

Inactivation of Legionella with the DiaCell® Water Treatment Technology

L. Pupuna, Ph. Rychen

The electrochemical DiaCell® technology with BDD/Si-Electrodes confirms its high potential for efficient water disinfection in the case of a contamination by Legionellae. The mixture of electrogenerated very strong oxidants at low concentrations from a typical potable water by DiaCell® is efficient enough to protect against such contamination.

Legionella constitutes a new and increasingly stronger contamination risk many of water systems, such as cooling towers or hot sanitary water distribution networks. European certifications impose concentration limits of 1'000 Cfu/mL^[1], waters with higher levels must be treated. At levels higher than 100'000 Cfu/mL the installations must be stopped and disinfected immediately. Many disinfections systems are used to prevent such contamination, by heat treatment (T>70°C) or chlorine injection, but water system managers and lawyers today are looking for a non-chemical solution^[2] to promote environmental protection. The topic of this work is the evaluation of inactivating Legionella in typical tap water by means of the non-chemical DiaCell® technology.

The results highlight an interesting capacity to need of produce strong disinfectants from a typical tap water without any addition, in order to disinfect and destroy biofilms where Legionella can proliferate.

The experiments were carried out using a monopolar DiaCell® with one compartment, 1 mm interelectrode distance, and a throughput flow of 160 L/h, current densities of 25, 50, 100 or 150 mA/cm². The test protocol consists of Legionella injection in 1L sample of pre-electrolyzed water, the analysis of disinfectant concentration and the Legionella inactivation over a period of 0, 5, 20 and 60 min.

In addition to microbiological measurements, the total disinfectant concentrations were measured by DPD standard method and expressed as total chlorine (ppm). This technique detects all disinfectants in the solution, free or total chlorine (combined chlorine, peroxy-disulfates, peroxy-dicarbonates, hydrogen peroxide, etc). The strain used in this study was a Legionella pneumophila serogroup 1 isolated from a hospital potable water system and identified by the Swiss Center of Legionella, Lugano.

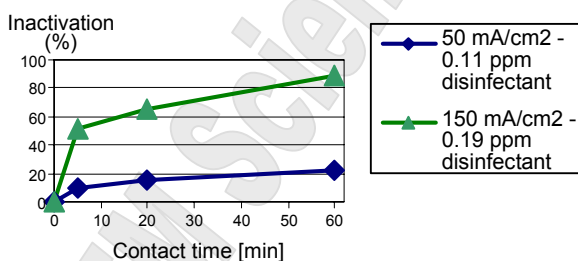


Figure 1: Legionella inactivation after injection in electrolyzed tap water without chlorides ([NaHCO₃]= 5mM)

Tests were done with several tap water qualities. Tap water containing a low level of chlorides (7 ppm) was electrolyzed. It was expected that negligible amounts of hypochlorite would be formed due to low mass transfer of chlorides towards the

electrodes. A high inactivation (90%) was reached after 60 minutes of contact time at 150 mA/cm² respectively at 0.19 ppm disinfectant concentration (Fig. 1).

A Legionella inactivation of > 99.99% at contact time < 60 minutes could be reached with a total oxidant concentration close to 0.70 ppm.

	Fresh water 7 ppm chlorides	Fresh water 75 ppm chlorides
Disinfectants concentration	0.19	0.71
Contact time after Legionella injection (4.10 ⁴ Cfu/mL)	Legionella	Inactivation (%)
5 min	51	99.9
20 min	66	99.99
60 min	90	100

Table 1: Destruction of Legionella injected in water treated on-line flow 160 l/h; DiaCell® 101

The simple DiaCell® electrolysis allows a good prevention against Legionella contamination for potable water for closed systems continuously treated. DiaCell® can be used to disinfect potable water contaminated by Legionella (4.10⁴ Cfu/mL). A remarkable inactivation is already observed after 5 minutes contact time. A low level of disinfectant (< 1 ppm) is sufficient to rapidly sanitize a distribution system. Then, a continuous low level of disinfectant (0.1 – 0.2 ppm) can keep this system disinfected.



Figure 2: DiaCell® configuration 101

The compact and modular DiaCell® shows interesting capabilities to disinfect or to considerably reduce biofouling in water distribution systems like cooling towers or hot water distribution pipes with remanent activity.

[1] Rapport du Conseil supérieur d'hygiène publique de France. Novembre 2001. Section des eaux, Section des milieux de vie, Section des maladies transmissibles; "Gestion du risque lié aux légionelloses", Novembre 2001
 [2] C. Campese, B. Decludt, "Les legionelloses déclarées en France en 2001", Eurosurveillance, 17 (2002) 121