

## Accepted Manuscript

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PII: S1385-8947(14)01051-1  
DOI: <http://dx.doi.org/10.1016/j.cej.2014.07.136>  
Reference: CEJ 12504

To appear in: *Chemical Engineering Journal*

Received Date: 12 May 2014  
Revised Date: 24 July 2014  
Accepted Date: 31 July 2014

Please cite this article as: J.C. Leyva-Díaz, A. González-Martínez, J. González-López, M.M. Muñío, J.M. Poyatos, Kinetic modeling and microbiological study of two-step nitrification in a membrane bioreactor and hybrid moving bed biofilm reactor-membrane bioreactor for wastewater treatment, *Chemical Engineering Journal* (2014), doi: <http://dx.doi.org/10.1016/j.cej.2014.07.136>

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Kinetic modeling and microbiological study of two-step nitrification in a membrane bioreactor and hybrid moving bed biofilm reactor-membrane bioreactor for wastewater treatment

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## ABSTRACT

A membrane bioreactor (MBR), a hybrid moving bed biofilm reactor-membrane bioreactor (MBBR-MBR) containing carriers in the anoxic and aerobic zones of the bioreactor and a hybrid MBBR-MBR which contained carriers only in the aerobic zone were used in parallel with the same urban wastewater and compared. The reactors operated with a hydraulic retention time (HRT) of 9.5 h. Kinetic parameters for heterotrophic and autotrophic biomasses, mainly ammonium-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB), were evaluated and related to organic matter and nutrients removals. The microbial communities of each wastewater treatment plant (WWTP) were analyzed by 454 pyrosequencing methods to detect and quantify the contribution of nitrifying bacteria in the total bacterial community. All three systems showed similar performance in terms of pollutant removal although the hybrid MBBR-MBR containing carriers only in the aerobic zone of the bioreactor (WWTP 3) showed the best performance from the point of view of the kinetics of heterotrophic and nitrite-oxidizing bacteria, with values of  $\mu_{m, H} = 0.02665 \text{ h}^{-1}$ ,  $K_M = 8.88081 \text{ mg O}_2 \text{ L}^{-1}$ ,  $\mu_{m, NOB} = 0.53690 \text{ h}^{-1}$  and  $K_{NOB} = 2.16702 \text{ mg N L}^{-1}$ . It supported the efficiencies of chemical

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