of available oxygen, causing the death of other organisms.

Key words: detergent, pollution, Kota, Rajasthan, India, diseases, human, animal, plants, eutrophication.

Detergents are capable of destroying the external mucus layers that protect the fish from bacteria and parasites, causing severe damage to the gills. Mostly fish die when detergent concentrations are near 15 parts per million (ppm); however, detergent concentrations as low as 5 ppm will kill fish eggs. The present study is investigating detergent pollution in river Chambal of Kota city in Rajasthan, India.

A few more harmful components of detergents which are anthropogenic components such as herbicides, pesticides and heavy metal concentrations (like zinc, cadmium and lead) can cause the water to grow murky. This blocks out light and disrupting the growth of plants.

Turbidity also clogs the respiratory system of some species of fishes. Pathogens from these toxic water bodies cause diseases, some fatal, in human or animal hosts diseases.

Drinking water contaminated with detergents can be hazardous to human health. The use of ecofriendly and biodegradable detergents should be encouraged to lower our laundry footprints.

Introduction

Among the different contaminants, detergent as an important pollutant has serious risks to natural ecosystems in river Chambal of Kota city in Rajasthan, India. Furthermore, detergents can pass into the wastewater treatment plants and have bad effect on their performance. They are part of human life and consumed for different aims especially hygienic purposes. Therefore, detergent components can enter to soil and water bodies from different sources. Detergents affect fauna and flora, and they have direct and indirect effects on ecosystems in river Chambal of Kota city in Rajasthan, India.

Eutrophication, foaming, and altering parameters such as temperature, salinity, turbidity, and pH are more important, and their effects need to be managed and controlled. Researchers confirmed that aerobic processes are able to degrade the most of detergents but anaerobic degradation is not possible because of restricted metabolic pathways and toxicity of them. [1,2] Sodium perborate and other detergent bleach products can irritate the nose, eyes, lungs and skin and might affect reproductive health. Some dyes used in laundry detergents are toxic to fish and other aquatic life; others are known carcinogens, according to the EPA. Phosphates in water come from a range of sources. Runoff from fertilizer on lawns and gardens is one contributor, and others include human and pet sewage, chemical manufacturing, vegetable and fruit processing and the pulp and paper industry. Soil erosion in areas lacking sufficient vegetation to hold the soil in place during strong winds and heavy rain is another source of phosphate pollution in river Chambal of Kota city in Rajasthan, India. [3,4] Most household detergents once contained phosphates because of their effectiveness at removing dirt, but now legislation prohibits their use in most products except specialized detergents and industrial cleaners. Excess phosphates create water that's cloudy and low in oxygen. All plants need phosphates to grow, but phosphorous is normally present in surface water at a rate of only 0.02 parts per million. Introducing additional phosphates in water results in a massive growth of algae, which are aquatic plants including many single-celled, free-floating plants. Excessive amounts of algae cloud the water in an effect called an algal bloom, which reduces the sunlight available to other plants and sometimes kills them. When the algae die, the bacteria that break them down use up dissolved oxygen in the water, depriving and sometimes suffocating other aquatic life.

Fertilizers containing phosphates pollute surface water in river Chambal of Kota city in Rajasthan, India. Phosphates enter water systems naturally by dissolving out of rock, but phosphates are also mined and made into chemical fertilizers to grow crops. Crops feed farm animals, which excrete phosphate-rich manure. Applying chemical fertilizers to soil already saturated with phosphates and spreading excessive amounts of manure on land causes phosphates to run off during heavy rainfall and pollute nearby water sources. When the amount of total phosphorous exceeds 100 parts per

billion (ppb) in streams or 50 ppb in lakes, eutrophication -- the effect of algal blooms -- is a danger. Excessive phosphate levels also affect the processes in drinking water treatment plants.[5,6]

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 in river Chambal of Kota city in Rajasthan, India. 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.[7,8]

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 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. The 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.

Discussion

Detergent soaps and powders are used for washing clothes and are used in washing machines. Synthetic detergents are cleansing agents, which contains an active agent called surfactant that wets the fabrics, emulsifies oily matter, solubilises grime and keeps dirt in suspension. Phosphate originates mainly from detergents, human waste (Urine and faeces), agriculture run off and soil phosphates which reaches aquatic environment through sewage and affecting aquatic ecosystem. Different brands of commercially available synthetic detergent soaps, detergent powders and sewage were analysed for Phosphate content using Vanadate Molybdate method by standard procedure [9,10]. The research finding states those Detergent builders Sodium tripolyphosphate ($\text{Na}_5\text{P}_3\text{O}_{10}$) can be substituted by a phosphate free Zeolite ($\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10} \cdot 2\text{H}_2\text{O}$ - Aluminium silicate). There are no separate legislations available in India to Control phosphates in Soaps, Detergents and Sewage which is polluting aquatic environment. Detergent is a common example of synthetic chemicals, massively and widely used in households, industries and agriculture over last few decades, which has severely contaminated the aquatic environment, causing problems to life therein. A large share of the detergent used, is biodegraded by natural processes but some of it remains undegraded or non-biodegradable, so they enter into water bodies and persists there as toxic compounds and gets concentrated in different tissues of the exposed animals. Detergents which are discharged in the water may change pH, total alkalinity, free CO_2 , DO and also affect the rate of photosynthesis and lead to eutrophication as investigated in river Chambal of Kota city in Rajasthan, India. . Thus, it has toxic effects on aquatic animals like fishes and causes mortality of animals.

Detergents also add another problem for aquatic life by lowering the surface tension of the water. Organic chemicals such as pesticides and phenols are then much more easily absorbed by the fish. Phosphates in detergents can lead to freshwater algal blooms that release toxins and deplete oxygen in

waterways in river Chambal of Kota city in Rajasthan, India. . When the algae decompose, they use up the oxygen available for aquatic life .[11]

Detergent is a substance that is oil-soluble and capable of holding insoluble foreign matter in suspension, used in lubricating oils, dry-cleaning preparations etc. Synthetic detergents are extensively used in various industries, laundries, textile industries and in households for washing operations. They are generally prepared in powder, cake and liquid forms for use. They are also used in washing powder and shampoos and in agriculture as phosphate fertilizers to shorten manufacturing cycle. In sprays of herbicides, insecticides and fungicides- they are used in wetting, dispersing and suspending of powdered pesticides and emulsification of pesticide solution to promote wetting, spreading and penetration of the toxicants. The detergents are also used in building and construction, in food and beverages industry, in bakery and cream industry, in crystallization of sugar, in leather and metals industry, in paints and protective coating, in pigment preparation, in waxes and polishes, in petroleum products and in textile industries. Surfactants are one of the major components of laundry and cleaning products . They break up stains and suspend the dirt in the water to prevent the re-deposition of the dirt onto the surface. Surfactants disperse dirt that normally does not dissolve in water.

Soaps and detergents consist of a large hydrocarbon tail with a negatively charged head. The main thing is that -the hydrocarbon tail is hydrophobic (water-hating or water-repelling) and negatively charged head is hydrophilic (waterloving). In aqueous solution, water molecules which are polar in nature, surround the ions and not the hydrocarbon part of the molecule. Whenever, a soap or detergent is dissolved in water, the molecules associate together as clusters called micelles. The tail sticks inwards and the heads outwards. During cleansing, the hydrocarbon tail attaches itself to oily dirt. When water is agitated or shaken vigorously, the oily dirt tends to lift off from the dirty surface and dissociate into fragments. This thus gives opportunity to other tails to stick to the oil. The solution now contains small globules of oil surrounded by detergent molecules. The negatively charged heads present in water prevent the small globules from coming together and form some aggregates. Thus, the oily dirt is removed like this.[12]

Detergents caused a large number of pollution in rivers and water bodies. The long carbon chain present in detergents used earlier contained lot of branchings. These branched chain detergent molecules were often degraded very slowly by the microorganisms present in sewage discharge septic tanks and the water bodies. Thus, the detergents persisted in water for long time and made water unfit for aquatic life in them. Nowadays, the detergents are made of molecules in which branching is kept at minimum. Thus, these are degraded more easily than branched chain detergents.

The damage degree of surfactants to aquatic plants relates to its concentration. When the content of surfactants is high in the water, it will affect the growth of algae and other microorganisms in water, resulting in decreased primary productivity of water bodies, thereby undermining the food chain of aquatic organisms in water bodies. A certain toxicity of surfactants will pass into the animal through animal feeding and skin penetration. When the surfactant concentration in water is too high in river Chambal of Kota city in Rajasthan, India, surfactants can enter the gills, blood, kidney, pancreas, gallbladder and liver, and produce aquatic toxicity effect.

Fish easily absorb surfactants by the body surface and gills, and with the blood circulation they distribute to body tissues and organs. Contaminated fish enter the body through the food chain and produce inhibition to various enzymes in the human body, thus reducing the body's immunity. The toxicity of surfactants on bacteria and algae can be expressed in ECO50, which means the suppression degree of surfactants on the movement of aquatic bacteria and algae within 24 hours

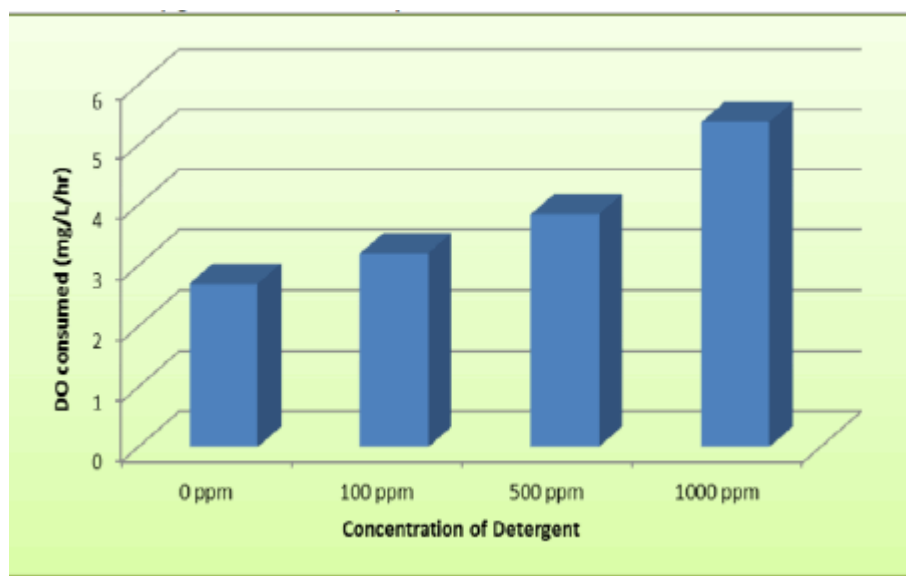


Figure 1: Showing dissolved oxygen consumed by fishes at different concentrations of the detergent.

Fish's DO consumption increased when it was exposed to the water containing detergent. With increase in concentration of the detergent, increased breathing and signs of distress were exhibited by the fish.

Results

All detergents are surface active agents; they can produce copious amounts of stable foam on the surfaces of our waterways. These foams are typically formed into a dense and thick layer that lingers for a very long time on the surface of the water. The foam may extend over a large body of several hundred square feet in size. These types of foam are a proven source of unhygienic domestic water for homes. Any drinking water contaminated with chemicals and everyday detergents can be a hazard to human health. Many people affected by chemically polluted water in river Chambal of Kota city in Rajasthan, India, report health issues, such as nausea, stomach cramps, sore throat, skin irritation, and even liver damage. Using chemically polluted water can be poisonous, and in several documented cases, it has led to fatalities for the users. In fact, chemically contaminated water is not preferred for the growing of certain crops, such as wheat, rice, and soybeans. Conventional laundry detergents leave chemical residues on clothes. These enter our bodies either through the skin or lungs. They cause many health problems, including allergies, skin infections and, in rare cases, cancer. The fragrances used in laundry detergents can prove allergic and be highly irritating to the lungs, causing serious health effects on people with asthma or chronic heart problems. The Bureau of Indian Standards (BIS) has laid down the standards for eco-labelling of detergents in India. Based on the quality, safety and performance of these detergents, a set of general and specific requirements for an Ecomark have been established. The standards suggest replacing phosphates with any other environment-friendly substance. They also stress that the surfactants used in the manufacture of household laundry detergent powders should be readily biodegradable and the products be packed in packages made of recyclable or biodegradable materials.

An environmentally superior detergent is one that uses fewer chemical ingredients. The toxicity of detergents decreases if you remove additives like perfumes, colour and brightening agents. Minimal packaging can also reduce environmental harm substantially. Synthetic surfactants may be replaced by nonpetrochemical surfactants or vegetable oil soaps; builders like phosphates can be replaced by sodium citrate and sodium bicarbonate; dyes and fragrances can be eliminated or minimised. One of

the traditional alternatives to detergents is reetha, which is known for its washing properties and is used in a number of shampoo preparations as well. Detergents can be made using soap and other household cleaning products. Soap, unlike detergents, is made from animal fat and is an excellent cleanser because of its ability to act as an emulsifying agent. Being salts of weak acids, soaps get converted by mineral acids into free fatty acids. These fatty acids, having a lower solubility, form a precipitate or soap scum, rendering them ineffective in acidic water. The formation of these insoluble salts in hard water can be overcome by mixing in such household chemicals as borax or washing soda that can help get better results

Detergent use can never be a totally nonpolluting activity. The consumer needs to be informed that the smaller detergent products can also be the least polluting ones. By using 'green detergents' that do not contain nonessential additives like perfumes, colour and brightening agents and minimal packaging we can ensure a cleaner environment.[13]

Detergent pods are contributing to the plastic pollution problem in river Chambal of Kota city in Rajasthan, India, leaking large amounts of untreated PVA (polyvinyl alcohol) into the environment, and possibly into the human food chain. Sewage containing detergent was responsible for the toxic foam. The presence of dhobi ghats, direct release of sewage containing phosphate detergents, industrial effluent and the turbulence caused near the barrages have been found responsible for the presence of foam in the river. A detailed analysis linking pollution to the quality of waste water in different drains and quality parameters assessed at different locations would have given a better idea of the major hotspots of pollution along the length of the river so that attention could be focused on those drains, spots and catchment areas responsible for causing increased pollution

Phosphate in the form of sodium tripoly phosphates (STPP) is the most commonly used builder which forms complexes with Ca^{++} and Mg^{++} ions creating a favourable condition for detergent action by reducing hardness of water. Soda ash, sodium chloride, sodium sulphate, sodium silicate and zeolite are also used as builders in the detergent. However, STPP as a builder in detergent, is preferred largely due to its greater ability to clean. In addition to builders, detergents have additives such as anti-re-deposition, whitening, bluing and bleaching agents; foam regulators, certain enzymes, perfumes and substances that assure crispness of the material. Common laundry detergent contains over 40% STPP ($\text{Na}_5\text{P}_3\text{O}_{10}$), although the global development is towards reducing this quantity, because it adversely affects the quality of the aquatic ecosystem and induces eutrophication (algal blooms, kills fishes and poor water quality). The P content in the STPP of detergent is 25.27%.

In order to tackle problems related to phosphate-containing detergents, the following action plan is suggested.

In India, none of the synthetic detergents is phosphate-free due to lack of mandatory legislations. Therefore, there is need for enacting strong mandatory legislation to regulate phosphate content in laundry detergents. There is need to create a national database on the total production and consumption of phosphate containing detergents in India and total out flow of P in rural and urban sectors. There is need to generate research-based data on the relative input of P into surface water from human excreta, detergents and agriculture for different regions of India. As urbanization in India shows an increasing trend, the per capita consumption is also likely to increase, as a result of which the total out flow of P from detergents to the sewage system will also increase remarkably in the near future. Therefore, there is need for mandatory legislation to set up sewage treatment plants in almost all cities so as to recover P not only from detergents, but also from human excreta. A partnership approach needs to be promoted in eutrophication management, at both local and national levels, since solutions are generally beyond a single regulatory body or party.

Conclusions

Green detergents are detergents which do not affect soil, lakes and rivers. If water is to be successfully reused to irrigate plants, it is critical that the reused water not be harmful to seeds and other creatures that impact the health of the soil. 'Green' detergents are also made from safer products and clean just as effectively as competing detergents that contain many more chemicals. In addition to dishwashing detergents there are also laundry detergents. Using 'green' laundry detergents also makes sure that there are no harmful chemicals absorbed into the skin or breathed in by the person cleaning. On the other hand, the detergents will cause little or no damage to whatever they are being used for: cleaning clothes or washing dishes. The benefits which 'green' detergents have on the society is that the society will be free of many toxins and the environment, overall, will be much safer than an environment filled with the chemicals coming from a conventional detergent. 'Green' detergents also result in better air quality. Reducing, reusing and recycling are what will clean the environment and make sure that our bodies are not polluted as well. The discoveries through toxicity and many other factors are what have brought humans so deep into the circle of life. Many humans are not careful and they buy items just for the sake of using them to get something done. Recycling the water is what will help humans in the long term. So remember the 3 R's: they are the key to sustainable life [14]

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