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Electrocoagulation-flocculation hybrid processes in relation to hydrogen cogeneration

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Electrocoagulation is a process which involves the electrolytic addition of a coagulating metal from a sacrificial metal electrode such as aluminum or iron placed in water that hydrolyzes and coagulates colloids. Several works have proposed mechanisms for the process which include the formation of hydrogen gas in the reaction cell, while an approach to examine its harvesting as a by-product for energy has not been addressed there.

\This paper is aimed to be a primary step looking at the development electrocoagulation-flocculation treatment processes of wastewater effluents that could make a potential hydrogen gas source. Electrocoagulation/flocculation (ECF) coupling with ultrafiltration (UF) for organics removal and flux enhancement and, with granular filtration (GF) and constructed wetland (CW) for P removal from secondary effluents are examined. Bench-scale experiments of ECF-UF and ECF-UF combinations and field, semi-industrial scale ECF-GF-CW pilot tests had been performed.

ECF, followed by sedimentation, removed humic acid up to 90% at pH 8.1 independently of current density and reduced fouling. Field pilot results show up to 97% of total P removal, reduction of TOC (53%) and most of the TSS. The hybrid action is explained by combining flocculation and adsorption mechanisms produced by the EF with transport, attachment and biodegradation mechanisms in the CW beds. The paper concludes that electrocoagulation can be effectively used in the removal of humic acid from water. ECF as pretreatment for UF membrane filtration improved filtrate quality and reduced the fouling, particularly by lowering cake influence. Iron-based ECF can provide a highly efficient method for fouling mitigation in both MF and UF of secondary effluents. And, complementing CW treatment with a physicochemical process of ECF reduces phosphate in both soluble and particulate forms, and removes organic matter and nitrogen compounds. Hydrogen bubbles have been observed in all processes above mentioned, the following step of quantifying its energy recovery potential is discussed.

Keywords: Hydrogen formation; electrocoagulation; effluent treatment; energy