

**Advanced systems for the enhancement of the
environmental performance of WINeries in Cyprus
(WINEC)**



Deliverable 37

**Engineering and Technological Parameters Development for the two
prototype solar photocatalytic reactors**



1. Summary

Winery wastewater contains high concentrations of organic compounds including phytotoxic and recalcitrant compounds like phenols. Its treatment by conventional processes is difficult due to the variability of the characteristics of winery wastewater.

As winery effluents' physicochemical characteristics vary significantly depending on the geographical location of the winery, the season, the vinification methods employed and the treatment facilities available, it was deemed necessary to use wastewater from different sources/wineries in the following study.

This research aimed at the optimization of the homogeneous solar Fenton process ($h\nu/\text{Fe}^{2+}/\text{H}_2\text{O}_2$), as post- and pre-treatment, for the removal and the possible mineralization of the organic content of winery wastewater effluent. The study included pilot scale experiments, with raw winery wastewater and winery effluent after biological treatment, via a Membrane Bioreactor (MBR). The main objective of using the solar prototype photocatalytic reactors was to fill the gap between the laboratory solar simulator (i.e. bench scale) and industrial scale plant, considering the actual conditions in pilot scale. The results of the experiments in pilot scale can be used as the basis for experiments in industrial scale at the system installed at Tsiakkas winery, following the membrane bioreactor.

The main goals of the pilot scale study were, the determination of the optimum conditions for the two winery wastewater effluents (raw winery wastewater and MBR treated wastewater), the determination of the mineralization of the effluent organic load (DOC), the study of the degradation kinetics and the evaluation of the toxicity towards microorganism and plants (*Daphnia magna*, *Vibrio Fisheri*, *Sinapis alba*, *Lepidium sativum*, *Sorghum saccharatum*).

The experimental conditions during the study of homogeneous solar Fenton of MBR effluent are summarized as follows: The H_2O_2 and Fe^{2+} concentrations ranged between 100-750 and 3 mg L^{-1} respectively, and the solution pH_0 ranged between 2.9-3.0. During the study of homogeneous solar Fenton of raw winery wastewater, the experimental conditions varied between 100 and 1000 mg L^{-1} for H_2O_2 and in the case of the iron catalyst between 5 and 29 mg L^{-1} , and the solution pH_0 was 2.9.

After 180 min of solar Fenton treatment, the COD removal of the MBR effluent was 85% for the optimum conditions ($5 \text{ mg L}^{-1} \text{ Fe}^{2+}$ and $500 \text{ mg L}^{-1} \text{ H}_2\text{O}_2$). The COD removal was found to be higher than DOC removal (~70%) indicating that the oxidation was not complete. Finally after 240 min of solar treatment the toxicity to *D. magna*, decreased to zero after 24 h and 48 h of exposure. With regard to the solar Fenton treatment of the raw winery wastewater, the mineralization of the effluent reaches almost 50% after 280 min of irradiation time. Extending the reaction up to 400 min of constant illumination, the COD abatement exceeds 80%. Proceeding at higher reaction times with over 50% COD abatement, the toxicity to *V. fishery* decreases significantly with the inhibition reaching down to 20% and is maintained at such low levels even after the COD of the effluent has been reduced over 80%.

For more information about the complete deliverable please send an email to lioann01@ucy.ac.cy.

