INDUSTRIAL PILOT PROJECT

Synchrotron small angle x-ray scattering as analytical tool for removal of Macrolide Antibiotics from water using clays

THE INDUSTRIAL CHALLENGE

The ecological effects on natural ecosystems together with the building up of antibiotic resistance are of high concern in the global health context, and to remove macrolide antibiotic (MA) from drinking water and wastewater utilities is of paramount importance to ensure safety for humans and the environment. Efficient and low-cost techniques for their removal are urgently needed and Vatteninfo Sverige AB is committed to provide cost-effective solutions for this issue. One way to investigate a nature-based approach for MA removal is to use clays, either natural or chemically modified, in their filters. That also represent a suitable alternative compared with activated carbon filters.

WHY USING A LARGE SCALE FACILITY

Synchrotron small angle x-ray scattering (SAXS) experiments are optimal to investigate nanostructured objects as clays. Compared to lab-source based SAXS systems, it provides better signal to noise ratios (SNR) and short collection times making possible to study very small amount, less than 2%, of microlite antibiotics adsorbed on the interlayer clay spacing. At the same time, it is also possible to study a broad variety of compositions on the system.

HOW THE WORK WAS DONE

Different clay/surfactant dispersions were prepared with and without the addition of erythromycin (MA). The surfactant was first dissolved in distilled water at different concentrations and heated above 20C to ensure that is fully soluble in water. After stabilization the corresponding amount of clay was added with continuous stirring. The clay concentration used was about two times the concentration of surfactant and the process was monitored for several days. Three different clays were studied, hydrophilic bentonite (nanoclay), montmorillonite K30 and Bentonite MED, all provided from Sigma. The surfactant employed was hexadecylpiridinium bromide (C16PyBr). Aliquotes of the samples were injected and sealed in quartz capillaries of 1.5 mm diameter for the SAXS measurements. The x-ray scattering experiments were conducted at the CoSAXS beamline of the MAXIV laboratory at 12.4 keV in a sample detector distance of 1.455 m. The q-range used was: $0.008 \leq q \leq 0.8$ Å^{-1}, see Figure.

THE RESULTS AND EXPECTED IMPACT

The SAXS results clearly showed an increase on the interlayer clay spacings indicating the adsorption of MA in swollen dispersions. Then can conclude that hydrophilic Bentonite and Bentonite MED were efficient to remove MA from water, and that the addition of a surfactant are beneficial to increase the capabilities of adsorption into the material. It was also confirmed that the adsorption of the MA model system took place in the interlayer spacing of the organic modified clays. Future studies could focus on the removal of chemically different macrolide antibiotics to develop a broad-spectrum of modified clay-based filters for pollutants.

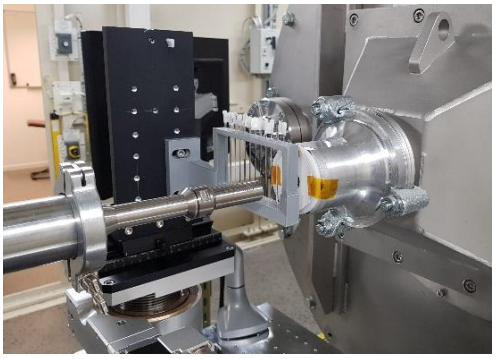

Figure. Organoclay dispersions with and without microlide antibiotics (MA) measured at the CoSAXS beamline at MAXIV Laboratory.

"Synchrotron SAXS has been critical to prove the intercalation of Microlite Antibiotics in our organically modified natural clays"/ Amelia M. Strömberg, Vatteinfo

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