

# MICROPLASTICS IN THE ENVIRONMENT, AN IMPAIRMENT OF SURFACE WATER QUALITY

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**Abstract:** In the present paper the authors propose to present the way in which plastic, collected and recycled incorrectly, becomes plastic microparticles in surface waters. These surface waters are used for the preparation of drinking water. Recently, European research has shown that the presence of these particles, called microplastics, influences the environment. The microplastics come from industrial products in general use but also from randomly discarded plastic waste. In our country the plastic waste represents an acute problem, in particular plastic packaging discharged into rivers and lakes. It is also known that enormous amounts of plastic floats in the ocean. On the other hand, plastic is a very important raw material, recycled and used in industry.

**Keywords:** microplastics, primary microplastics, secondary microplastics, surface water quality

## 1 DEFINITION AND CLASSIFICATIONS OF MICROPLASTICS

Microplastics are small plastic particles which we find in the environment. The U.S. National Oceanic & Atmospheric Administration classifies as microplastics particles less than five millimetres long which can be harmful to our ocean and aquatic life, [6].

Regarding the size, according to the professional literature, plastic particles can be classified into:

- plastic particles > 25 mm: macroplastic
- plastic particles 5-25 mm: mesoplastic
- plastic particles 1-5 mm: large microplastic particle (L-MPP)
- plastic particles < 1 mm: small microplastic particle (S-MPP)

With regarding to origin, there currently exist two classifications of microplastics [1] [2] [6]:

- primary microplastics, are manufactured and a direct result of human material and product use;
- secondary microplastics, are microscopic plastic fragments derived from the fragmentation of larger, (macroscopic), plastic debris.

Both types are recognized to persist in the environment for a long time, particularly in aquatic and marine ecosystems. The plastic resin beads

created for use by manufacturers are often called “nurdles”, (a pre-production microplastic pellet about the size of a pea). The entire cycle and movement of microplastics in the environment is not yet known [1] [6].

## 2 THE ORIGIN OF MICROPLASTICS

Microplastics come from a variety of sources. Some of these are (including primary and secondary microplastics), cosmetics, clothing, plastic packaging (bags and PET bottles), industrial processes and many others [2]. The microplastics in the environment are the result of improperly disposed plastic waste, and the path of microplastics into water and soil is actually very short.

According to current studies, a large amount of microplastics comes from primary microplastics generated by industry, especially the cosmetics industry, and is used in our daily life. Plastic granules or pellets in the desired particle size are made for the cosmetics industry. Some relevant examples are [4]:

- Toothpastes;
- Hair care, styling;
- Shower gel, cream bath, soap;
- Facial cleanser, peeling, scrub;
- Skin care;
- Make-up, blush, powder, concealer;
- Eye make up;
- Lipsticks, lip gloss, lipliner.

These are common cosmetic items used daily which through normal use will enter into waste water in the centralized sewage system. According to statistics reports, 500 tonnes of primary microplastics are produced annually in Germany (for cosmetic use). Besides the cosmetics mentioned above, we should also mention those used in car care, certainly these are not quantities to be neglected!

But the largest quantity of fine plastic particles that gets into the environment are the secondary microplastics. These are caused by the physical, biological and chemical aging and fragmentation processes of larger plastic waste [1]. Examples:

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plastic bottles, plastic bags, foils, synthetic clothing, plastic components of cars, plastic furniture, plastic carpets and rugs, household appliances, plastics used in construction, all sorts of disposable items and others. The list goes on. There is almost nothing we use which does not contain plastic components.

Another form of microplastics are synthetic fibers. When washing clothes made of polyester or polyacrylic, microplastic particle fibers enter into the wastewater [2]. Investigations of the wastewater from washing machines showed that a single piece of clothing in a single wash cycle can lose over 1,900 plastic fibers [2].

Being microplastics, one can think that these quantities are not important. But pollution with large pieces of plastic has become a problem for the oceans of the planet. And these large particles generate the secondary microplastics.

How does one find out if a product contains microplastics ? Sections 3 and 4 discuss some synthetic materials in the form of fine particles used in cosmetics which are shown in table 1.

Table 1. Synthetic materials used in cosmetics

Abbreviation	Plastic
ANM	Copolymer of acrylonitrile with ethylacrylate
EVA	Ethylene Vinylacetate Copolymer
PA	Polyamide (Nylon-12; Nylon-6; Nylon-66)
PE	Polyethylene
PP	Polypropylene
PES	Polyester (Polyester-1; Polyester-11)
PET	Polyethylene terephthalate
PI	Polyamide (Polyimide-1)
PUR	Polyurethane (Polyurethane-2; Polyurethane-14; Polyurethane-35)

### 3. HOW DO THE MICROPLASTICS GET INTO THE SURFACE WATER?

The worldwide increase in the production and use of plastics (300 million tons per year) and the inadequate collection of plastic waste is leading to a global accumulation of plastic materials in the environment, especially in water. It is estimated that 75 million tons of plastic waste is in the oceans. Countries with strong economic growth do not always comply with environmental legislation. Media sources usually refer to Asian countries, but we know there are other countries as well.

The presence of microplastics in the oceans was already described in the 1970s. More than 30 years later, the plastic particles could also be detected in rivers and lakes [2]. To develop effective

countermeasures, it must be determined how microplastics get into surface waters.

The primary microplastics reach the surface waters through the centralized sewer system [4]. Usually, our municipal wastewater treatment plants do not have filters or other systems for retaining fine plastic particles. A part of these fine particles are retained in sewage sludge. Depending on the treatment of the sludge, they can be incinerated, or they get into the ground if the sludge is used as a fertilizer. In the second case, a small part will be carried by the wind and may reach the lakes, rivers or the sea.

Also, fine plastic particles are transported by wind from landfills. These quantities are much more significant.

Macroplastics get into rivers and lakes by direct discharge. This happens especially in rural areas.

Environmental organizations in Romania annually collect hundreds of tons of plastic from the surface of the water and from shores. See Figure 1, Bridge over the Bega River made of plastic bottles.



Figure 1. Bridge over the Bega River made of plastic bottles.

Through the effects of UV radiation and friction and due to the freeze-thaw cycle, larger pieces of plastic disintegrate, generating microplastics.

Another source of secondary microparticles is from the normal tread wear of tires. This microplastic is washed away by rain and discharged into the sewerage network. The quantity depends on traffic intensity but also on road and tire quality.

In conclusion, microplastic particles can occur in all surface waters.

### 4 ENVIRONMENTAL RISKS OF MICROPLASTICS

According to current knowledge, microplastic particles were found in surface waters

(seas, lakes, rivers), but also in water sediments (beach and ground sediments) [3].

Microplastics do not break down for many years. Because of this, they can be ingested, incorporated and accumulated in the bodies and tissues of many organisms.

Because the aquatic habitats are increasingly burdened, the impact of microplastic on the environment and people will become more and more important. Microplastics are taken up by aquatic organisms and in this way spread through the food chain. Ultimately, microplastics can also be injected by humans.

In the technical literature, according to research, the plastic materials have a risk potential because:

- They contain toxic additives. In plastic materials used in most products the basic polymer is incorporated into a compound with different additives, which are chemical compounds added to improve the performance, functionality and ageing properties of the polymer [5]. Many of these additives are toxic. Because of this, not all types of plastic are used in the food industry.

- They can absorb dangerous substances from the environment and release them later again to the environment [4].

- They offer through porosity a habitat for microorganisms. Plastics can be colonized by microorganisms in the form of a biofilm and serve as a vector for pathogenic germs.

- They can cause blockages in the digestive tract, not only in microorganisms, but also fish, birds and other animals. Here, the danger created by plastic bags and foils is for the aquatic environment. They can become traps for birds and larger animals.

- Plastic packaging is also used for toxins (pesticides, insecticides and others). These toxins adhere to the plastic and get into the environment. Many of these toxins are long lasting.

Microplastic particles are undesirable substances which can get into the food chain. In 2014, the media reported microplastics in beer, mineral water, milk, fish, shellfish and honey [1] [4]. Already in 2013, scientists from the University of Oldenburg reported the detection of microplastic particles in honey (40-660 / kg) [1]. They assume that the microplastic particles from the atmosphere settle on plants and flowers, where the bees absorb them with the pollen. The particles are also detectable in flowers and honeycombs [1].

Other research was conducted by independent laboratories, and of course, contested by the producers.

The media has reported about microplastics found in drinking water which have included very fine particles of polyvinyl chloride (PVC), polyamide (PA), polyethylene (PE), polyester (PEST) or epoxy resin.

In its scientific report on the presence of microplastic particles in food, the European Food Safety Authority (EFSA) concluded in June 2016 that there is currently insufficient data for a reliable risk assessment [1].

## 5. WHAT CAN WE DO TO AVOID MICROPLASTIC POLLUTION?

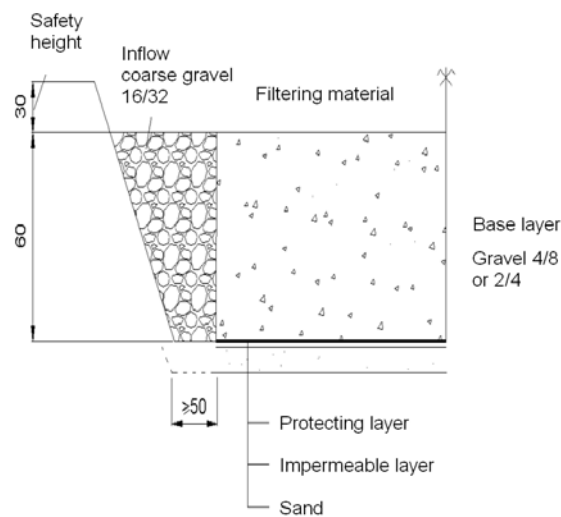
Reduce the consumption of cosmetics containing primary microplastics (may be difficult)!

Replace microplastic particles, from industrial products, with other inert particles that are not polluting [4]. Some authors recommend "natural cosmetics".

Using filters and other equipment to reduce primary microplastics from wastewater, Figure 2.



b)



a)

Figure 2. Sand filter (a) connected to a small sewage treatment plant (b)

Reduce the consumption of plastic packaging. This is a European goal for which even Romania is making efforts. Plastic bags or other plastic packaging can be used several times. They should not be discarded after one use.

Produce and promote natural fiber clothing.

Collect and recycle used plastic objects. Currently, less than 5% of recyclable waste is

recycled in Romania. The tendency is decreasing. Here we propose street trash receptacles for plastics, as well as for glass and paper.

Educate the younger generation but also adults. The local waste collection services organize consumer awareness actions annually, their target group being children. Adults are more indifferent. Even in companies or offices, separation and recycling of waste is not respected.

Introduce strict regulations against pollution. We believe that separation and collection of recyclable waste can greatly reduce the pollution of the environment. Plastic is one of the most important recyclable materials.

Implement regular and consistent cleansing of coasts, river and lake shores.

Introduce a deposit-return system for plastic packaging. Introduced in almost all EU countries, in Romania this system is not yet functional and probably will not be in the near future.

Encourage the collection of plastic as a resource. Currently, there are already such collection units complementary to the local waste collection service.

Practice ecological tourism. The "Picnic Law" stipulates how to keep camping sites clean.

Plastic packaging containing toxins should be collected and treated as "special waste."

Require strict control of the material cycle in industry especially for plastics and composites containing plastic.

Use bioplastics. These are plastics produced from renewable resources, for example corn, potatoes, wheat, tapioca or sugarcane. Details and classification are presented in [1]. Actually, bioplastics were the first mass plastics produced industrially.

## 6. FINAL CONCLUSIONS

Plastic is used in our everyday life. We cannot imagine living without plastic products. As mentioned above, we still do not have enough data to assess the microplastic impact in surface water used for potable water. This means that studies and measurements must be continued and systematized. Especially macroplastic pollution of the environment must be reduced and stopped in our country. We have to live ecologically and consume rationally. The best results will be achieved through education and awareness.

The microplastics found in drinking water probably come from plastic pipes and plastic containers or plastic bottles. We consider that this cannot be avoided because of the aging of the materials (generating microparticles). It is important that the plastic does not contain toxic ingredients. Correct and complete collection and recycling of plastic is also a goal, and here we can all do something without incurring high costs. In most cities in Romania, the infrastructure already exists.

## REFERENCES

- [1] Annette Rexroth, 2017, *Bundesanstalt für Landwirtschaft und Ernährung – Ernährung im Fokus – Titelthema „Mikroplastik in Lebensmitteln“*;
- [2] Bayerisches Landesamt für Umwelt (LfU), 2017, *UmweltWissen – Wasser, „Mikroplastik in Gewässern“*;
- [3] BUND Friends of the Earth Germany, Juni 2017, *„Mikroplastik in Kosmetika“*;
- [4] Greenpeace, Juni 2014, *„Mikroplastik in Kosmetika“*;
- [5] John N. Hahladakis, Costas A. Velis, Roland Weber, Eleni Iacovidou, Phil Purnella, *Journal of Hazardous Materials*, 344/2018, *„An overview of chemical additives present in plastics: Migration, release, and environmental impact during their use, disposal and recycling“*.
- [6] National Oceanic and Atmospheric Administration, updated: 10/10/17, *„What are microplastics?“*.