

Membrains Membrains

A quest to an efficient, non clogging microplastic filter

INTRODUCTION

For the last decades, a dramatic increase of microplastic in the environment has taken place. To find a solution we investigated the suitability of a Manta Ray-inspired, non-clogging water filter to combat the worsening issue of microplastic water pollution. The Manta Ray is a source of inspiration as it can efficiently filter plankton from seawater to feed itself without its gills clogging. We examined the ability of the gills to create the so-called ricochet effect. This effect is created by the anatomy of the gills, which creates turbulent water swirls that make particles bounce off the gills while water can pass in between. The simulations' results are summarized in Table 1 and the simulation parameters are listed in Table 2.

RESULTS OF OUR RESEARCH

Our simulations showed that the ricochet effect is indeed a promising approach to building efficient, non-clogging filters. Suitable flow velocities for the ricochet effect were identified.



Inlet Flow Velocity (m/s)	Particle Mass Flow (kg/s)	% Water	% Particles		
0.25	0.0025	18.4	9.44		
0.5	0.005	18.5	2.70		
1	0.01	22.0	0.0480		
2	0.02	27.3	0.00		
4	0.04	67.0	0.00		
6	0.06	68.5	0.00		
Table 1: Percentage of the inflowing water and particles that exit through the clean outlet for					

Particle Diameter	Particle Density	Mesh Size	Wall Condition	Reynolds number	Water viscosity		
0.45-0.55 mm	1.3 g/cm ³	0.02-0.2 mm	No slip	1660-19900	0.001003 kg/ms		
Table 2: Simulation parameters							

NEXT STEP

Print the optimized Filter and test it in real life.



FIGURE 1:

Visualisation of the filter setup. The blue arrows indicate water flowing into the filter inlet. The red arrows indicate water flowing out of the two outlets. The top and bottom outlets are the dirty and clean outlets respectively. The green lines represent the discrete2-dimensional mesh generated for simulations.







FIGURE 3: CAD model of the new filter

Most important references: Ricochet Filter https://www.science.org/doi/10.1126/sciadv.aat9533 Suspension Feeder https://royalsocietypublishing.org/doi/10.1098/rsif.2021.0741 Particulate matter as contamination of mucosal systems https://doi.org/10.1063/5.0054075 Manta Rays and Ricochet Effect http://insidescience.org/index.php/news/manta-rays-filter-water-way-never-previously-seen

Analysis of existing sustainable water filters and their efficiency http://potterswithoutborders.com/wp-content/uploads/2011/06/analysis-and-comparison-of-sustainable-water-filters.pdf

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