Chapter 8: Conclusions and recommendations

The design of a solar photocatalytic pilot plant to handle 350 L of polluted water was proposed and the assembly process was outlined in detail. Main engineering parameters in the assembly were the selection of configuration, accessory type and material, desired flow rate, and operation time. A figure-of-merit, collection area per order (A_{CO}), was used to relate degradation kinetics, dependent on catalyst and target compound, to a working operation time of the proposed design. Discussion over the validity of results was presented, and in general, it was seen that atrazine is slower to degrade than 2,4-D. Regarding the catalysts, for data used Fenton proved to be the most efficient, however further research should be conducted to determine if this behavior stays true under solar irradiation conditions.

Information regarding pesticide use and container disposal in Mexico is scarce and comes from private industrial information sources. To verify the accuracy of the information offered, research should be complemented with information actual users of pesticides provide. In Mexico there is little education over the hazards of pesticide and re-use of its containers. Many of them are left in fields, becoming point sources of pollution to the environment.

Recent legislation in Mexico calls for management plans for containers of pesticides. Recycling is the most environmental-friendly end-of-life option, which can too, render economical benefit in the sale of raw materials. To recycle containers, they should be cleaned, and water coming out from this process is to be subjected to special pre-treatment before conventional treatment. Solar photocatalysis presents a low-cost, energy efficient sustainable option for the treatment of effluents polluted with pesticides.

Photocatalysis using Fenton reagent has been proven effective to degrade of 2,4-D and atrazine. Full mineralization occurs to 2,4-D and atrazine's last known degradation compound is cyanuric acid. Literature reports Co-PMS as a Fenton-like reagent that is effective in the degradation of both pesticides.

The pilot plant assembly is simple and the design, versatile. Other than the compound parabolic collectors, parts can be easily purchased locally, with only two valves having to be bought in Mexico City with a four week waiting period. Materials are cheap, and the attachment options enable for a quick setup and dismantling if needed.

The most versatile configuration, with less energy requirements was to place the four CPC in series with three-way valves at the ends. A 0.5 HP centrifugal pump is required to drive the system.

A figure-of-merit for solar photocatalytic plants was reviewed. In its analysis it presented several absurds, and more research should be directed toward its enhancement. The kinetic parameter k, is the link between reaction kinetics and pilot plant operation. A revision of the form of A_{CO} is proposed. Under the conditions used for this work, A_{CO} was found unsatisfactory to compare amongst solar photocatalytic systems.

The figure-of-merit A_{CO} was used to compare amongst degradation efficiency between Fenton and Co-PMS reagents. With data taken from literature, Fenton came out as the most efficient reagent for the degradation of both 2,4-D and atrazine. However results should be taken cautiously and all of them are probably over-specified because data was taken with reactions under different conditions than the ones the proposed plant will work with. Laboratory research under the conditions of operation of the plant is needed to truly asses the pilot plant working time.

The impact of pH is neglected, as all data was taken under Fenton-favorable conditions. (pH≈3). At a more environmental-friendly neutral pH, literature points out Co-PMS as a more efficient catalyst for the degradation of pesticides.

Future lines of investigation may be centered around two areas: 1) development of alternative figures-of-merit and scale up terms and 2) enhancement of Fenton and Fenton-like reactions by the periodic addition of oxidant. In the first line, the impact of irradiation on the velocity of reaction and k should be properly addressed, to account for performance differences according to climate. The second line suggests the detailed study of the influence of adding oxidant species in the velocity of degradation. If found to improve overall reaction, additions to the pilot plant should be considered (i.e. dosification pump for controlled addition of reagent).