Efficient Reduction of Chemical Oxygen Demand in Industrial Wastewaters

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The specific properties of boron doped diamond on silicon (BDD/Si) electrodes help to reduce the chemical oxygen demand (COD) in industrial wastewaters below the environmental reject levels. The COD degradation obtained in real industrial wastewaters and the increase of the biodegradability demonstrate a high potential application of the DiaCell® technology.

Depending on the industry activity and the situation, maximum chemical oxygen demand (COD) levels between 200 and 1000 mgO_2/l ($ppmO_2$) must be reached in order to release the wastewaters back into the environment [1]. Wastewater treatment technologies, such as filtration, biological digestion, or incineration exist but these technologies are either expensive or generate sludges which must be eliminated in a second step. The technology presented here consists of the reduction of the COD or the increase of the biodegradability of initially nonbiodegradable industrial wastewaters through a highly efficient electrochemical treatment.

Tests have been realized in a pilot laboratory (Fig. 1) with a DiaCell® 101 (one compartment with 1 mm gap between electrodes), a flux of 200 l/h, and temperatures ranging from 20 to 30°C. The electrical current supply of the DiaCell® is optimized according to the solution to be treated and the level of COD. Many kinds of real wastewaters from pharmaceutical, electrochemical or chemical industries have been tested.

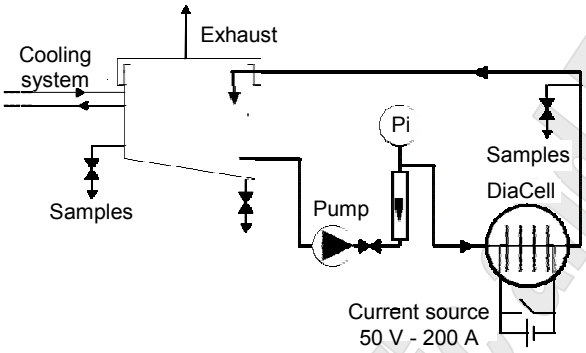

Figure 1: DiaCell® test pilot

Electrochemical treatment with BDD/Si electrodes having high anodic over voltage (+3 V), generates highly oxidizing elements as hydroxy radicals to break down organic molecules independently of their biodegradability. The electrochemical degradation of COD consists in the destruction of organic molecules down to the formation of CO_2 equivalent of total mineralization. The maximum theoretical elimination rate is 300 $ppmO_2/Ah$ (100% current efficiency), but in some cases, this yield is difficult to reach mostly due to mass transfer limitation at low COD level.

In case of effluents with high organic concentrations, such as emulsions from degreasing baths, a first pretreatment (acidification) can be used to break the emulsion and reduce the COD level from 100 g/l O_2 to 8 g/l O_2. The DiaCell® technology can be efficiently used as second step to finish the treatment (Fig. 2), reducing the COD concentration below 1 g/l O_2 with only 0.13 kWh/l. The COD lowers down to 50 - 100 ppm, requiring approximatively 0.2 kWh/l.

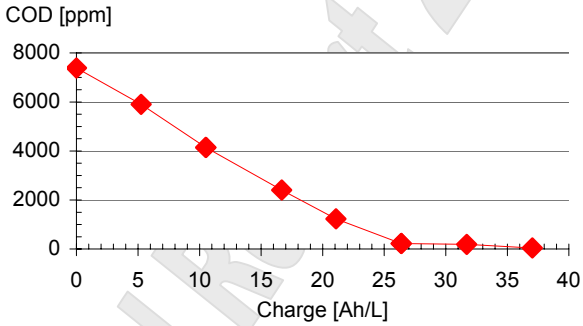

Figure 2: COD reduction of degreasing bath after pretreatment; voltage: 5 V, DiaCell® 101, flow: 180 L/h, 20 - 25°C

Non-biodegradable wastewaters with very high organic load from pharmaceutical or surface finishing industry have been pretreated by DiaCell® (Fig. 1) in order to initiate a biological digestion. A DiaCell® treatment step with an electrical charge of 5 Ah/l is sufficient to initiate a massive biological action on a nonbiologically degradable COD.

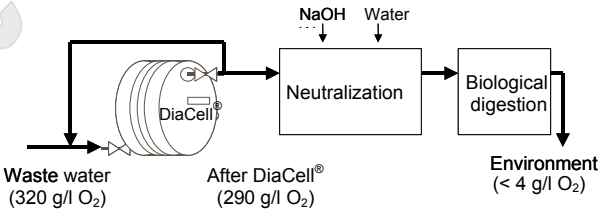

Figure 3: Treatment steps for highly loaded COD wastewaters

The DiaCell® technology has proven to be useful either alone, as a final treatment to reach low COD values in conformity with environmental legislations, or as a pretreatment to increase the efficiency of a subsequent biological digestion. This technology offers a new efficient treatment and is more cost-effective than present incineration or evaporation solutions.

[1] *Office fédéral de l'environnement, des forêts et du paysage (OFEFP), "Déversements de l'industrie chimique dans les eaux ou dans les égouts publics", Informations concernant la protection des eaux, Report N° 40 (2001) 36*