MANUFACTURING AND APPLICATION OF RACEWAY PONDS FOR WASTEWATER TREATMENT

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Photo-Fenton process is considered a promising treatment for wastewater with high and low contaminant load. Drawbacks such as high operating cost, narrow pH range (acidic pH) for efficient operation, large production of iron sludge, and limited treatment capacity still require research efforts to be properly addressed.

On the other hand, tubular photo reactors designed for efficient photon capture, like compound parabolic collectors, CPCs, have been used to treat high pollutant wastewater. Other reactors, as flat collector (FP) and raceway pond reactors (RPR), have been also tested (see table 1) and compared in terms of efficiency and cost to treat industrial wastewater by solar photo-Fenton (Cabrera-Reina et al., 2019).

Table 1. Comparison between RPR, CPC, and FP (Cabrera-Reina et al., 2019).

Parameter	Cost	Efficiency (common polluted wastewater)	Efficiency (high polluted wastewater)	Treatment capacity	Accumulated energy
RPR	Low	High	Medium	High	Medium
CPC	High	High	High	Low	High
FP	High	High	High	Low	High

The cheaper operation of RPRs and its larger volume/surface ratio (Wang et al., 2013) indicated the potential application of these kind of reactors to treat industrial wastewater by solar photo-Fenton (Cabrera-Reina et al., 2019).

In order to develop the modeling and application of RPRs for photo-Fenton process, 3D additive manufacturing is proposed. The prototyping of such a reactor with different materials has not been considered. This contribution is focused on the selection of materials and mechanical parameters for reactor prototyping and subsequent testing of the chemical suitability of the reactor for carrying out the advanced oxidation processes under study.

In order to manufacture RPR by 3D printers as an alternative way for rapid and less cost practical choice, PLA (polylactic acid) was tested in a lab-scale RPR through FFF (Fused Filament Fabrication) printing technology. PLA was selected due to its high printability, low price, and its chemical and mechanical properties,

First, a set of pieces of printed PLA was exposed during 8 days to conditions recreation the reaction environment: acidic pH, (around 3), 300 mg·L^{-1} H_2O_2, and 20 mg·L^{-1} Fe (II) under sunlight. The variation of TOC in the solution was measured over time and results and confirmed PLA resistance to the reaction environment.

After that, as shown in Fig. 1, the lab-scale prototype of RPR was printed. The wall thickness was 4 mm and the capacity was 500 mL. The appropriate optical path depends on liquid depth, iron concentration and irradiance distribution in the reactor. Indeed, liquid depth could be used as an operation variable and set as a function of solar irradiance (Rivas et al., 2014). However, due to the nature of the process, FFF creates porosities placed at the interface between the layers, so water leakage in FFF printed products is a challenge (Morales-Planas et al., 2018). Results are presented and discussed in regard of the diverse assays performed to address this issue, following reported studies and adjusting printing parameters such as printing velocity or the dimensional precision.

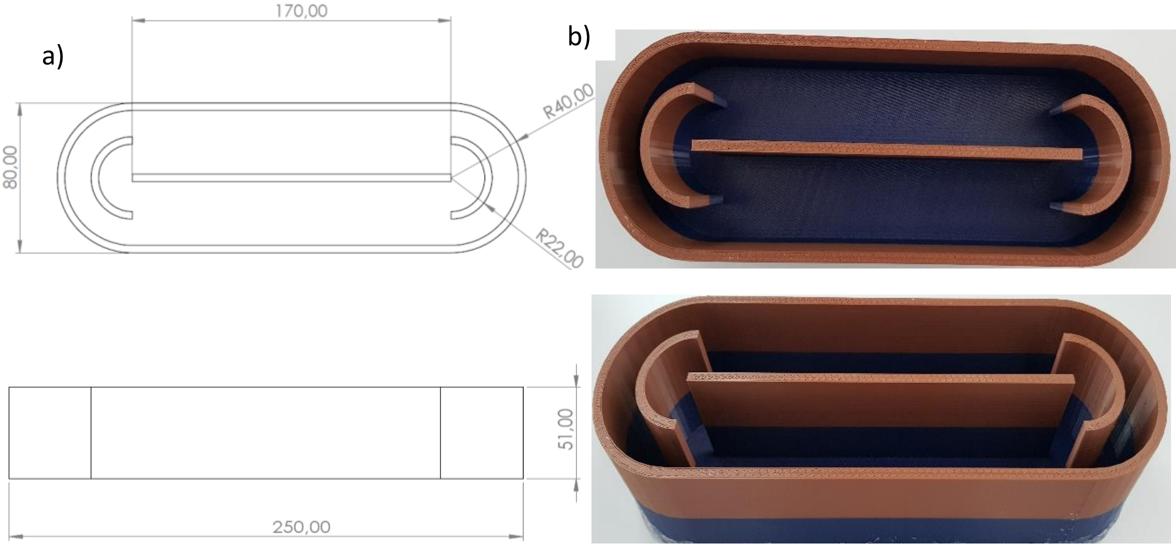

Fig. 1 Lab-scale RPR. a) scheme of designed RPR(mm). b) printed PLA RPR.

Finally, the printed PLA lab-scale RPR was tested for holding a photo-Fenton process and it was compared with a standard pyrex reactor under similar conditions (artificial UVA light, Fenton reagents and contaminant). The results of different assays, with and without contaminant confirm that no organic matter from the container contaminated the solution. This work shows the promising capability of PLA to be used as a photo-Fenton reactor. Next steps will be oriented to increasing the reactor capacity and study its durability.

References

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