Chemical Engineering and Processing 63 (2013) 1–6

Contents lists available at SciVerse ScienceDirect

Chemical Engineering and Processing: Process Intensification

jo u rn al hom epage: www.elsevier.com/locate/cep

Water denitrification by a hybrid process combining a new bioreactor and conventional electrodialysis

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a r t i c l e i n f o

Article history:
Received 11 April 2012
Received in revised form 9 November 2012
Accepted 10 November 2012
Available online 20 November 2012

Keywords:
Granular Activated Carbon
Electrodialysis
Denitrification
Fixed biomass
Bioreactor

a b s t r a c t

A feasibility study of an innovated denitrification process is achieved in this present work. It consists of a combination of the electrodialysis (ED) and the Column of Immobilized Biomass on Granular Activated Carbon – CIBGAC. In order to perform the electrodialysis process, the influence of various parameters such as current intensity, chloride, and sulphate concentrations were estimated. Therefore, an *optimum* efficiency of the denitrification for an applied *current intensity* value of 50 mA was obtained. The competition between the chloride and nitrate ions was encountered using the electrodialysis process inducing a slow electromigration of the nitrates. In contrary, the presence of sulphate ions had no influence on the electrodialysis during the denitrification. On the other hand, the biological denitrification of brines by electrodialysis was carried out. A clear decrease of pH was observed from 7.5 to 6.2 and the monitoring of the nitrate and nitrite ions through the bio-compartment affirmed the efficiency of this process. The successful establishment of the hybrid denitrification process was realized. Indeed, the treated water in dilute compartment was in conformity in terms of nitrates concentration and even more the concentrations of different ions are below the amounts recommended by the World Health Organization (WHO). TOHOH he brine solution after biological treatment agrees with WHO standards in terms of nitrate and nitrite ions.

1. Introduction

The high concentration of nitrates in drinking waters is mainly due to intensive use of nitrogen fertilizers in agriculture and the increase in domestic waste [1]. Excessive concentrations of nitrate in water can be hazardous to human health, especially for infants and pregnant women such as the asphyxiation in infants (methemoglobinemia) and risk of birth defects. *Several conventional nitrate removal methods* such as ion exchange, electrodialysis, membrane and biological processes were used. Electrodialysis (ED) is one of the most commonly used technique for the removal of specific ions such as nitrates even at high levels, however they produce large amounts of brines which are extremely concentrated not only in nitrate, but also in the various ions present in water (sulphate, hydrogen carbonate, chloride) and, it achieves only a transfer of the pollution in the sewers [1,2].

A biological denitrification is known as a further method used to decontaminate wastewater where microorganisms convert nitrate into nitrogen gas under anoxic conditions. This technique seems to have clear advantages in the feasibility and economics aspects. Nevertheless, every process *has* its own set of advantages and *disadvantages namely* the changes in treated water characteristics (temperature, turbidity, composition etc.) and through *bacterial contamination* risk also [3,4].

The main purpose of this work is to propose a new hybrid denitrification process combining the electrodialysis (ED) and Column of Immobilized Biomass on Granular Activated Carbon (CIBGAC) bioreactor. The electrodialysis (ED) ensures the separation of nitrate ions and the production of suitable drinking water and the quality of the drinking water is not affected by the biological process or by bacterial contaminants, even when the (CIBGAC) bioreactor treats the nitrate concentrate provided by ED treatment, and gives a complete elimination of nitrate (Fig. 1a).

The optimization of each technique composing the hybrid process allows the improvement of its performance. The experimental

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http://dx.doi.org/10.1016/j.cep.2012.11.004