Application of heterogeneous Fenton-like processes for the elimination of organic pollutants: Photo-Fenton, Sono-Fenton and continuous Catalytic Wet Peroxide Oxidation Systems

Raúl Molina, Rey Juan Carlos University (Móstoles, Madrid, Spain)

Summary
Over the past two decades, the environmental protection has emerged as a crucial point of influence in the social and political life, as well as in the technology and economical level of the countries. It has to be pointed out that the volume of wastewaters increases with regards to a country's level of industrialization, and therefore the control of the effluents becomes a critical necessity in the society. Thus, the more strict control of the quality of the effluents dumped to municipals sewers or nature streams leads in more restrictive environmental laws and regulations (European Directive 2000/60/CE). The effective removal of pollutants from wastewaters becomes a challenging task and has stimulated the development of new technologies to comply with tightening regulations. Organic compounds such as aromatic hydrocarbons, phenolic compounds, chloride pesticides or polycyclic aromatic hydrocarbons are common pollutants in the effluents of several industries. These compounds are refractory to conventional chemical and biological treatments, and it is accompanied with bio-toxicity and refractory behaviour for the micro-organisms. This is why different methods are being studied as an alternative for wastewater degradation. In this way, new technologies named Advanced Oxidation Technologies (AOT's) are an interesting alternative for the destruction of organic pollutants in industrial wastewaters. These technologies involve the generation of non-selective and highly reactive hydroxyl radicals (OH•), which are not only one of the most powerful oxidation agents, but have a higher oxidation potential than others commonly used water oxidant chemicals. Among the Advanced Oxidation Processes, Fenton's reagent has emerged as an interesting alternative for the treatment of dissolved organic pollutants in wastewater streams. This technique is based on the generation of powerful OH· radicals from hydrogen peroxide in presence of a metallic ion, commonly Fe(II), or other low valency transition metals Fe(III), Cu(II) or Mn(II), dissolved in the aqueous medium. However, the limited range of the pH (3-4) in which the reaction proceeds and the need for recovery of homogeneous catalyst to comply with the European environmental regulations are the major drawbacks of this technology. In this sense, a growing research field is the immobilization of transition metals (especially iron species) over different supports, which provides an easy separation and recovery of the catalyst from the treated solution. On the other hand, integration of Fenton system with UV-visible radiation and acoustic cavitation (photo and sono-Fenton systems) provides more powerful oxidation techniques for wastewater purification. This work reviews different heterogeneous Fenton processes using iron species supported over a mesoporous silica material (Fe_2O_3/SBA-15) and their successful application for the treatment of model pollutants and also real industrial effluents. Finally, a step forward is carried out showing a lab scale set-up where the Fe_2O_3/SBA-15 is employed as Fenton-like heterogeneous catalyst for the treatment of industrial wastewaters by catalytic wet oxidation in presence of hydrogen peroxide (CWPO), in a continuous up-flow fixed bed reactor (FBR). Among different industrial effluents, the treatment of wastewaters coming from a pharmaceutical industry by the FBR will be shown.

Keywords: Heterogeneous Fenton-like processes, industrial wastewater, pharmaceutical wastewater, SBA-15, Fixed Bed Reactor.