A comparative study on the GAX based absorption refrigeration systems: SGAX, GAXH and GAX-E

Ali Saberi Mehr a, Mortaza Yari b,*, S.M.S. Mahmoudi a, Amir Soroureddin a

aFaculty of Mechanical Engineering, University of Tabriz, Iran
bDepartment of Mechanical Engineering, Faculty of Engineering, University of Mohaghegh Ardabili, Ardabil 1779, Iran

A R T I C L E   I N F O

Article history:
Received 30 September 2011
Accepted 20 March 2012
Available online 28 March 2012

Keywords:
Ejector
GAX cycles
Ammonia–water absorption refrigeration
Exergy
COP
Second law efficiency

A B S T R A C T

In this paper, two GAX-ejector absorption refrigeration cycles are proposed and investigated thermodynamically. In the first cycle (GAX-E Model A), the ejector draws vapor from the evaporator and raises the absorber pressure. In the second combined cycle (GAX-E Model B), the ejector is used to raise the condenser pressure. The performances of these two cycles are compared with those of the standard GAX (SGAX) cycle and two different arrangements of the hybrid GAX (GAXH Model A and GAXH Model B) cycles at the same working conditions. The comparison is performed through parametric studies in which the effects of generator and evaporator temperatures as well as the degassing range on the first and second law efficiencies are investigated. It is found that the COP of GAX-E Model B cycle is higher than that of the SGAX cycle by up to 16.7%. The maximum second law efficiency for the GAX-E Model B cycle is only slightly lower than the highest efficiency value which is obtained for the GAXH Model B cycle. As there is no compressor in the GAX-E Model B cycle, this cycle can be recommended for refrigeration purposes from the viewpoint of thermo-economics.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Nowadays, using renewable energy sources such as solar energy, geothermal energy and waste heat have been paid more attention as they are eco-friendly. Recently, these low-grade energy sources are utilized in vapor absorption refrigerant systems (VARS) and ejector refrigerant systems (ERS) for refrigeration and air conditioning purposes. These two systems use natural refrigerants such as water or ammonia which are environmental friendly and have almost no impact on global warming [1,2].

In the conventional absorption refrigeration cycles the solution temperature varies considerably along the absorber, so that the absorption heat is rejected at various temperatures. In order to make efficient use of this waste heat, the absorber is divided into two sections: the lower temperature section of the absorber rejects heat to the surroundings as usual, whereas, the heat rejected at higher temperature part of the absorber (high quality energy) is utilized to preheat the strong solution entering the generator. Such a configuration of absorption refrigeration cycle is called the GAX cycle which was first proposed by Altenkirch and Tenckhoff in the beginning of last century [3]. Several studies in the literature on the simple GAX systems indicate that the performance of GAX cycle is around 20–30% higher than that of conventional absorption systems for the same operating condition. These GAX systems can be used for air conditioning and for chilled water as well as hot water production. They operate at a generator temperature range of 140–190 °C which could be achieved by using solar energy, biomass and waste heat from micro turbines, gas turbines and industrial flue gases [4].

Garmella et al. [5] studied the performance of a GAX system in both heating and cooling modes over a wide range of ambient temperatures. The COP of system was reported 0.925 and 1.51, at ambient temperatures of 35 and 8 °C, (at cooling and heating modes), respectively. Ng et al. [6] investigated experimentally a gas-fired ammonia–water absorption GAX cycle with a cooling capacity of 2 TR. They found a COP value of about 0.8 at the specified operating condition. A comparison between the performances of an ammonia–water GAX and the single effect systems, for panel heating applications, is performed by Kang and Kashiwagi [7]. They focused on the effect of UA ratio on the total COP of the two systems. Herold et al. [8] proposed a GAX cycle with a higher solution flow rate in the high temperature end of the absorber. They called this configuration the branched GAX cycle and reported an enhancement of 20% in the COP compared to that of the conventional GAX cycle. Kang et al. [9] carried out a parametric study on