

Research Paper :

Design and development of producer gas operated heat exchanger

C.B. KHOBRADE, S. JAIN, N.L. PANWAR AND S.H. SENGAR

Accepted : November, 2009

ABSTRACT

Hot water is used in many industries where the hot water is used as a working fluid such as yarn bleaching, jetropa boiling, small agro processing industries, dairy industries and for community cooking purpose etc. Looking to this heat exchanger, operated on wood fired natural draft gasifier was designed and developed for hot water generation at the Department of Renewable Energy sources, College of Technology and Engineering, Udaipur. The system was designed to produce 180 litre of hot water per batch for thermal application. The temperature of water reached from 27 to 97.9°C within a period of 80 minute. The exhaust temperature ranged from 81.7 to 113°C. The flame temperature was measured between 312 to 532°C. The average efficiency of the heat exchanger system worked out to around 25.65 per cent for single trial in a day and 35.56 per cent for four batches in a day. The design of heat exchanger and system description are presented in this paper. In the economic consideration, benefit cost ratio, pay back period were found as 1.92 and 7.5 months, respectively.

See end of the article for authors' affiliations

Correspondence to:

S.H. SENGAR

Department of Electrical and Other Energy Sources, College of Agriculture Engineering and Technology, Dapoli, RATNAGIRI (M.S.) INDIA

Key words : Natural draft gasifier, Heat exchanger, Thermal application

Energy is a key input for technological, industrial, social and economical development of a nation. However, a large number of consumers in domestic, agricultural, commercial and industrial sectors are faced with a situation of energy availability that is characterized by inadequate quantity, poor quality, un-affordability, un-sustainability and negative environmental consequences. The challenge for the country is ensuring affordable- clean energy for all in a sustainable manner.

Rapid industrialization in India has resulted in an ever-increasing demand for process heat and steam. Most of these industries are in the metallurgical and food processing sectors and have to use petro-fuels like furnace oil, light diesel oil (LDO) or diesel to meet their energy demands. However, due to uncertain supplies and high cost of these fuels, there is an urgent need for other sources of energy.

A heat exchanger is a device that is used to transfer heat between two or more fluids that are at different temperatures. Heat exchanger is an essential element in a wide range of system. The most commonly used type of heat exchanger is the shell and tube type heat exchanger applicable for a wide range of operating temperatures and pressures. One fluid flows through the tubes and second fluid flows within the space between the tubes.

The shell and tube type heat exchanger was designed for hot water generation. Hot water is used as a working fluid in many industries for different processes such as

yarn bleaching, jetropa boiling, rose boiling, etc. and for small scale industries like agro processing industries, dairy industries. It can be used in hostels, hospital and big hotels, institutions and for community cooking etc.

METHODOLOGY

The designed heat exchanger was fabricated at workshop and tested in the month of June-July 2007 at the Department of Renewable Energy Sources, College of Technology and Engineering, Udaipur. The location of the area is 24° 38' N – latitude, 73° 44' E – longitude and at an altitude of 582.5 m above mean sea level.

Design of heat exchanger system for hot water generation:

The heat exchanger was designed for hot water generation. This heat exchanger operated on natural draft gasifier.

The system was designed to generate hot water with following assumptions:

Design data:

- Operating pressure (P) = 1 atmospheric
- Temperature gradient (Δt) = 70°C
- Specific heat of water (C_p) = 1 kcal kg⁻¹ °C⁻¹
- Capacity of water = 180 litre per batch

The heat exchanger designed for 180 litre of hot water.