EXECUTIVE SUMMARY

Supply of pure drinking water is a major problem in rural and coastal areas of developing countries. Purification of water is carried out by various techniques. Desalination of seawater is a proven technology for producing drinking water. In desalination, impure water is heated, converted into steam and then is condensed using a condenser. In solar desalination systems, heating of sea water is done by solar energy and condensation of steam is achieved by using a suitable heat exchanger or a condenser. Commercial solar desalination systems are used worldwide but these systems use conventional energy sources such as electricity to run the system. A small desalination system for a family in rural areas is not yet easily and commercially available. The aim of this study has been to design a solar desalination system for a rural family which does not use any conventional energy source for heating of water and condensation of steam.

In this work, a parabolic concentrator is used as a heating source. Solar energy is focused by the concentrator on an absorber which contains salt water. Water gets heated and converted to steam. The steam is then condensed by the condenser to get purified water. Conversion of water to steam depends largely on solar intensity available at a location. Different reflective materials were tested for finding a cost effective reflective material. The size of the concentrator was decided as per the water requirement of a family. Factors such as solar radiations, reflectivity of material and efficiency of concentrators were considered for designing the parabolic concentrator.

Using experimental analysis and a ray tracing software, Tonatiuh, area at the focal region and optimum time for tracking were worked out. Transient thermal analysis was performed using ANSYS to determine the effect of shift of focal area on the temperature distribution of the absorber. The effect of height of absorber on the quality of condensate water was studied by testing purified water samples in water testing laboratory. The material of the absorber was selected on the basis of capacity to withstand temperature and scale formation. The absorber of the desired size was then fabricated and a black coating was provided on the surface for absorption of maximum solar radiations.

Steam generated from the absorber was then condensed in a condenser to obtain distilled water. Condenser is a water tank in which steam generated at the absorber flows through copper pipes. Mass of water and area of pipe required for the condenser were calculated using theoretical analysis. Selection of diameter, length and shape of the tube was done with the help of CFD analysis. Experimental analysis was performed on the designed condenser. Heat losses were analyzed using a theoretical analysis. The optimum size of the tank was then estimated and CFD analysis performed for the revised value of heat input. Finally, a new tank of smaller dimensions was fabricated and
subsequent experimentation performed using it.

The designed system was then tested at different times and for different quantities of water. It was found that the system effectively evaporates seven to ten liters of water and condenses steam into water which can be used for drinking purpose. Testing was done on impure water collected from Alibag beach and Khadkvasla lake from Maharashtra, India. Purified water obtained from the designed system was tested in the water testing laboratory. The results obtained from the laboratory show that purified water is suitable for drinking with negligible impurities in it. Payback period of the system was calculated and found to be just 2.7 years.

A mathematical model was developed to predict the amount of water to be evaporated depending upon the intensity of solar radiations, size and material of the concentrator and absorber. Experiments were performed with the system on different days and times to measure the rate of evaporation by varying these parameters. These results were utilised to develop a mathematical model which predicts the time of evaporation of the impure water. The model was validated with experimental results obtained for different months and found to be 93 percent accurate.