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# Introduction

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This special issue overviews a wide range of applications of nuclear magnetic resonance (NMR) spectroscopy and imaging in environmental biotechnology. The various contributions were presented in the symposium "NMR in Environmental Biotechnology," organised by the Wageningen NMR Centre and the Research School for Environmental Chemistry and Toxicity, held on November 5th 1999 in Wageningen, the Netherlands.

The first use of NMR techniques in environmental biotechnology was the application of $^{1}H$ and $^{13}C$ NMR spectroscopy in the 1960s to the 1970s as an advanced analytical tool for elucidation of the molecular structure of the constituents of the effluents of wastewater treatment plants. Since then, NMR spectroscopy has evolved to a powerful tool to study the abiotic or biotic conversions and ultimate fate of pollutants during their treatment. This can be done using natural abundant nuclei, although the use of enriched material significantly improves the sensitivity of the analysis. A wide variety of NMR techniques is currently available, such as CPMAS, 2D and 3D NMR. This special issue presents papers that illustrate the large potential of $^{1}H$, $^{13}C$, $^{15}N$, $^{31}P$ and $^{19}F$ NMR spectroscopy for biodegradation studies in bacterial cultures and sludges (Part I), soils (Part III) and solid waste (Part V).

A completely different application is the use of magnetic field gradients in $^{1}H$ NMR to observe static and time-dependent proton distributions in an object. In this way, the porosity, diffusional properties, mass transfer kinetics and flow patterns in various biosystems can be quantified. Such information is of great help in understanding the physical and chemical properties of the complex matrixes that are encountered in environmental systems, e.g., biofilms, membranes and soils. The contributions included in Part II relate to these NMR diffusion and flow measurements.

Finally, the role of NMR to study heavy metals is pointed out. Some metals often associated with pollution, e.g., Cd and Al, can be probed directly by NMR spectroscopy. Apart from the direct application of NMR spectroscopy, their metabolic and/or physical behaviour can also be probed indirectly via their paramagnetic effects on the aqueous solvent. Part IV introduces the reader to the so-called relaxation time measurement methodology and illustrates its potential for a number of case studies.

This special issue illustrates the impact of NMR techniques in environmental biotechnology, a new, upcoming interdisciplinary scientific field. For both applied and fundamental research, NMR techniques can assist the environmental biotechnologist in his/her work, as NMR is a tool that gives information inaccessible by any other analytical technique.

We gratefully acknowledge the Wageningen NMR Centre for dedicating the symposium as a User Meeting of the European Community activity "Training and Mobility of Researchers — Access to Large Scale Facilities" (ERBFMGETC950066). This centre has organised in the past related symposia in the area of Environmental Science [2] and Biotechnology [1]. We would also like to refer the reader to those thematic special issues on NMR applications in these adjacent scientific fields.

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## References

1 Hemminga M.A. and J Visser, Eds. 2000. Special Issue NMR in Biotechnology. *J Biotechnol* 77: 1–150.
2 Rietjens, I.M.C.M., Ed. (1998). Special Issue NMR in Environmental Science. *Biodegradation* 9: 391–525.

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