Applied Thermal Engineering 48 (2012) 359–366

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng

Comparative efficiency assessment of novel multi-flash integrated geothermal systems for power and hydrogen production

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HIGHLIGHTS

- ► Energy and exergy analysis of novel multi-flash integrated systems.
- ► Comparative study of energy and exergy efficiencies of integrated systems.
- ► Comparison of three different efficiency definitions.

ARTICLE INFO

Article history:
Received 2 February 2012
Accepted 18 April 2012
Available online 27 April 2012

Keywords:
Geothermal
Multi-flash system
Hydrogen
Electrolyzer
Exergy
Energy
Efficiency

ABSTRACT

This paper focuses on a comparative assessment of multi-flash (single to quintuple) geothermal power generating systems integrated with electrolyzers through three definitions of energy and exergy efficiencies. The Operating parameters such as ambient temperature and geothermal source temperature are varied to investigate their effects on the respective efficiencies of individual and integrated systems. The effect of increasing the number of flashing steps on the efficiencies is also studied. The results show that second and third definitions of efficiency provide with same trends, whereas the first definition provides a completely opposite trend. It is also noticed that a rise in ambient temperature and geothermal source temperature results in higher energy and exergy efficiencies and that the quintuple flash system is found to be the most efficient for practical applications. For a base condition, it is observed that overall system exergy efficiency varies from 6.52% to 47.29% with increase in the number of flash from single flash to quintuple flash.

1. Introduction

Extensive use of fossil fuels either for power generation or for heating or cooling purposes has various local and global environmental problems, including a drastic increase in greenhouse gas emissions. Fossil fuels are said to be main culprit as they reject CO_2, NOx, SOx etc. to the environment. In order to reduce the dependency on fossil fuels, researchers have been trying to come up with alternative energy options, particularly with renewables. Geothermal option is one of such alternative energy source which can help us reduce our dependency on fossil fuels. Apart from finding alternative energy source, researchers have also started studying multigenerational systems as they come with the benefit of enhanced efficiency [1].

Geothermal is the source of energy which lies under the Earth's crust and is readily available to human kind either for direct use (heating or cooling) or for power generation purposes [2–4]. Geothermal energy is considered to be a clean source of energy as it is extracted from Earth's crust and when used has no emission of greenhouse gasses [5]. The use of geothermal energy is highly dependant on the temperature of the source. Geothermal source temperatures are divided into three categories which are high temperature source, moderate temperature source, and low temperature source [6]. High temperature geothermal sources are best suited for power generation using flash systems [7], moderated temperature sources can be utilized to produce power using Organic Rankine cycles or can be used to provide heating or cooling using absorption technology, and low temperature sources are best suited for direct use such as heating. There are three different types of power plants which are usually used to generate power using geothermal source. These three power plants are dry steam power plant, flash/binary power plant, and flash-system power plant [8]. Studies conducted by [9,10] for comparison of multi-flash systems

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doi:10.1016/j.applthermaleng.2012.04.039