SUMMARY

Municipal wastewater comprises of domestic (or sanitary), industrial wastewaters, infiltration and inflow into sewer lines, and storm water runoffs. The characteristics of municipal wastewaters vary from location to location depending upon the sources of discharge, the effluents from industries, land uses, ground water levels, and degree of separation between storm water and sanitary wastes.

Solar photochemical detoxification technologies can provide the environmental waste management municipal with a powerful new tool to destroy waste with clean energy from the sun. The solar photocatalytic treatment of municipal wastewaters (for small communities) was also proposed. Photocatalytic methods are certainly a very important technology, not only for water purification, but also for air purification (e.g. sterilization of air in hospitals).

The solar heterogeneous or homogeneous photocatalytic method used for the treatment of municipal wastewater. More specifically, the method consists of the combination of a common physicochemical precipitation, a solar photocatalytic reduction of the organic content of wastewater by the use of a heterogeneous or homogeneous solar photocatalytic method.

Because they are very technologically and environmentally attractive, solar photocatalytic process have seen spectacular development in recent years. In the beginning research in solar photocatalytic chemistry was centered only on converting the solar energy into chemical energy, but today the entire range of solar photocatalytic detoxification application has a
promising future. The potential applications of solar detoxification include drinking waste, ground water and industrial wastewater treatment, disinfection of hospital waste etc.

The study will lead to optimization of the solar photocatalytic treatment for the application to municipal waste because the rapid pace of urbanization and industrialization has brought in the host of environmental problem in recent years. The use of this technology is not seen at particular area region so it would prove beneficial for the remediation of waste in municipal, industries and other applications. The use of renewable energy of sun would be feasible from the energy conservation and clean technology point of view.

Any treatment process must guarantee the elimination of pollutants, in the effluent to meet discharge standards, which are directly related to the type of pollutant in the wastewater. The elimination of pollutants in wastewater needs different basic treatment like chemical oxidation, air desorption, liquid to liquid extraction, adsorption, inverse osmosis, ultra filtration and biological treatment. The selection of the techniques depends upon the concentration of the effluent (incineration and chemical oxidation for higher concentration of pollutant/adsorption and membrane filtration for lower concentration). Cost of the process and volume of the effluent also determine the type of treatment technique to be used.

The chapter 2 describes the experimental work. The material and methods used for the study are described in detail explaining the objective of each experiment and the analytical techniques used.

The first part portrays the designing details of the solar system in which the experiments are performed. The modifications were carried out in existing parabolic trough solar collectors
used for thermal processes, in order to make the collector suitable for the photocatalytic applications.

TiO$_2$ was used as the photocatalyst in this study. It has been proved to be one of the best photocatalyst in terms of cost and stability. Hydrogen Peroxide was used as a hole scavenger, to improve the reaction rate. The properties of TiO$_2$ as a photocatalyst and hydrogen peroxide are also described in this chapter.

The municipal wastewater was collected from a municipal wastewater treatment plant (MWTP). Grab composite samples were collected from the collection tank before entering the treatment cycle. The major waste water constituents were COD, Total Coliforms Organism MPN/100 ml; Cr, Ni, Cu and Zn were studied.

Experiments at different pH values were performed at an optimum catalyst and hydrogen peroxide concentration that gave best reduction. pH values 2, 4, 6, 8 and 10 were selected as it could be the possible pH values of any type of municipal wastewater.

Microstructural analysis by XRD was performed for the catalyst surface. The obtained statistical models were evaluated for each response function and the experimental data were analyzed statistically applying analysis of variance (ANOVA) and using Design-Expert 6.0.6.

In the chapter 3, synthetic municipal wastewater was prepared in the laboratory used for the study. Distilled water was used to prepare the wastewater. The optimized parameters were then validated for the actual municipal wastewater. Solar photocatalytic oxidation has been investigated through laboratory experiments as an alternative to conventional secondary treatment for the organic content reduction of high COD and metal ions wastewater.
The experimental design followed the sequence of dark adsorption studies of organics, followed by photolytic studies (in absence of catalyst) and finally photocatalytic studies in presence and absence of additional oxidant (H₂O₂). All the experimental studies have been performed at pH values of 2, 4, 6, 8, 10 and the initial pH value of the wastewater (normal pH). For photocatalytic studies, TiO₂ has been used as a photocatalyst. Optimization of catalyst dose, pH and H₂O₂ concentration has been done.

Chapter 4 incorporates the study of photocatalytic disinfection of Total Coliform (TC) bacteria as water microbial pollution, reducing the Chemical oxygen demand (COD) as organic pollution and metal ions (Cr, Cu, Ni, Zn) as inorganic pollution index using catalytic and oxidant in presence of sun light. The municipal wastewater was monitored for TC reduction and in separated stage was contacted with solar radiation, solar radiation/TiO₂, solar radiation/TiO₂/H₂O₂ of them and various parameters such as contact time, pH and different concentration of TiO₂ and H₂O₂ were studied in terms of their effect on reaction process. The absorption and reduction of the municipal wastewater at different pH values (7.2, 2, 4, 6, 8 and 10) was also investigated. The detention time was kept constant i.e. 300 min.

Chapter 5 dealt with the statistical models i.e. ANOVA and Design-Expert 6.0.6, a DoE software tool from Stat-Ease which has been used for evaluating each response function and statistical data analysis. The adequacy of the final models was verified by graphical and numerical analysis. The RSM has been used to determine the relation between percentage of COD and metals like Cr, Cu, Ni and Zn removal with operating parameters such as solar
radiation/TiO$_2$ and solar radiation/TiO$_2$/H$_2$O$_2$ and pH values were fixed 2, 4, 6, 8 and 10 separately performed using Response Surface Methodology (RSM),

Chapter 6 is about the post treatment studies and Techno-economic analysis for the solar detoxification process. Reuse study of the catalyst is described as a part of post treatment studies. In the techno-economic analysis the present treatment technologies have been compared with solar detoxification. Cost is always an important consideration in selecting innovative technologies for development. The cost of the early solar technology is higher than for the more advanced competitors. The catalyst reuse studies were performed. The effect of reuse on quantum yield was also observed.