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Building Integration of Solar Thermal Systems

The purpose of this study is the presentation of one, as much as possible, complete picture regarding the building integration of solar thermal collectors. The aim of this study is the avoidance of the classic solar thermal systems which are usually installed on the roof of buildings creating aesthetic problems to the general figure of the building and are replaced by the building integrated ones.

Initially, a literature review is undertaken which includes other similar applications and a report on the historical evolution of solar energy. An introduction to the theory of solar energy and of solar thermal collectors is also carried out. Subsequently, the ideas concerning the integration of solar thermal collectors on the building envelope are presented. After the selection of the best idea, the flat plate collector is designed including a listing of all its characteristics. The technology of structural materials is then presented. The properties of the structural materials and more analytically those of insulating materials, which are very important in their use and strength for this specific application, are presented. Consequently, the estimation of the U-value is carried out for various types of walls and roof constructions. Subsequently, the thermal analysis of the flat plate collector with all necessary equations used for the performance evaluation of the collector as well as the other important parameters of the system are presented in detail. This is followed by the simulation of the solar thermal system and the basic steps followed for the construction of the experimental unit for a thermosiphonic hot water system are presented. Subsequently, a study of the solar irradiance is carried out by using “TRNSYS” software. Particularly, the deviation for various orientations of the solar collector is presented graphically. This is important in view of the fact the collector is installed vertically, which is not the best orientation. The experimental procedure to

record the various temperatures and the values of the solar radiation falling on the collector surface is presented. Based on these measurements the system performance was estimated (55%) as well as the inlet water temperature and useful energy collected. Furthermore, a second experiment was carried out under stagnation conditions for the measurement of the maximum temperatures the system attains which may create fire issues. It was proved that this is not the case as the temperatures were lower than $100^{o}C$. Finally, the conclusions obtained from this work are reported together with a listing of the perspectives of these ideas for future applications and for the correct exploitation of the produced heat.