Efficiency of arsenic oxidizing bacterial biofilms for arsenic contaminated drinking water treatment

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EFFICIENCY OF ARSENIC OXIDIZING BACTERIAL BIOFILMS FOR ARSENIC CONTAMINATED DRINKING WATER TREATMENT

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In drinking water supplies, arsenic exists mostly as two inorganic forms, arsenite [As(III)] and arsenate [As(V)] which are toxic to living organisms [1]. According to WHO recommendations, the drinking water standard was reduced from 50 to 10 µg/L and many regulatory agencies have recently accepted this new standard [2]. Most of the existing treatment processes are effective only on arsenic anionic forms [As(V)] and not on neutral and mobile arsenic complexes [3]. To overcome this lack of efficiency, a first oxidation step of As(III) form is necessary and is usually performed using strong oxidant or binding materials that are costly for small drinking water treatment units. An alternative to theses physico-chemical treatments is the biological treatment using As(III)-oxidising bacteria [4]. Numerous autotrophic bacteria are able to oxidise arsenic. Among them, *Thiomonas arsenivorans* [4-6] is able to oxidise As(III) up to 100 mg As(III)/L and appears to be a good candidate for its known capacity to use As(III) as an energy source and carbon dioxide or carbonates as carbon source. An As(III)-oxidizing biological treatment pilot unit coupled to trapping units for As(V) removal at the outflow of the biological bioreactor was performed on site in order to study the strength of the biological process in real operating conditions. The bioreactor was previously inoculated with the autotrophic As(III)-oxidizing *Thiomonas arsenivorans*. Then, it has been intermittently fed with contaminated water from the drinking water well, at site temperature (15-17°C) and under downstream mode. As(III)-oxidizing biofilm development has been followed during the pilot functioning using CE-SSCP-16S (targeting the global community) and PCR-DGGE-*aoxB* (targeting As(III) oxidizers) fingerprinting techniques. Results showed a complete colonization of the mineral support (*i.e.* pozzolana) by indigenous bacteria of the groundwater to be treated. Moreover, the oxidation yield of the biological step was in the range of 54 to 100 % depending on the residence time (from 30 to 7 minutes) and the residual As concentration at the end of the complete treatment process (biological oxidation and trapping) was below 2 µg As/L. These results are thus very encouraging for an industrial application in regard to the strength and its absence of nutrients supply, except for the low amount of oxygen needed if it is not in sufficient concentration in the site water.

[1] Argos M., Kalra T., Rathouz P.J., et al... www.the lancet.cm, DOI: 10.1016/S0140-673(10)60481-3, **2010**.

[2] WHO, *Guidelines for drinking-water quality*. World Health Organization Press, Geneva, **1996**.

[3] Wang S. and Zhao X., *Journal of environmental Management*, **2009**, *90*, 2367.

[4] Battaglia-Brunet F, Joulian C, Dictor M-C, Garrido F, Morin D, Coupland K, Hallberg KB, Johnson DB, and Baranger P ,**2006**, Ant. Van Leuw. *89*, 99.

[5] Michon J., Dagot C., Deluchat V., Dictor M.C., Battaglia-Brunet F., Baudu M., *Process Biochemistry* **2010,** *45*, 171-178.

[6] WAN J., Klein J., Simon S., Dictor M-C., Joulian C., Deluchat V., Dagot C. *Water Research***, 2010,** 44, 5098-5108.