Investigation of Technical Feasibility of a Solar Hot Air Generator

ABSTRACT

Hot air at low temperature is required by different industries as a process heat for drying and processing of various products. Till date, fossil fuel is the prime source of energy to generate hot air for these applications, but shrinking oil reserves and growing environmental concerns have compelled to search for renewable sources of energy. Therefore, renewable energy sources such as solar energy (thermal mode) could be an attractive option to replacement of conventional fuels in such industries. Success of such application is site specific. Therefore, site specific investigation is required. The North Bank Plain Zone (NBPZ) is one of the six agro-climatic zones in Assam, India. Except tea processing and some other industrial units, extensive industrialization is not seen in this zone. However, considering the resources available in this NBPZ region, prospect of industrial growth could be anticipated in near future. The supply of sustainable energy would be key issue under such prospective scenario and renewable energy could be a solution. Being situated in the tropical region, the zone receives abundant solar radiation throughout the year which could be harnessed, particularly for solar thermal energy generation for various industrial purposes. However, temporal assessment and development of technology will be required to make such plan successful. Keeping in view of this, the present study is conducted to investigate prospect of utilization of solar energy for process heat in this zone. This investigation is carried out by collecting data from Automatic Weather Station (AWS) installed in Tezpur University and long term data available at NASA website (National Aeronautics and Space Administration). An attempt has been made to develop a laboratory scale solar hot air generator (HAG) to harness solar thermal energy. The performance of HAG has been investigated experimentally. Experimental works were conducted at varying radiation level,

mass flow rate, geometries of corrugation of absorber plate (longitudinal and transverse), mode of air flow (single or double pass) and glazing cover (single or double) under the meteorological conditions of Tezpur in Assam, India to access their thermo hydraulic efficiency. In an attempt to validate the experimental results, a theoretical model also has been developed for the performance of HAG that dynamically predicts the outlet temperature of air. Corresponding to maximum radiation (866 Wm^{-2}) the HAG generates hot air at 62^0C at a mass flow rate of 0.03 kg s^{-1} which is equivalent to o.807 kW of thermal output. The instantaneous efficiency was the highest (30.88%) with longitudinal corrugation with double cover and double passes corresponding to solar radiation 866 Wm^{-2}.

Key words: Solar Thermal Energy, Hot Air Generator, Longitudinal Corrugation, Transverse corrugation, Thermo Hydraulic Efficiency, Theoretical Model