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Simulation of Solar Assisted Absorption Cooling and Electricity Generation along with Thermal Storage

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Abstract : Availability of a wide variety of renewable resources, such as large reserves of hydro, biomass, solar and wind in Canada provides significant potential to improve the sustainability of energy uses. As buildings represent a considerable portion of energy use in Canada, application of distributed solar energy systems for heating and cooling may increase the amount of renewable energy use. Parabolic solar trough systems have seen limited deployments in cold northern climates as they are more suitable for electricity production in southern latitudes. Heat production by concentrating solar rays using parabolic troughs can overcome the poor efficiencies of flat panels and evacuated tubes in cold climates. A numerical dynamic model is developed to simulate an installed parabolic solar trough facility in Winnipeg. The results of the numerical model are validated using the experimental data obtained from this system. The model is developed in Simulink and will be utilized to simulate a tri-generation system for heating, cooling and electricity generation in remote northern communities. The main objective of this simulation is to obtain operational data of solar troughs in cold climates as this is lacking in the literature. In this paper, the validated Simulink model is applied to simulate a solar assisted absorption cooling system along with electricity generation using organic Rankine cycle (ORC) and thermal storage. A control strategy is employed to distribute the heated oil from solar collectors among the above three systems considering the temperature requirements. This modeling provides dynamic performance results using real time minutely meteorological data which are collected at the same location the solar system is installed. This is a big step ahead of the current models by accurately calculating the available solar energy at each time step considering the solar radiation fluctuations due to passing clouds. The solar absorption cooling is modeled to use the generated heat from the solar trough system and provide cooling in summer for a greenhouse which is located next to the solar field. A natural gas water heater provides the required excess heat for the absorption cooling at low or no solar radiation periods. The results of the simulation are presented for a summer month in Winnipeg which includes the amount of generated electric power from ORC and contribution of solar energy in the cooling load provision

Keywords : absorption cooling, parabolic solar trough, remote community, validated model
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