Aquatic humic substances, iron and manganese removal by ultrafiltration and nanofiltration membranes combined with coagulation-flocculation-sedimentation

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Surface water and groundwater sources for human supply require treatment to remove substances that can cause human diseases and rejection. Aquatic humic substances, such as iron and manganese, interfere with the aesthetic and sanitary quality of the water because they cause color, odor and taste unpleasant. In addition, humic substances can form trihalomethanes which are serious harmful substances [1]. Aquatic humic substances are heterogeneous organic materials, resultant of the microbiological degradation of vegetable and animal residues, which can be produced in situ or transported by rain by percolating the soil [1] [2]. In water, iron and manganese can be found as its reduced forms under anoxic conditions [1] or forming complexes with humic matter [3] [4]. The presence of carboxylic and fenolic groups in the humic substances, enables their complexation with metallic ions, altering their availability, speciation and transport properties [3] [4] [5].

In this report, a comparison between two membrane separation processes, ultrafiltration (UF) and nanofiltration (NF), both of them combined with a coagulation, flocculation and sedimentation system was studied viewing to evaluate its efficiency for removing humic acids, iron and manganese. The previous coagulation step was developed by jar test, using PAC (polyaluminium chloride) as coagulant. The water was stirred rapidly for 10s at a velocity gradient of 340s⁻¹, followed by 20min of slow mixing at a velocity gradient of 12s⁻¹ and a sedimentation period of 30min. The membrane filtration process was carried out in a Koch Membrane System LABCELL CF-1 type cross-flow, flat cell, lab-scale filtration unit, operating in a batch mode. Two types of membranes were applied in the experiment, ROGA cellulose acetate ultrafiltration membrane (MWCO 8kDa), operating at 4bar; and MPF-36 hydrophilic composite NF membrane (MWCO 1kDa), operating at 8bar.

The jar test system was feed with groundwater, containing 17,48 mg/L DOC, 0,784mg/L Fe and 0,199mg/L Mn, and with lake water, containing 13,20 mg/L DOC, 0,237mg/L Fe and 0,018mg/L Mn. After sedimentation, the resultant effluents fed the membrane filtration system. For groundwater, removal capacity of humic acids in terms of DOC was 92% and 81% using NF and UF membranes, respectively; and for lake water was 81% and 78% using NF and UF membranes, respectively. Iron co-removal was effective, exceeding 99% in all cases. Removal of manganese was limited, 53% and 27% applying NF and UF, respectively, for groundwater, and 5% with both of the membranes for lake water, possibly due to its limited capacity to form complexes with humic substances.

Membrane fouling is a major problem for filtration systems application. In this case, coagulation, flocculation and sedimentation pretreatment contributes by removing humic
acids and iron, enhancing ultrafiltration and nanofiltration performance by reduction of fouling, evidenced as reduction on permeate flux decline.

**Key Words:** aquatic humic substances, iron removal, manganese removal, membrane filtration.

References