Study of Cr(III) and Mn(II) loaded resin by benchtop nuclear magnetic resonance.

M. Bernardi[1, a], .L. Hantson[2] and Y. Gossuin[1].

[1]Biomedical Physics Department, UMONS
[2]Chemical and Biochemical Engineering Department, UMONS
[a]Corresponding author: marie.bernardi@umons.ac.be

Heavy metals ions such as Cr(III) and Mn(II) are known to be toxic and must be removed from wastewater. These ions have also paramagnetic properties which allowed the use of Nuclear Magnetic Resonance (NMR) relaxometry to monitor their removal from water by a strong cation exchange resin. In this research, kinetic and equilibrium isotherm experiments were performed.

Heavy metals have become a major public health and environmental concern [1]. The removal of these metals from water is often performed by ion exchange. In this context, ICP-AES spectroscopy is currently used to study ion exchange efficiency. However, this technique is indirect and destructive. Some heavy metal ions like Cr(III) and Mn(II) have paramagnetic properties that can affect the Nuclear Magnetic Resonance (NMR) relaxation times T_1 and T_2 of water protons which can be easily measured by benchtop NMR relaxometry [2-3]. Therefore, T_1 and T_2 can be used to follow the evolution of the concentration of paramagnetic ions in solution and thereby monitor the removal of heavy metals by a strong cation exchange resin.

Batch experiments were carried out to study the ion exchange kinetics: a sample containing a small amount of Dowex Marathon MSC resin was put in contact with aqueous solutions containing the paramagnetic ion of interest before being shaken by a vortex mixer (Figure 1). The transverse relaxation time (T_2) was measured at different time intervals which allowed the monitoring of the amount of adsorbed metal. Repeating the same experiment with different metal concentrations provided the adsorption isotherms.

The experimental kinetic data were in good agreement with the pseudo-first order kinetic model. The equilibrium isotherms of Cr(III) and Mn(II) were described by the Langmuir and Freundlich models.

The next step will be to reproduce these experiments with other adsorbents like activated carbon at different magnetic fields. In the future, it will also be interesting to carry out a so-called NMR column experiment in order to follow the loading of resin in real-time through the measurement of the NMR signal.

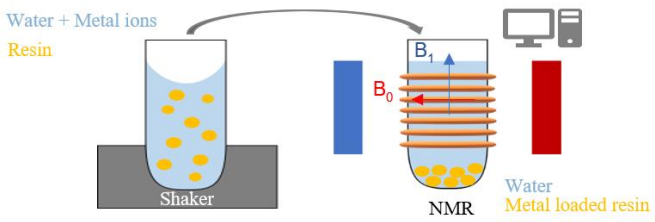

Figure 1. Experimental set-up

References

[1] Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., & Sutton, D. J., Molecular, Clinical and Environmental Toxicology. Experientia Supplementum,101, 133-164 (2012).

[2] Gossuin, Y., Hantson, A.-L., & Vuong, Q. L, Journal of Water Process Engineering, 33, 101024 (2020).

[3] Gossuin, Y., & Vuong, Q. L., Separation and Purification Technology, 202, 138-143 (2018).