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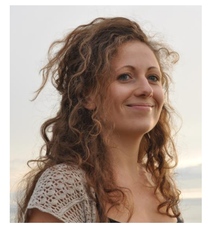

Retention of nanoplastics during the purification of drinking water

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Background

Microplastics have been detected in various freshwater ecosystems. Although it has not been possible to identify and quantify nanoplastics in the (aquatic) environment yet, nanoplastics are expected to be present as well.

However, the human exposure to nanoplastics and potentially negative effects on human health are widely unknown.

Research aim

If nanoplastics are present in surface waters used for drinking water production, how efficient are common purification technologies in removing nanoplastic particles?

1. **Coagulation- flocculation- sedimentation (CFS)**
2. **Rapid sand- filtration**

Drinking water purification from surface water

In the Netherlands, drinking water is made from surface (40%) or groundwater (60%). At first, surface water treatment usually contains CFS and riverbank- or dune-filtration to remove suspended particles. Also further water treatment varies, but normally sand and activated carbon filtration are applied (Fig.1).

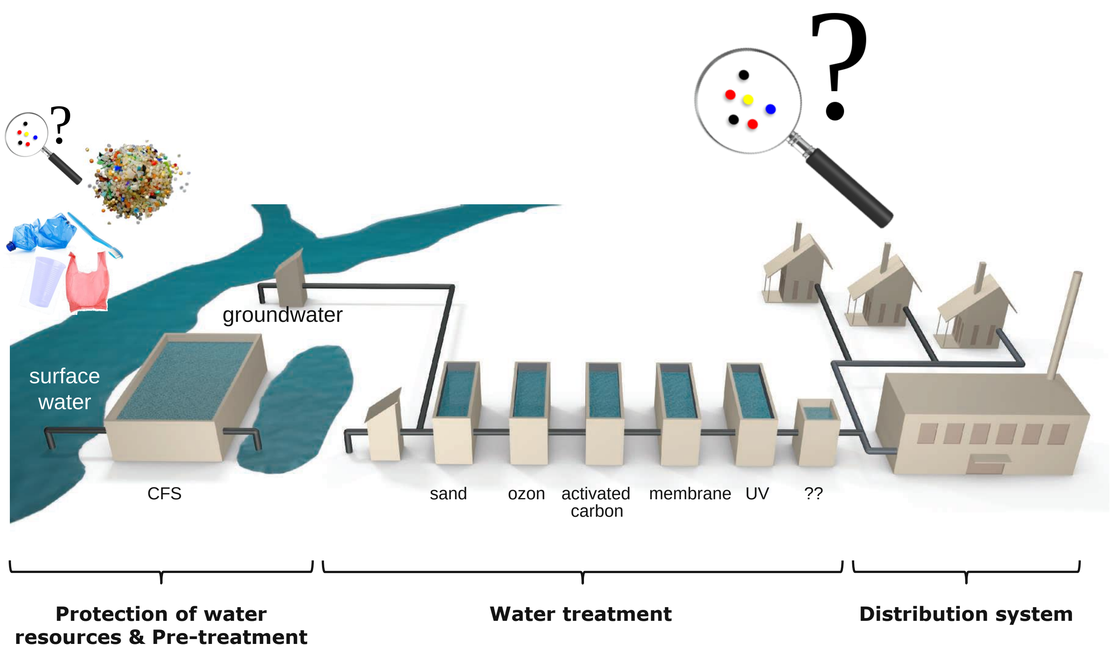

Fig. 1: Applied technologies for the production of drinking water that aim in particle removal, disinfection, biological filtration and removal of natural organic matter (adapted from Rosario-Ortiz et al. 2016).

Experimental setup

Two different water types (surface and drinking water) and four types of nanoplastic were used: the concentrations of polystyrene spheres of 2 sizes (50 & 200 nm) and 2 charges (uncharged and carboxylated) were determined using UV-Vis spectroscopy (229 nm).

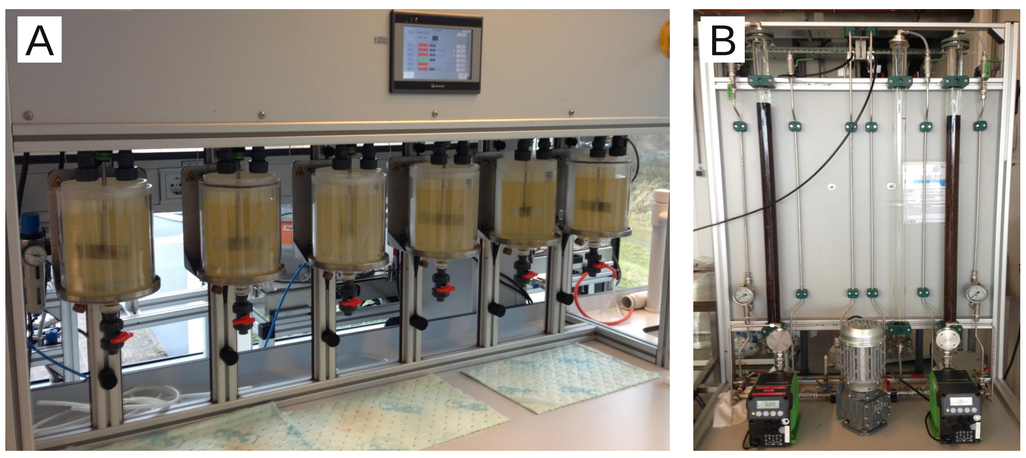

Fig. 2: Bench-scale studies simulating (A) Coagulation- flocculation- sedimentation using surface water (1.8L) and (B) rapid sand- filtration using drinking water (column height 80 cm and diameter 3.5 cm).

1. Coagulation- flocculation- sedimentation

… is a technique that is based on adsorption to reduce suspended particles (water turbidity) from surface waters. To test this, surface water was spiked with nanoplastics (10 mg L^{-1}), dosed with a coagulant ($FeCl_3$, 12 and 18 mg L^{-1}) and stirred. Samples were taken from the water surface after 0, 20, 60 and 120 minutes (Fig.2A). In practice, settling times of 20 to 60 minutes are applied.

2. Rapid sand- filtration

…is a technique that is applied to remove suspended particles and flocs. The column consisted of 'used', bio-fouled sand and a top layer of anthracite (3 cm) originating from a full scale plant. Drinking water was spiked with nanoplastics (2 mg L^{-1}) and pumped through the column with a flow rate of 7 L h^{-1}(Fig. 2B).

Results

1. Coagulation- flocculation- sedimentation

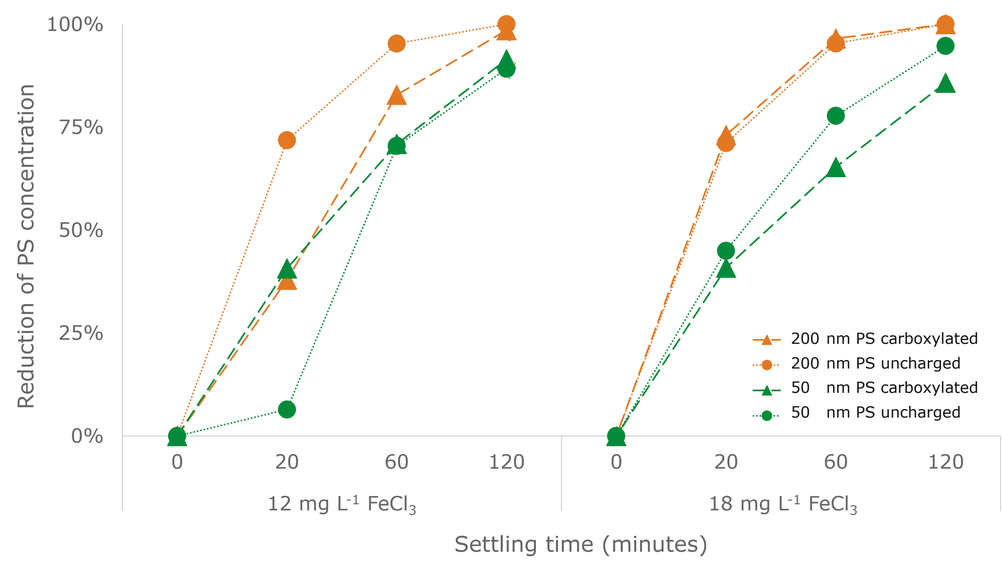

Fig. 3: Reduction of nanoplastic (polystyrene of different sizes and charges, 10 mg L^{-1}) concentration when purifying surface water with CFS using $FeCl_3$ (12 and 18 mg L^{-1}).

2. Rapid sand- filtration

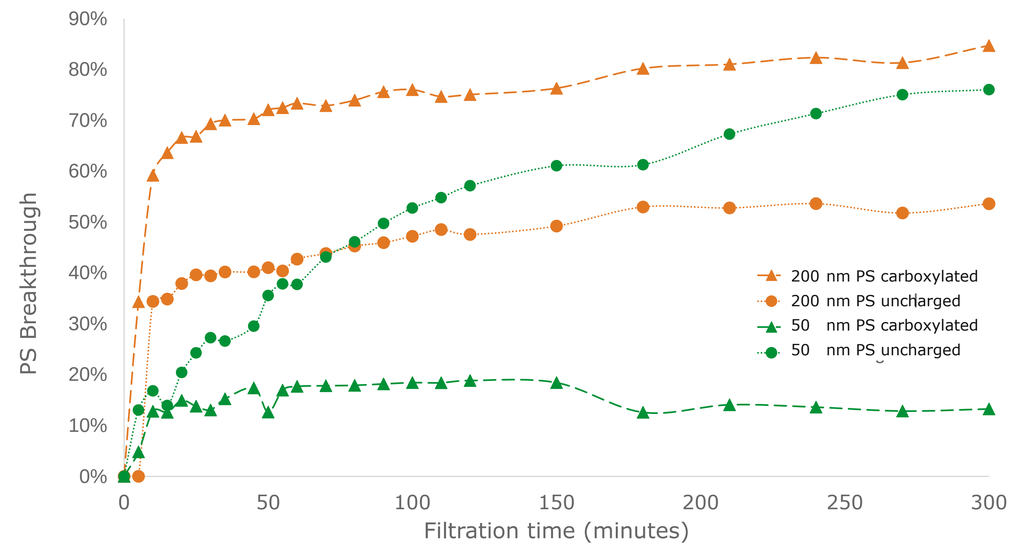

Fig. 4: Breakthrough of nanoplastic (polystyrene of different sizes and charges, 2 mg L^{-1}) using rapid sand-filtration. The filtrate was sampled directly after passing the column, then the PS concentration was determined and compared to the originally injected PS concentration.

Conclusions

1. Coagulation- flocculation- sedimentation

- **Nanoplastic removal by 38-73% after 20 minutes, and by 86-100% after 60 minutes.**
- **Bigger nanoplastic was removed more efficiently while particle charge had no impact.**

2. Rapid sand- filtration

- **A breakthrough of nanoplastic was detected within the first minutes.**
- **Nanoplastic removal varied between 87% (50 nm carboxylated) and 15% (200 nm carboxylated).**

Reference:
Rosario-Ortiz F, Rose J, Speight V, Gunten Uv, Schnoor J. 2016. How do you like your tap water? *Science* 351: 912-14

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