NanoFASE Deliverable D7.3

Report on differences in framework for assessment of intentional versus unintentional terrestrial NM exposures

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Research Report Summary

Exposure assessment frameworks were established for commercial or near-market terrestrial ENM applications of zerovalent iron nanoparticles (nZVI) as used for groundwater remediation, and nanopesticides.

NANOFER STAR nZVI was used for laboratory (ageing, column experiments) and field (Písečná site case study) experiments. CuO nanoparticles were used in a nanopesticides study.

Nanoparticle tracking analysis (NTA) with NanoSight Sample Assistant was used to provide model parameters. It gave good results for less reactive particles but did not give reliable results for nZVI. There was large variation between replicates (no statistically significant trend exists). The method seems to be not suitable for nZVI because of heterogeneity and low stability (high reactivity) of nZVI dispersion.

We explored the worst case scenario of the fate of nZVI particles escaping the application zone that could be transported towards receiving water (renegade particles). The concept of renegade nanoparticles was proposed within the NanoRem project as a plain idea without details. We have developed the concept (chapter 4.3), the experiments to test it and the method to observe it in the field (chapter 4.6). In the lab experiments, particles were prepared in a single reactor or combined reactors with anode- and cathode-volume separated by ion-membrane (renegade emulation). Such particles were used for sand-packed column tests. Early arriving particles (renegades) were observed and fate descriptors were determined. The method has been continuously improved.

NZVI fate is modelled using the fate descriptors gained from the column experiments that can be correlated with easy-to-measure parameters (proposed model). On the case study site (Písečná) ZVI was observed in distant observation points (cathode traps) but a second sampling campaign did not confirm it. Study of bacterial consortia confirms that nZVI does not significantly influence consortia diversity in the long term. Our results confirm the low risk of nZVI application for groundwater remediation even under the most hazardous scenarios.

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Nanopesticides are used and applied like conventional pesticides. However, due to their differing physicochemical properties (dissolution rate, bioavailability, persistence time…), it is likely that their transport within an agricultural soil will be specific. We first compared the transport of copper oxide nanoparticles (CuO NPs), which are used as a fungicide, between a planted and an unplanted soil column, in order to determine the impact of rhizosphere on CuO NPs transport. A polyamide canvas separated plant and soil, in order to get a homogeneous root mat only at the surface of the column. The first results demonstrate that soil solution from the rhizosphere has a higher copper-based particle concentration than the unplanted column after 2 weeks in soil and a rainfall episode. This higher copper-based particle concentration may be caused by a higher pH and new organic species in the rhizosphere, which can modify the dissolution rate of CuO NPs.

The nZVI and CuO nanoparticles exposure assessment framework was compared with the more general one for less reactive particles at low concentration presented in NanoFASE D7.2 (Table 12). The main exploitable result is the complex methodology for studying renegade behaviour – laboratory experiments and field strategy (cathode traps) that can be used for proving the safety of nZVI application for specific nZVI and sites.

The lifecycle of the particles of concern is depicted in Figure 1.

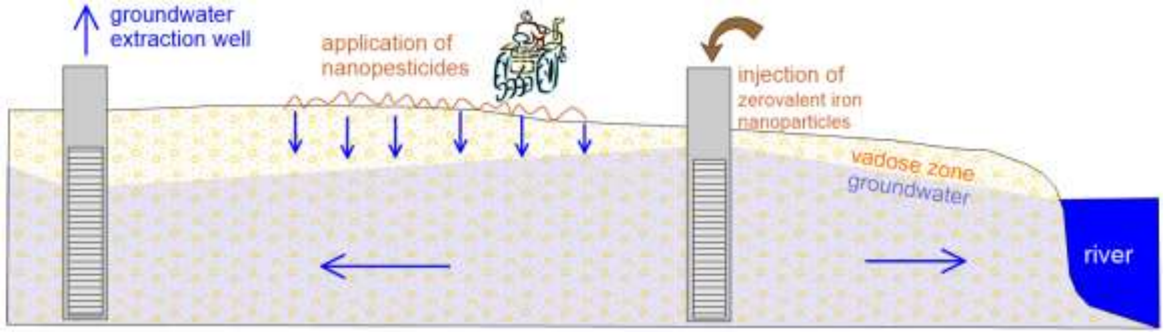

Figure 1. Release, fate and exposure of nanopesticides and nZVI

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