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PHARMACEUTICAL REMOVAL WITH BIOFILM CARRIERS AND ACTIVATED SLUDGE

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EXECUTIVE SUMMARY

Today's knowledge on removal of pharmaceuticals in activated sludge systems and membrane bioreactors is rapidly increasing and has reached a level that makes discussions on potential optimisation strategies relevant. For biofilm systems, pharmaceutical removal is much less investigated, despite their frequent use. Clear comparative studies on removal of pharmaceuticals between moving bed biofilm reactors (MBBRs) and other biological treatments systems are also lacking. Accordingly, batch experiments with biofilm carriers and nitrifying activated sludge from several municipal WWTPs were carried out to assess the removal of seven pharmaceuticals. A distinct difference between nitrifying activated sludge and suspended biofilm carrier removal of the pharmaceuticals was demonstrated. The biofilm carriers demonstrated considerably higher removal rates per unit biomass (i.e. suspended solids for the sludges and attached solids for the carriers) of diclofenac, ketoprofen, gemfibrozil, clofibric acid and mefenamic acid compared to the sludges. Among the target pharmaceuticals, only ibuprofen and naproxen showed similar removal rates per unite biomass for the sludges and biofilm carriers.

Carriers and sludge, for the batch experiments, were collected from several full-scale plants. All plants where characterized with respect to either the concentration of carriers or suspended solids. Further characterization was made with respect to sludge age and nitrification capacity for the activated sludges and with respect to surface area, biofilm mass and nitrification capacity for the carriers. Batch experiments and measurements of nitrification capacities were made in completely mixed and fully aerated batch reactors. Pharmaceuticals, 100 µg/L, were added to the reactors and 9 to 12 samples for pharmaceutical analysis were withdrawn from the reactors over 24 h. The samples were centrifuged, filtered, loaded on SPE-cartridges, Oasis HLB 3cc (60 mg), and analysed with a GC-MS, Agilent 5973N Mass Selective Detector. Measurements of pH, NO_3-N, NO_2-N and NH_4-N were made.

The observed pharmaceutical removal was generally much higher for suspended biofilm carriers than for activated sludges, which is showed for diclofenac and ketoprofen (Figure 1a and 1b). Furthermore, normalization of the first-order removal rates by the biomass concentration showed that the higher removal observed for the carriers compared to the sludges was most often induced by a higher removal capacity per unite biomass for the carriers than the sludges.

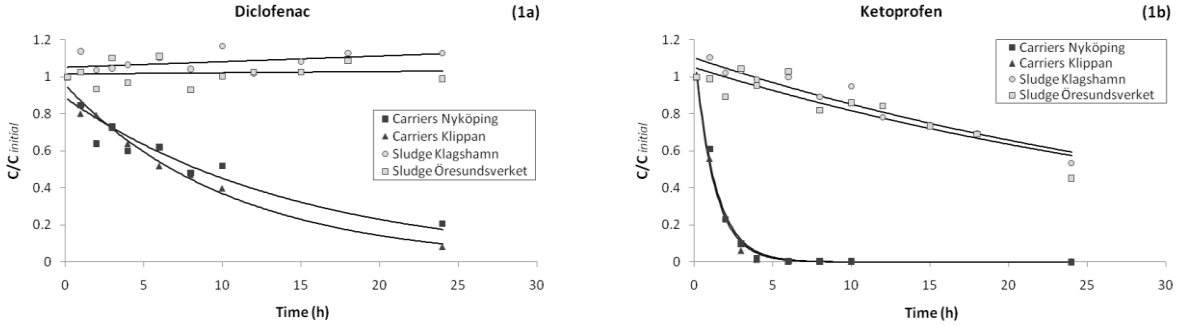

Figure 1a and 1b. Observed removal of diclofenac (1a) and ketoprofen (1b) in the batch experiments.