Treatment of wastewater from microelectronic industry: process analysis of a combined process scheme

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Abstract

The production of semiconductors requires a series of specific treatments in which a large amount of ultra-pure water is used. As a consequence of this, a large amount of polluted process water is produced that must be treated before discharged into the sewer [1]. The treatment cost of the wastewater is a significant effect on the industrial total cost and the microelectronics industry is trying to adopt production processes accompanied by water treatment processes for production of ultra-pure water at a reasonable cost, involving water reuse [2].

The principal pollutants are inorganic compounds such as mineral acids (sulfuric, nitric, hydrofluoric, phosphoric acids), ammonium hydroxide, heavy metals (copper, cobalt) and organic solvents. The mineral acids and the metals are successfully removed by most of the treatment processes of the semiconductor sewage industry [3].

There are some problems in the treatment of organic compounds, among these is Tetramethyl Ammonium Hydroxide (TMAH, $(CH_3)_4NOH$. This last is corrosive, slow to biodegrade and eutrophic to aquatic environments [4-5]. Disposal of TMAH wastewaters from an industrial plant is a difficult and costly issue.

The scientific literature shows that it is possible to remove this pollutant by using chemical/physical processes (e.g. advanced oxidation processes (AOP) and adsorption) as well as biological processes (e.g. anaerobic digestion).

In this paper, an integrated process stream is proposed for the treatment of wastewater produced by electronic industry. A combination of chemical-physical and biological processes for the removal of TMAH and other pollutants as nitric and acetic acid is described in order to purify the water. Firstly, a series of experimental results obtained in the laboratory scale is reported, after in accordance with these results a process scheme is proposed and simulated with commercial software in order to investigate the technical feasibility and describe the overall mass balance of the whole scheme.

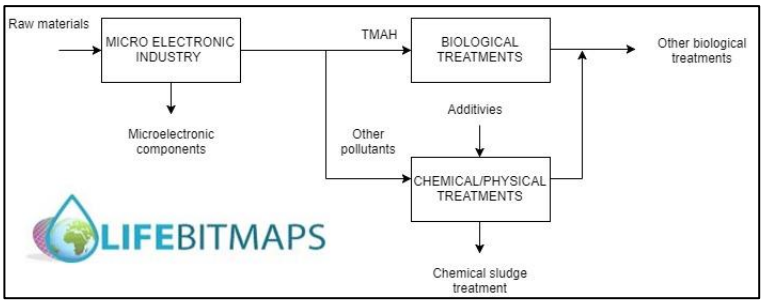

Figure 1: Block scheme of the process proposed for the removal of TMAH and other pollutant from industrial electronics wastewater. The process was conducted within Life Bitmaps project

Recent Publications (minimum 5)

1. Prisciandaro M., Capocelli M., Barba D., Piemonte V., Process analysis applied to water reuse for a "closed water cycle" approach. Chem Eng J. (2016) 304: 602–608.
2. Degremont http://www.degremont-industry.com/en/your-industri- sector/microelectronicsindustry, (2015).
3. Huang C.J., Liu J.C., Precipitation flotation of fluoride-containing wastewater from semi-conductor manufacture. Wat. Res. (1999) 33: 3403-3412.
4. Lin H.L., B.K. Chen, H.P. Hsia, G.H. Yang, Y.F. Yang, Y.C. Chao, S.S. Cheng, Use of two-stage biological process in treating thin film transistor liquid crystal display wastewater of tetramethylammonium hydroxide. Sustain. Environ. Res. (2011) 21: 155-160.
5. Ballard T., N. Chowdhury, B. Heiniger, D. Horner, A. Lau, S. Mehta, B. Schilling, R. Ubaldi, J. Williamson, Novel Process for the Treatment of Wastewaters from the Microelectronics Industry. IWC 13-34, 74th Annual International Water Conference 2013, Orlando Florida

Biography

Ida DE MICHELIS got the degree in Chemical Engineering in the year 2003 in the University of L'Aquila. In the same University in the year 2007 she got the Ph.D degree in engineering and physics-mathematics modeling. The main research activities are relative to the bio-hydrometallurgical sector, in particular she have studied the recovery of base and precious metals from ores (primary raw materials) and solid wastes (secondary raw materials). In the research ambit, she has also collaborated in project for the design and start-up of pilot plant for the treatment of spent batteries (recovery of Mn and Zn) and WEEE (recovery of rare earths). She is also involved in researches about the treatment of industrial wastewaters. In this ambit, in the 2012, she won a Marie Curie research fellowship.

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