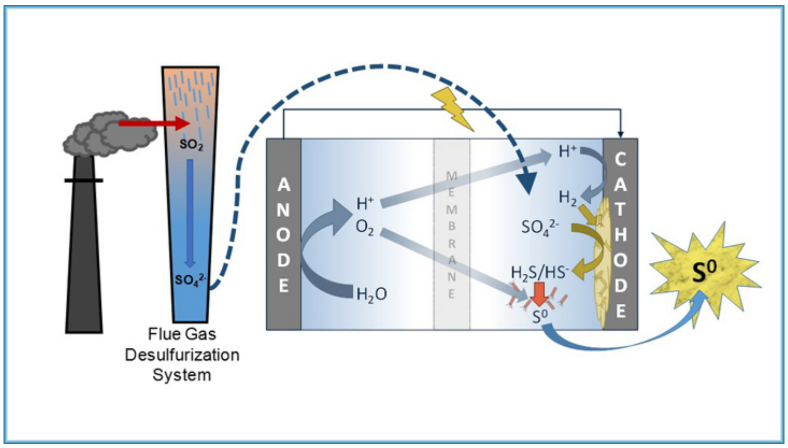
UABDIVULGA
BARCELONA RECERCA I INNOVACIÓ

29/03/2019

Recovery of elemental sulfur from industrial wastewater: a new application of bioelectrochemical systems



Industrial activities generate wastewater and gases with high sulfate content. Sulfate is not harmful but if it is disposed into sewers or rivers, some bacteria transform them into hydrogen sulfide, which is toxic and corrosive. Hence the importance and need to develop new technologies, such as microbial bioelectrochemical technologies, to treat and even reuse and recover sulfur compounds. In this study, real industrial wastewater from the treatment of gases is used for the first time demonstrating that bioelectrochemical technologies improve the growth of bacteria that favors the elemental sulfur recovery.

Sulfate is a sulfur compound found naturally in the environment, either in a solid form, forming minerals such as gypsum, or in a dissolved form in all types of water. Industrial activities such as paper, pharmaceutical, mining, food processing, etc. generate wastewater with high sulfate content. In addition, industries that burn fossil fuels generate sulfur dioxide, which is a gas that causes the so-called acid rain. For this reason, these industries require the treatment of this gas and water with high sulfate content.

Sulfate is not very harmful to health. But if it is disposed into rivers or sewage systems, the microorganisms known as sulfate-reducing bacteria (SRB) transform it into hydrogen sulfide. Hydrogen sulfide, with an unpleasant odor characteristic of rotten eggs, has been shown to be toxic at low concentrations, apart from damaging sewer facilities for its corrosive power. For these reasons, the treatment of effluents rich in sulfur is essential to avoid possible impacts. Beyond the simple treatment, the recovery of elemental sulfur from these effluents in order to be reused as fertilizer or to be reincorporated into the production lines of other industries is an opportunity to recover resources within the framework of the circular economy.

In recent years, the research world has focused on microbial electrochemical technologies due to its versatility to treat wastewater, produce energy and also produce a wide range of chemical compounds. These technologies work like electric batteries, so, they contain an anode where an oxidation reaction takes place and a cathode where a reduction reaction takes place. To be microbial, microorganisms must catalyze one or both reactions. These bioelectrochemical systems generate a flow of electrons that can be used for energy production or the supply of electrons necessary for the production of chemical products.

Microbial electrochemical technologies is one of the research lines of GENOCOV from the Departament d'Enginyeria Química, Biològica i Ambiental at UAB. These emerging technologies can be applied, for example, to the treatment and recovery of sulfur compounds. Particularly, the PhD research of Enric Blázquez studies the treatment of wastewaters with high sulfate content in a bio-cathode. In this system, SRB colonizes the surface of the cathode and uses the electrons to transform the sulfate into hydrogen sulfide. This hydrogen sulfide must be subsequently oxidized to recover elemental sulfur. The results obtained showed that in the electrolysis of the water that takes place at the anode, there is an oxygen flow to the cathode that allows the growth of microorganisms responsible for producing sulfur from hydrogen sulfide, named sulfur oxidizing bacteria (SOB).The work Treatment of real flue gas desulfurization wastewater in an autotrophic biocathode in view of elemental sulfur recovery: Microbial communities involved uses for the first time real industrial wastewater from the treatment of gases generated by the combustion of fossil fuels. The results show that the real wastewater used decreases the capacity of the SRB but improves the growth of SOB, which favors elemental sulfur recovery. The studies carried out so far have allowed: a) to produce elemental sulfur in a single reactor from sulfate (Blázquez et al., 2016), b) to determine key conditions to optimize sulfur production (Blázquez et al., 2017) and c) to demonstrate that the technology is applicable to real wastewater (Blázquez et al., 2019), demonstrating the great potential of microbial electrochemical technologies for the recovery of sulfur. At the same time they have allowed to treat wastewater without the addition of other compounds to help bacterial growth, which is one of the typical limitations of other biological treatment technologies.

Albert Guisasola
GENOCOV (www.genocov.com)
Department of Chemical, Biological and Environmental Engineering
Universitat Autònoma de Barcelona
Albert.Guisasola@uab.cat

References

Blázquez, E., Baeza, J.A., Gabriel, D., Guisasola, A. (2019). **Treatment of real flue gas desulfurization wastewater in an autotrophic biocathode in view of elemental sulfur recovery: Microbial communities involved**. *Science of Total Environment,* 657, 945–952. DOI:10.1016/J.SCITOTENV.2018.12.037.

Blázquez, E., Gabriel, D., Baeza, J.A., Guisasola, A. (2016). **Treatment of high-strength sulfate wastewater using an autotrophic biocathode in view of elemental sulfur recovery**. *Water Research,* 105, 395–405. DOI:10.1016/j.watres.2016.09.014.

Blázquez, E., Gabriel, D., Baeza, J.A., Guisasola, A. (2017). **Evaluation of key parameters on simultaneous sulfate reduction and sulfide oxidation in an autotrophic biocathode**. *Water Research,* 123, 301–310. DOI:10.1016/j.watres.2017.06.050.