Estimation of Titanium dioxide and Silver engineered nanoparticles environmental exposure risks in water: a case of Gauteng Province, South Africa

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INTRODUCTION

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Due to the uncertainties of input data, three emission scenarios (rQ-values) were derived using a series of equations (see Figure 2), namely minimum (least risk), probable (most realistic), and maximum (high risk). The input data used in modelling the scenarios comprised of: market penetration of nanoparticles in GP; demographic data e.g. population (POp), gross domestic product (GDp), WWTP efficiency, etc. These dilution factors (SQ values) (0.75, 1 and 3) were employed to model the risk reductions (rQ-values) due to seasonal changes of water volumes in the GP. The values were based on personal communication with experts in the water sector. Data from peer-reviewed literature on the toxicity of EnPs under question to the aquatic organisms — the no-observed-effects concentration (NOEC) values — were used to calculate the PNEC. Thus, the risk profile (rQ) for each EnP to the aquatic environment was computed as a ratio of FEc to PNEC.

CONCLUSION

Findings from this study suggest urgent need for risk assessment measures be prioritised for nTiO2 to protect the GP aquatic environment from potential adverse environmental effects of nanoparticles (particularly those containing TiO2). As the application of nanoparticles containing other EnPs increases, their risk levels are expected to rise as well. Risk assessment of EnPs is expected to support safe, responsible, and sustainable utilisation of nanotechnology capabilities. It is recommended that nanosafety data be improved through new research in this field. Also, the development of capabilities for measuring actual concentrations of nanoparticles in the environment can provide more effective risk assessment framework where values like those derived from our study can be compared.

REFERENCES


STUDY LIMITATIONS

The model is limited by lack of published data on worldwide nanomaterial production volumes and applications (the determining model input parameter) because few companies disclose the use and amounts of nanomaterials to data. Thus, the range of available data is broad and introduces very high uncertainty on the published values. The published nanosafety data used for PNEC calculation is fragmentary and inconsistent. Hence the modelled values may be highly estimated or even lower than the actual values due to input-data errors.

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RESULTS AND DISCUSSION

Results were based on the three modelled possible scenarios (due to data uncertainty), and suggested that nTiO2 posed higher risk to the GP aquatic environment as rQ-values >> 1 (see Table 1). Where nAg did not show any risk concerns at present as its rQ-values << 1 (see Table 2). The risk increased substantially for nTiO2, when considering the dilution factor (SQ) of 0.75 and 1 estimated during the country’s dry seasons, where the risk quotient was rQ > 10 for both probable and maximum scenarios.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Risk quotient values (RQ) for nTiO2</th>
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<tbody>
<tr>
<td>nTiO2</td>
<td>Min</td>
</tr>
<tr>
<td>rQ (D=0.75)</td>
<td>3.415009</td>
</tr>
<tr>
<td>rQ (D=1)</td>
<td>5.651257</td>
</tr>
<tr>
<td>rQ (D=3)</td>
<td>8.537534</td>
</tr>
</tbody>
</table>

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