

ABSTRACT

A Full-Scale Solar timber Dryer with a Slagbed Acting as Roughened Absorber and Heat Storage Media

Ricardo Marcus Clarke

Developing countries with a timber resource that can be manufactured into finished products either for local use or export often lack the capital to build high-cost drying kilns. These countries such as those from the Caribbean region are in the tropics where solar radiation and ambient temperatures are high. A full-scale solar timber dryer was designed for use on a commercial basis. The solar kiln has the collector external to the kiln. The collector has a double cover made of specially designed plastic film. This is an air heating type of collector with a non-porous absorber, and a heat storage. The effective collector area is 36 m². The wooden drying chamber has well insulated walls, roof and doors, with a capacity of 5,000 board feet of nominal 1" (2.5 cm) thick wood. The solar kiln was constructed, tested and operated on a full scale. This slag bed collector is unique in which the natural characteristics of the slag rocks produce a roughened absorber surface. The slagbed acts as the heat absorber as well as the heat storage media.

The heat balance system of equations were developed here for the first time for a system such as this. In the thermal analysis this set of equations was the basis for two computer programs which were written, and may be used as design tools for optimising the thermal performance of air heaters with or without a roughened absorber plate. Simulation results clearly indicate that systems with roughened absorbers greatly enhance the thermal performance of the collector. This design with a Reynolds roughness number, $e^+ = 0.1$,

I would like to express my gratitude to the persons who produced a 280% increase in the heat transfer coefficient relative to a smooth absorber although, there is only a 5% increase in friction factor.

One type of hardwood, teak, was dried using this solar kiln. Results of drying runs show that the system runs efficiently during the night and over prolonged cloudy periods maintaining kiln temperatures 10-15 °C above ambient temperature. This is facilitated by the slagbed thermal storage unit and the insulated chamber.

Results of drying runs carried out using this design show that hardwoods can be dried to a final moisture content(MC) of 8% in about two to three weeks with minimum defects. Tests carried out clearly indicate that solar kiln drying is twice as fast as natural (air) drying and that the drying time is comparable to conventional kiln drying using electrical heating. The final MC obtained with our solar kiln is as low as that obtained electrical kilns, and lower than that achieved by air drying. The fast drying times obtained using this solar kiln is similar to that of those kilns using electrical heating which take about two weeks.

A special thanks to Mr. Renaldo Jugochan for his support and assistance in the preparation of this thesis.

Many thanks to my family and friends who have offered their prayers for me. Finally, sincere thanks to my wife, Parbati and my son, Stefan for their support, patience and encouragement throughout this project.